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Project B-039-IDA

RELATIONSHIP OF COSTS AND WATER USE EFFICIENCY FOR IRRIGATION PROJECTS IN IDAHO

by

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ABSTRACT

Seventeen representative irrigation projects located between Payette and St. Anthony, Idaho were selected for study. These cooperating districts obtain their water from the Snake River and its tributaries. They range in size from 2400 to 150,000 acres and employ a wide range of management and water pricing policies, as well as methods of water diversion and distribution.

Information on project administration, operation and maintenance costs were gathered for years 1974, 1975, and 1976, and water diversions, deliveries and losses were measured or estimated for the 1977 irrigation season. These data were analyzed using procedures which expressed water costs and water used efficiencies uniformly for all projects studied. Highly significant relationships existed between selected O & M cost to water use data and physical characteristics of project systems.

Characteristics of conveyance, application and diversion systems varied considerably among projects. Annual project operating costs, including costs for electrical power, ranged from $1.85 to $61.40 per acre and irrigation efficiencies ranged from 12 percent to 59 percent for the 1977 season. Project diversions ranged for 2.6 to 12.6 acre feet per acre.

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CONCLUSIONS AND RECOMMENDATIONS

This research project was initiated to assimilate and analyze characteristics and operating costs for irrigation water delivery organizations in Idaho. Specific research objectives were:

1. To obtain water cost information for a wide range of irrigation projects diverting water from the Snake River and its tributaries.
2. To obtain measurements of irrigation project water-use and irrigation efficiencies.
3. To study relationships between water-use efficiencies and costs to define factors that will provide improved water management.

Operation, maintenance and power costs were collected for the years 1974, 1975 and 1976 for seventeen irrigation projects in Idaho. Most cost information was obtained from annual reports and audits released by irrigation project accountants. Costs were broken down into categories common to all organizations to facilitate comparison and development of relationships among costs and water-use parameters. Major cost categories included administrative, water control, maintenance costs and costs for power and water storage. Personnel costs and vehicle maintenance materials costs were also evaluated. Costs were expressed as dollars per irrigated acre, system mile and system user. All costs were adjusted to 1977 price levels using U.S. Bureau of Reclamation O & M indices. Costs collected for multiple years were indexed and averaged into a single value. A list of irrigation projects cooperating in the study is included in Table 5 of Chapter IV.

Project water usage was evaluated for the 1977 season only.

Information and data such as system diversions and farm deliveries were, in most cases, measured by irrigation project personnel, and diversions of projects are also measured by the U.S. Geological Survey. Canal seepage losses were estimated using canal measurements and information pertaining to soil characteristics. Irrigation requirements of project crops were calculated using a combination evapotranspiration equation, crop acreages and average cropping dates. Surface runoff losses and return flow from projects were measured and estimated by project and University personnel. Deep percolation losses were estimated using an inflow-outflow accounting procedure of monthly project water use. Two projects experienced water shortages during 1977. However, operating procedures and irrigation efficiencies did not change significantly during that year. All water usage was analyzed for monthly periods on a project-wide basis.

O & M cost information, water usage and efficiencies and project and system characteristics have been presented in tabular form in the report text and in report appendices. A simple-linear correlation analysis was performed on 213 project statistics. Relationships among and between project cost and water use efficiencies were evaluated and are presented and discussed in Chapter VI. These relationships will provide managers, planners and administrators with information concerning causes and effects among costs for irrigation project O & M and water-use efficiencies.

Multiple linear statisfical analyses techniques were used to develop equations which describe project efficiencies and costs. The number of independent variables used in these equations ranged from 2 to 5 variables. Variables for which information is more easily available were used when possible to develop equations. These equations can be used in future studies by irrigation organizations, state agencies and University researchers to estimate various O & M costs of irrigation projects in Idaho and to study relationships between various system characteristics.

Per unit costs for O & M categories varied widely among cooperating projects due to variations in project shapes, soil types, terrain, age and types of water diversion and conveyance. Four of seventeen projects pump all water delivered to project farms. Two of these projects deliver water to irrigators at pressures sufficient for operation of impact-type sprinklers. Groundwater is a major source of water for two projects studied, the A & B and the Wood River Irrigation Districts. Average pumping lifts for the four major pumping projects range from 90 to over 600 feet.

Ages of project systems in 1977 ranged from less than 13 years to over 90 years. Total project operating costs (total system costs) ranged from $1.85 per irrigated acre to $61.30 per irrigated acre. Costs for administration, water control and maintenance only, ranged from $1.80 per irrigated acre to $12.80 per irrigated acre. Project irrigation efficiencies in 1977 ranged from 12 to over 59 percent.

The authors wish to point out that all cost and water use information covered in this report is only approximate. Each irrigation project evaluated used a different method of cost accounting; therefore, some assumptions in grouping of costs and delineation of cost categories were mandatory. Also, many of the water use components listed in the report required some estimating to be made for some projects, particularly for farm deliveries, operational spills, canal seepage and deep percolation losses. An equation calibrated and tested for southern Idaho was used to etimate crop evapotranspiration (ET) rates. However, for projects in areas away from weather data colection sites, inaccuracy of ET estimation is possible due to variation in climatic factors such as wind speed and relative humidity from those factors measured. This error is most probable for the Bell Rapids, King Hill, Cedar Mesa and Salmon River projects where wind speeds and air vapor pressure deficits are generally higher in summer months than at the Kimberly measurement site. Overall, however, water-use data presented in this report is representative of actual use by projects during 1977. New methods of calculating irrigation requirements, deep percolation losses and seepage losses were developed and tested during this study. These methods are discussed in Chapter III.

Conclusions

Specific objectives of this research study were completed; cost information and water-use data were gathered for seventeen irrigation projects in Idaho, and relationships between water-use efficiencies and costs were studied and evaluated. System costs and characteristics related to water-use efficiencies were defined.

Irrigation projects evaluated in this study are diverse and represent most systems in southern Idaho. Cooperating projects encompass a broad range of geopgraphic locations and topographic characteristics. Management and operation practices varied among evaluated projects and variance in the degree of system operation and maintenance was highly significant.

Management personnel of most cooperating projects were concerned with efficient operation of project conveyance systems. However, two major objectives of project management are to use diverted water efficiently and beneficially and to minimize short run and long run costs of operation. These two objectives are often in conflict with one another, and often result in a compromise consisting of moderate water-use efficiencies and moderately low annual operation and maintenance costs.

It is concluded from observations of project operation and data collected from projects studied that water-use efficiencies of all projects can be increased over present efficiencies with a degree of increase dependent on project system types and soil and topographic characteristics. As shown in graphical representations of project water-use included in Appendix E of this report, deep percolation of water from project farms and operational losses of water from project conveyance systems caused by spillage of excess water comprise a large portion of system diversions for most projects studied. Decreases in these two types of water losses could be effected mainly by increases in manpower within the water delivery organization and on project farms. Deep percolation losses could be decreased and project application efficiencies could be increased by increased monitoring of soil moisture levels and crop water requirements and use of irrigation scheduling services. Because most deep percolation was apparantly caused by overapplication of water rather than poor operation or design of application systems, decreases in amounts of water applied per irrigation and frequencies of irrigation could be decreased with relatively small increases in total per acre operating costs. Project conveyance efficiencies of most projects can be increased by better measurement and control of water at farm delivery points and by reduction of canal spills. Increases in water control personnel would be necessary, resulting in higher water control costs. Magnitudes of cost increases would depend on existing water measurement practices and numbers of measuring devices present in project systems. However, no major modification of project or on-farm system designs would be necessary to decrease those water losses.

Increases in project irrigation efficiencies above those attainable using the suggested changes in operation noted above would most likely result in substantial increases in costs to system users. These large cost increases would result from changes in system designs such as lining of canal sections, automation of farm deliveries and system diversions, conversion of gravity application systems to sprinkler systems or improved methods of surface irrigation, and reduction of evaporative and seepage losses from water conveyance and storage systems.

It is concluded by the authors that overall, management personnel of the seventeen projects evaluated are knowledgeable of system needs and water losses and are effective in operating and maintaining project systems with monies generated by annual user assessments. These assessments are relatively low for irrigation projects in Idaho due to high costs and low financial returns present in irrigated farm operations and amounts of expenses farm operators are willing to pay for water diversion and application. In most cases, benefits obtained by more efficient use of diverted water are not considered by project farmers to be of sufficient magnitude to offset costs of achieving those higher water use efficiencies.

Analytical methods for cost and water use evaluation used in this study were adequate for accurate delineation of cost categories and estimation of uses and losses of diverted water within project boundaries. Statistical analyses of collected information emphasize diversities within relationships between operation and maintenance costs and uses of water within individual irrigation projects in Idaho.

Recommendations

Costs for seventeen irrigation projects in Idaho were gathered and evaluated for years 1974, 1975, and 1976. These costs were adjusted to 1977 prices. Collection and evaluation of O & M costs of these same projects for years 1977, 1978 and 1979 and for future years would add significantly to the data base used to develop cost relationships. Also, expansion of the number of cooperating irrigation water delivery organizations in future studies will increase the range of project types over which estimating equations developed would provide reliable estimates.

Measurement and calculation of project water use for years other than 1977 for project studies would provide comparisons of variations in water use between different irrigation seasons and would define actual project water use more accurately. Increased measurement of diversions, farm deliveries and operational spills by project personnel would add greatly to data accuracy and would decrease significantly the task of estimating water use.

Relationships among project costs and water usage are meant to help project management and public administrators to understand concepts of project system operation and behavior. Equations presented which define O & M costs of projects can be used to estimate annual costs of other projects similar to those studied. Accuracy of estimates will be contingent on accuracy of data used in the equations and characteristics of projects evaluated.

to 1972 costs. Collection and evaluation of O&M costs of those same projects for years 1973, 1974, and 1975 and for future years would add significantly to the data base used in deriving cost relationships. Time expansion of the surveys of cooperating irrigation water delivery organizations in future studies would increase the range of project types over which estimating equations could be used and would provide reliable estimates.

Measurement and calculation of actual water use for years other than 1972 and in more studies would provide comparisons of relationships in water use between different irrigation seasons and would give a better [illegible] which use more accurately. Such use measurement of diversions, farm deliveries and operational spills by project personnel would add greatly to data sources, and would increase significantly the ease of estimating water use.

Relationships among project costs and water use, are needed to help project management and public administrators to understand concepts of project system operation and behavior. Equations presented which derive O&M costs of projects can be used to estimate annual costs of other projects similar to those studied. Accuracy of estimates will vary, subject to accuracy of the values in the equations and characteristics of project.

INTRODUCTION

The Idaho Water Resources Research Institute (IWRRI) of the University of Idaho is concerned with planning, allocation, and consumption of Idaho's water resources in manners which will maximize benefits to all citizens of this state. Because Idaho's agricultural base depends in large measure upon irrigation, assistance in planning for effective use of water for irrigation is a major area of interest of the Institute.

Growing competition for Idaho's water resources by industrial, municipal, recreational, and hydroelectrical activities is focusing increased interest upon defining and decreasing nonrecoverable or unused water "losses" by irrigation entities. In addition, increases in energy costs and demands in Idaho dictate more efficient and effective use of pumped or diverted water, with larger volumes remaining in rivers and reservoirs for electrical power generation.

Much of Idaho's water diverted for irrigation is distributed to individual users by irrigation water delivery organizations know as irrigation districts or irrigation companies. These irrigation water delivery organizations, distribute water over large land areas, to beneficially fulfill transpiration and evaporation requirements of actively growing crops and agrcultural soils. However, not all water diverted for irrigation by projects or individuals is used for crop evapotranspiration. Seepage from permeable reservoir and canal systems can enter groundwater systems or may be used consumptively by phreatophytes. Lack of precise measurement or control of water in project systems can result in spillage of water into rivers, surface drains or drainage wells. Water which is delivered to project farms may percolate into local or regional groundwater systems or may leave project farms as return flow.

All delivery organizations incur costs associated with supplying water to project users. These costs are affected by system maintenance schedules and problems, water control and measurement techniques and attentiveness, topographical constraints, means of water diversion, pumping costs, system design, construction repayment and personnel requirements. Evaluation of project operating costs, organization personnel, system characteristics and water usage can provide relationships between various project expenditures, physical parameter and water use. These relationships can be used to provide information for developing improved plans of system management and water conservation for irrigation water delivery organizations and water users, and in estimating operation and maintenance costs under modified operating regimes.

Previous Studies

The University of Idaho, in 1972, completed a four year study of operation and maintenance costs of 29 irrigation organizations in the western United States (Brockway and Reese, 1973). Cost for administration, water control, and maintenance and personnel requirements were determined by examination of project records and interviews with organization managers and staff. Specific function costs such as weed control and measuring device maintenance were presented for both open channel and pipe systems, with all costs adjusted to a 1968 base.

Claiborn (1975) determined irrigation water use efficiencies for six irrigation projects in the Upper Snake River Region of southern Idaho during the 1974 water year. The six irrigation projects were selected as typical of irrigation systems in southern and eastern Idaho. River diversion data, conveyance system seepage loss data, crop distribution, and return flow data were compiled. Deep percolation losses and irrigation efficiencies were derived using an inflow-outflow water balance analysis technique.

Farm efficiencies for the projects in 1974 varied from 11 to 62 percent. Project irrigation efficiencies ranged from 10 to 42 percent. By predicting attainable farm efficiencies of 60 percent, Claiborn projected attainable project irrigation efficiencies to range from 35 to 51 percent. Low farm efficiencies recorded by Claiborn were attributed to over-irrigation caused by long field runs combined with high intake soils. Claiborn determined that lining main canal systems to reduce seepage would not significantly increase project irrigation efficiencies, but that large decreases in river diversions could be obtained by increasing farm irrigation efficiencies.

In 1975 the Idaho Department of Water Resources (IDWR) implemented a survey of 640 farm operators in four survey regions of southern Idaho. The department obtained ratings concerning water use efficiency for selected farm operators from locally-based agricultural agency staff and interviews with personnel from 14 irrigation water delivery organizations serving the area (Kerpelman et al, 1976).

This project by IDWR was considered to be another step in gathering data to be used by the Department in the continuing development of state water-use plans. The final report recommended target groups and possible incentive programs for improved water-use efficiency. IDWR personnel found that many organizations allow farmers free use of water, resulting in continually open headgates and wasted water. Abuse (over-use) of water by individual water users was rarely recorded by most of the surveyed organizations, although responsibility for maintenance of an adequate water supply was principally that of the project management. IDWR personnel observed that individual farmers most often do not have the necessary overview to manage efficiently an entire project's water supply, and concluded that organizations should institute greater control over diversions to decrease on-farm water-use inefficiencies (Kerpelman et al, 1976).

The major perceived problems of the surveyed water organizations were anticipating demand and supplying adequate quantities of water. Demand for water tended to be nonuniform and simultaneous, indicating that delivery of water often cannot be scheduled far in advance because farmers have not (or cannot) assess their irrigation needs far in advance. In addition, farmers often required water at the same time. Efficient delivery and system management, which is often a time-lagged process, was often difficult under these circumstances. Thus, IDWR theorized that water organization improvements and on-farm improvements would serve to compliment one another. Often a substantial problem in increasing water use efficiencies was the inability of organization personnel and water users to identify and assess actual problems in system design, operation and maintenance, although most do have some ideas for system improvement (Kerpelman et al, 1976).

Hammond (1978), in summarizing the IDWR study, suggested that there exist two basic points of view from which to consider the effects of more efficient use of irrigation water. One view is held by those who may benefit from increased water-use efficiency, whereas opposing views are held by those who may be adversely affected by decreased water diversions. These conflicting points of view imply that a broad approach encompassing multiple objectives is necessary in developing a program to promote irrigation water conservation.

Hammond has stated that the irrigator is most responsible for all decisions related to the application of water to the production of crops, and that improving on-farm irrigation management is to a large extent dependent on the amount of initiative and effort expended by the individual. However, Hammond did conclude that water delivery organizations can prove water-use efficiencies through more intensive management practices and technology, and by adopting operating policies which encourage efficient use of water by member farmers.

From the 1975 IDWR survey results, it was found that most farm operators perceive system improvements such as concrete lining of ditches and conversion to sprinkler irrigation as the best means of improving operating efficiency, water conservation, and crop production, whereas only 3 percent of the farm operators surveyed indicated benefits from using some type of professional irrigation scheduling service (Hammond, 1978; Kerpelman et al, 1976).

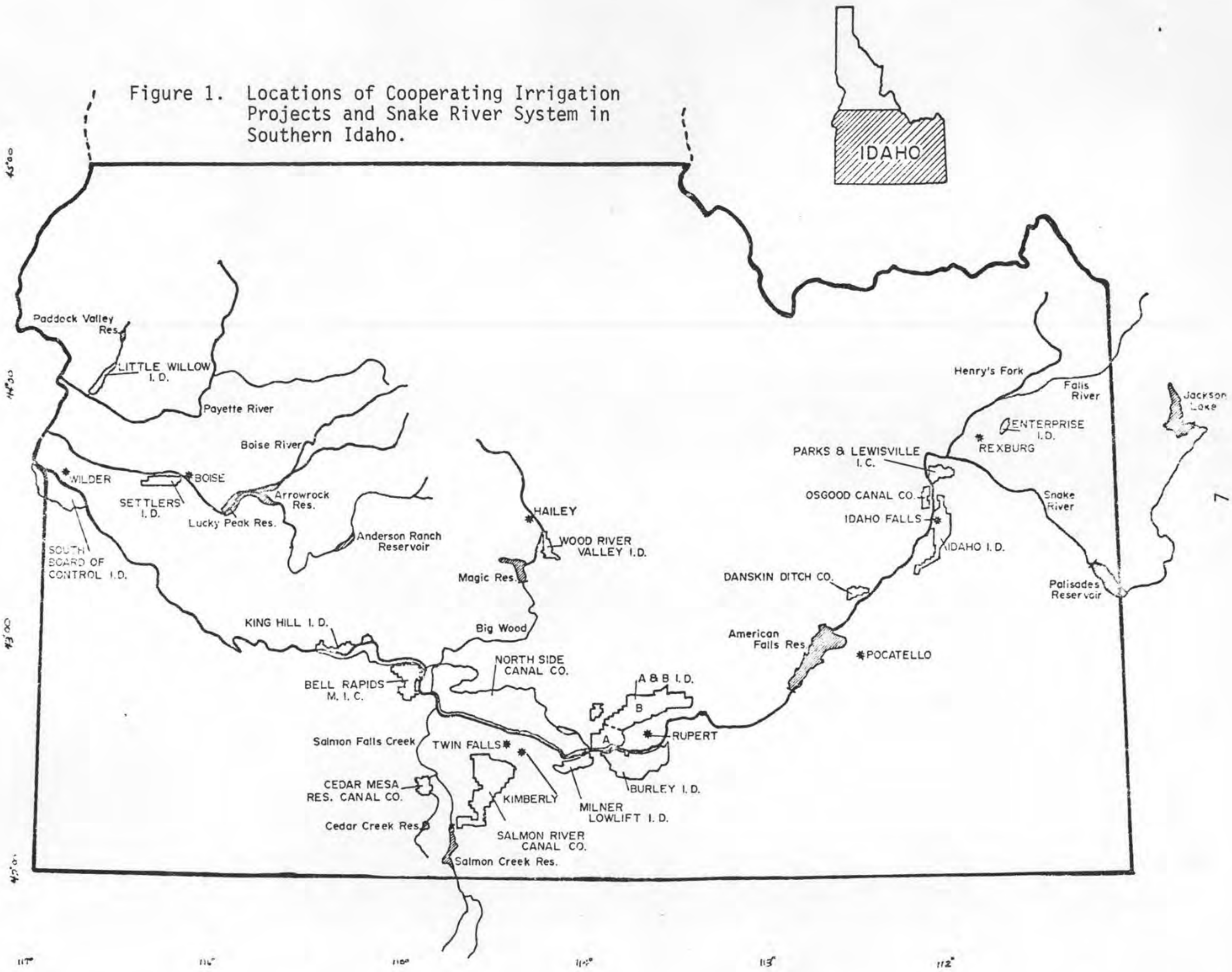
In a study by the Interagency Task Force on Irrigation Efficiencies (1978), the problem of inefficient irrigation in the United States was examined. Recommendations were developed regarding appropriate Federal objectives, policies, agency roles and action programs. Alternative irrigation methods, systems, and farming practices were reviewed and recommendations regarding implementation were established.

Study Objectives

This study was initiated to provide information concerning relationships between operation and maintenance costs, personnel requirements and water usage for irrigation water delivery organizations in southern Idaho. Water usage and efficiencies of seventeen irrigation projects were measured and computed for the 1977 irrigation season. Cost information was gathered for a three year period which included the 1974, 1975 and 1976 irrigation seasons for these same projects. Irrigation projects cooperating in this study include the Enterprise Irrigation District, Parks and Lewisville Irrigation Company, Osgood Canal Company, Idaho Irrigation District, Danskin Ditch Company, Burley Irrigation District, A & B Irrigation District, Milner Low Lift Irrigation District, North Side Canal Company, Wood River Valley Irrigation District, Salmon River Canal Company Cedar Mesa Reservoir and Canal Company, Bell Rapids Mutual Irrigation Company, King Hill Irrigation District, Settlers Irrigation District, Owyhee Project, South Board of Control, and Little Willow Irrigation District. Locations of these projects are indicated in Figure 1.

Although the 1977 water year was considered a drought year in southern Idaho, personnel of the majority of projects studied did not indicate noticeable changes in water use or system managment. Two irrigation projects encompassing land areas served by the Salmon River Canal Company and the Wood River Valley Irrigation District did experience water shortages, necessitating reductions in irrigated areas. However, no significant difference in water-use efficiencies were reported for the 1977 irrigation season (Worstell, 1978) on these two projects.

Figure 1. Locations of Cooperating Irrigation Projects and Snake River System in Southern Idaho.



CHAPTER II

IRRIGATION PROJECT CHARACTERISTICS

Irrigation projects in southern Idaho vary markedly in terms of shape, size, age, and distribution system design and management. However, most Idaho projects do have basic similarities in general layout, purpose of operation, organization, and types of equipment and costs involved in operation.

Physical Description

An irrigation project is composed of an irrigation water delivery organization and project water users or farm operators. The delivery organization operates and maintains project diversion and distribution systems and is responsible for conveyance and delivery of irrigation water to individual farms and turnouts or head gates. Project farms or on-farm systems distribute delivered water over cropped lands using a variety of application systems and methods.

Distribution Systems

Construction of irrigation distribution systems in Idaho began in the 1870's along the Boise and Upper Snake Rivers on land areas covered with dense sagebrush and native grass associations. Initial systems supplied water to lands adjacent to natural streams and supply canals were constructed to minimize excavation since all work was done by men and animals. These early developemnts are small, generally less than 10,000 acres.

Beginning in 1900, larger distribution and conveyance systems with control structures were developed by private organizations and Federal programs to reach lands lying further from water sources. Technological advances in hydraulic and irrigation engineering were used in designing most of these systems; therefore, operational water losses are generally lower and conveyance efficiencies are generally higher than those of earlier systems.

Successful development of electric and engine-driven pumps, deepwell drilling equipment, submersible centrifugal and turbine pumps has in recent years allowed increased access to supplies of surface and groundwater for Federal and private irrigation development purposes. The A & B Irrigation District, Rupert, Idaho, a U.S. Bureau of Reclamation project and the Bell Rapids Mutual Irrigation Company, Hagerman, Idaho are two recent Idaho developments where water is lifted considerable heights from groundwater and surface water sources.

Prior to 1906, the economic survival of irrigators in Southern Idaho was entirely dependent upon heavy spring runoff and sustained summer river flows. In 1906, the Jackson Lake impoundment in Wyoming was created by construction of a log crib dam at its outflow. The log structure was later replaced by a combination earth and concrete dam and the storage capacity was increased. By 1926, the necessity to further regulate natural flows of the Snake River resulted in construction of American Falls Reservoir, designed to store 1,700,000 acre-feet of water. Other storage reservoirs built since that time include Palisades, Island Park, Lake Walcott, and Blackfoot Reservoirs in the Upper Snake River Region, and Anderson Ranch, Arrowrock, and Lucky Peak Reservoirs in the Boise River drainage. Irrigation storage systems constructed along other Snake River tributaries include Salmon Creek, Cedar Creek, Magic, and Paddock Valley Reservoirs in southern Idaho and Owyhee Reservoir in eastern Oregon.

Canal systems in Idaho are predominately unlined channels, although a few projects have lined short sections of canal in areas of highly permeable soils or rock outcroppings to decrease seepage losses. Many projects have also integrated concrete diversion and control structures into the distributive system, as well as concrete chutes and siphons to overcome changes in elevation or terrain. Due to system economics, however, unlined channels remain as the major water conveyance system in the state. No large irrigation systems in Idaho are composed entirely of pipe, although several utilize large pipe networks pressurized by pumps located along main canals.

Farm delivery structures (turnouts) vary from wood, concrete, or steel gravity structures to high pressure valves. Many turnouts have no provision for measuring rates of water delivery, whereas some are equipped with weirs, submerged orifices, rated sections, or meters. In most projects, turnouts are operated and measured by project personnel, referred to as ditchriders in this report. However, in a few systems, turnout regulation is performed by irrigators, although rules and guidelines concerning scheduling and maximum allowable water delivery rates are provided.

The degree and costs of system maintenance varies substantially among water delivery organizations. Large organizations normally perform all maintenance and replacement services. Many smaller projects hire outside labor and services to maintain their distribution networks, while some regulate system maintenance to lateral associations comprised of water users. Projects with extensive delivery systems and those which require relifting or pressurization of diverted water normally have more rigorous and costly maintenance programs and facilities.

Project Farm Systems

At the turn of this century, flood and border irrigation were common methods of irrigation across the state, and in the eastern region of Idaho, these methods still prevail. Furrow methods are now the dominent form of irrigation in the middle and western regions of southern Idaho, although large-scale sprinkler irrigation in some areas has come into use since the late 1940's when lightweight steel and aluminum piping became economically and commercially available.

Depending upon soil type, ground slope, field lengths, crop types, and management practices, border and flood irrigation can be quite efficient. These methods work best on moderately permeable, well-leveled fields with ground slopes less than 1 percent. Field lengths need to be relatively short (less than 800 feet), depending upon soil permeabilities, and management of flow rates and lengths and frequencies of irrigations is crucial to avoid excessive deep percolation and runoff losses. Historically, border and flood irrigation methods in Idaho have required large volumes of irrigation water, contributing significant recharge to local and regional ground water systems in the eastern part of the state (Brockway et. al, 1971; Galinato 1974).

In contrast to flood or border irrigation, furrow irrigation does not wet the entire soil surface. Irrigation is accomplished by running water in small channels (furrows) which convey the water as it moves down or across the slope of a field. Efficient irrigation with furrows depends on the lateral movement of water from the furrows. A variation of the furrow method is the use of small rills or corrugations for irrigating close-spaced crops such as grains, alfalfa, or pasture. The labor requirement for furrow irrigation is greater than for most other methods of surface irrigation. Considerable experience is needed to divide the water in the supply ditch into uniform furrow streams and to maintain flow rates which adequately irrigate the field while keeping runoff and deep percolation at minimal levels. As with border irrigation, water can be applied most efficiently with furrows on fields with uniform slopes, generally less than 2-3 percent. Soil erosion may be a hazard with this method. Furrow irrigation works best on silt loam to loam soils, although properly designed and operated systems can be applied over a large range of soil types (Booher, 1974).

A sprinkler system is a network of tubing or pipes with sprinkler heads or nozzles attached for spraying water over the land surface. Sprinkler irrigation usually functions well over high infiltration rate soils and has in many instances reduced water use and soil erosion on previously surface-irrigated fields by significant amounts. Sprinklers have also allowed irrigated development in areas of steep, undulating terrain, short water supplies, or shallow, sandy soils. Commonly used sprinkler systems in Idaho include hand-move, side roll (wheel-line), solid-set, and center-pivot systems pressurized by electric, natural gas, or diesel-powered pumping plants. When properly matched to soil intake rates and crop water needs, sprinkler systems with high application uniformities can result in high water use efficiencies. However, labor requirements of the non-automated systems can be high, and energy required to furnish high pressured water to operated sprinkler systems can be costly. Advances in low pressure sprinkler technology and automation may significantly reduce these costs and requirements.

System Operation

A majority of irrigation organizations in Idaho deliver water based on a continuous flow principle, where delivery is provided at a constant rate. Normally a 24-48 hour notice is required by project personnel before an increase or decrease in the farm delivery rate can be obtained. Thus, to avoid excessive water spillage, irrigators need to direct a constant head of water about their farm and plan, well in advance, the future water needs of their crops. This delivery method may result in water spillage while changes in irrigation sets are made or while sprinkler lines are moved, and does induce use of 12 or 24 hour set times, often resulting in over-irrigation and deep percolation and nutrient losses. The use of continuous delivery does, however, lend itself to simplified operation of the water delivery system and most often insures all users of adequate delivery rates.

A few older systems in eastern Idaho operate under the principle of demand, where the irrigator opens and closes farm turnouts to suit his irrigation needs. This method works quite well where an abundant supply of water is available to, and in, the distribution system. Operational spills along, and at the end, of the system often occur, however, when a portion of the water-users terminate irrigation simultaneously. Conversely, short term shortages may result during certain periods of high water use.

In systems where portions of a delivery organization's maintenance and water control duties are relegated to lateral associations, users along each lateral may share the water on a rotation basis. This principal works quite well on laterals having few users and good cooperation and communication systems.

In some irrigation projects where water is delivered to farms under pressure conducive to sprinkler operation, continuous flows of water are supplied to mainlines, while irrigators operate farm laterals according to demand. Guidelines are often provided to farm operators defining the maximum number of laterals or risers allowed to operate simultaneously on each farm unit. Experience by organization personnel is required in operation of project pumping systems to furnish desired flow rates and operating pressures during the irrigation season. Often, however, to satisfy forseen system demands, project pumps are operated at inefficient pumping rates or heads due to inflexibilities in pumping plant design, especially during early and late periods of the irrigation season and during common times of irrigation set changes (i.e., 8:00 a.m., 4:00 p.m.)

With the advent of citizen-band radios and other advances in communication and transportation equipment, increased flexibility and troubleshooting of system problems has enabled better system management and increased conveyance efficiencies.

Organization of Project Water Users

The two major types of water delivery organizations operating in Idaho are irrigation districts and mutual irrigation companies. These two organizations are similar in function and purpose, in that each is established to divert and deliver irrigation water to multiple water users and farms. Basic differences between mutual irrigation companies and irrigation districts are in their organizational structure.

The mutual irrigation company or water company, is a voluntary organization of landowners formed for the purpose of supplying irrigation water, at cost, to lands of company members who own its stock. The mutual company is a non-profit corporation that derives its operating funds from assessments levied against the shareholders. Companies in Idaho are organized under the state's general incorporation laws, although additional provisions exist which place restrictions on their formation and regulate company relations with their stockholders. The most common apportionment of stock among company shareholders is to issue one share of stock for each acre of land to be irrigated. The irrigator is entitled to such proportion of water available to the company as his land or stock bears to the total. However, in some instances, shares of stock entitle the holder to a specific quantity of water or to a specific fraction of water available to the company, regardless of the acreage irrigated. An example of this instance is the Salmon River Canal Company in Hollister, Idaho.

Irrigation districts are defined in this report as public or "quasi-municipal corporations" organized under Idaho laws for the purpose of providing a water supply for the irrigation of lands embraced within its boundaries. Irrigation districts are empowered by the state to issue bonds and derive revenue primarily from assessments levied upon the land within the district. Districts in Idaho have public character as a political subdivision of the state, with defined geographical boundaries. As quasi-public divisions, irrigation districts are created under legislative authority through public agencies with the consent of a specified portion of resident landowners or water users. Districts in Idaho have an established taxing power with assessments able to serve as liens against district land. Districts are also able to generate revenue by charging users for water use and, in some cases, sale or rental of water or power outside the district.

In summary mutual irrigation companies in Idaho are private and voluntary, whereas irrigation districts are public and involuntary and must follow definite procedures laid down by state and Federal statutes. Finanacial arrangements of mutual companies rest on its capital stock and do not involve the land of the owners, while financial arrangements of districts rest directly upon the land to which the water right is usually firmly attached. Companies may often exercise certain discretionary tolerances in pressing collection of assessments due, whereas districts must require prompt payment of all user assessments. Management of company affairs is under direct control of water users and consequently more removed from local politics than is the case with irrigation districts, which are largely controlled by state laws enacted by elected legislators.

In general, irrigation companies and districts in Idaho follow similar management policies concerning operation and delivery of diverted water. In this report the terms "water delivery organization" and "irrigation project" refer to both mutual irrigation companies and to irrigation districts. Seven mutual irrigation companies and ten irrigation districts have been evaluated and reported as a part of this study.

Operation and Maintenance Services

Irrigation districts and companies were formed and are operated to serve the water users or shareholders in the most feasible manner possible. Numerous philosophies and management policies exist among organizations in Idaho regarding user services. Each is considered the most effective and economical for its particular area and system.

Personnel

All water delivery organizations require some form of management to insure proper regulation of water delivery, system maintenance, and financial affairs. This regulation most often entails the employment of office staff to perform overall management, secretarial, and clerical functions, water control personnel to oversee conveyance and delivery of diverted water, and maintenance personnel to maintain, construct, or replace system components. Small projects (less than 5000 acres) often require only one or two people to operate the system by combining various work functions. Larger irrigation projects or more elaborate systems involving pumping plants or long supply networks may employ numerous people to perform one task of system operation.

The board of directors along with office staff and manager comprise the administrative section of the irrigation water delivery organization. Project managers supervise all system operations and project business matters, and act as liasons between boards of directors and organization personnel and water users. The manager is in charge of directing daily project activities and resolving problems in system operation.

A board of directors sets company policy and assessments and provides advisory support to project management regarding long-term management direction, hiring of personnel, and system maintenance programs. Directors often are water users or shareholders and recieve no salary for their services, although travel expenses are often provided. Office personnel may include secretaries, treasurers, accountants, hydrographers or engineers, who perform daily administrative business and handle financial affairs of the organization.

Water control personnel include project watermasters, ditchriders, and pumping plant operators. A watermaster functions as an overseer of water delivery operations and serves as supervisor to ditchriders who perform actual farm delivery of irrigation water and any system water measurement. The position of watermaster is often absent on projects less than 30,000 acres.

Size of irrigation project maintenance crews in Idaho range from 0 to several hundred employees, depending on system size, age, and design. Ditchriders often serve on a maintenance crew during off-season months.

Equipment

Most large organizations maintain large fleets of trucks and heavy equipment for water control and maintenance operation, whereas smaller irrigation organizations may rely on hiring outside labor and equipment for maintenance programs. Often, ditchriders furnish privately-owned vehicles for transportation and are reimbursed for mileage.

Age of equipment varies among irrigation projects. Some vehicle and equipment fleets are regularly replaced with modern components, while some organizations operate equipment purchased 50 years ago. Irrigation organizations which pump significant amounts of water often operate large, well-equipped shops for pump repair and rehabilitation.

Materials

Large irrigation water delivery organizations undertake much of the construction and replacement of component parts of the project using organization personnel and materials. Construction activities may include turnout fabrication and placement, canal lining, ditch digging, or channel straightening. Large amounts of material supplies are used by these activities as well as by regular system maintenance activities such as weed control, pump motor reconstruction, canal cleaning, structure renovation, and vehicle maintenance.

CHAPTER III

Project and System Analysis Techniques

Various methods of collecting and analyzing project data were used to provide for accuarate accounting of project costs and water uses as well as sytem characteristics. Information and data from each project were reduced or rearranged to provide a common format for accurate comparison of project characteristics and functions.

Data Collection

Assimilation of data describing system operation, costs, design, and water use necessitated the use of personal interviews and telephone conversations with organization personnel, attainment of annual financial reports or audits from the organization, review and use of data from previous research studies and state and federal reports, and actual water measurement on some projects. A general information file was completed for each project with assistance from project employees and personnel from the Idaho Department of Water Resources and the United States Bureau of Reclamation. Information in each file included financial records, equipment lists, personnel salaries and work schedules, crop acreages and distributions, system parameters, and material and power uses. Cost information was collected for calendar years 1974 - 1976.

1977 Water Use Analysis

Evaluation of usage of water diverted by irrigation projects requires measurement, estimation, or computation of all major sources, losses, and uses of water within project boundaries. Water-use parameters evaluated included operational losses, return flows, farm runoff losses, deep percolation, crop consumptive use (evapotransipration), seepage losses, effective precipitation, total diversions, and supplemetary inflows to project lands.

Measurements of system diversions and farm deliveries by most projects was available from the United States Geological Survey (USGS, 1977) and project personnel. However, in no cases were direct measurements of system seepage, evapotranspiration, deep percolation, or farm runoff losses available.

Evapotranspiration

Monthly evapotransiration (ET) of water by project crops was estimated using a Penman-type equation and regional climatic weather data along with crop coefficients based on project crop distributions and planting dates.

The ET equation used is a combination equation modified in Idaho by Wright and Jensen (1972) to estimate potential ET from a well-watered reference crop of alfalfa with 20 cm or more of top growth.

The modified combination equation is:

$$E^* = \frac{\Delta}{\Delta+\gamma} \ (Rn - G) + \frac{\gamma}{\Delta+\gamma} \ 7.44 \ (0.75 + 0.9923 \ u) \ (e_z^o - e_z) \qquad (1)$$

where:

E^* = the estimated daily evapotrative flux, watts/m^2

Rn = net radiation (estimated from solar radiation), watts/m^2

G = soil heat flux, watts/m^2

u = average wind speed at 2 meters, meters/second

e_z^o = the mean saturation vapor pressure in mb at maximum and minimum air temperature

e_z = the saturation vapor pressure in mb based on the 0800-hr dew point temperature;

Δ = the slope of the saturation vapor pressure-temperature curve;

γ = the psychrometric constant mb/^{o}C.

The coefficients in the wind term (0.75 + 0.9923 u) were developed using National Weather Service anemometer data recorded at Kimberly, Idaho (Jensen, 1972; Wright and Jensen, 1977).

Potential evapotranspiration (ET_p) of a reference alfalfa crop, in mm of water per day, equals 0.0353 E*. Equation 1 can be used to calculate daily evapotrative flux for daily meteorological data, or to estimate average daily ET_p using mean weekly or monthly values of radiation, windspeed, temperatures, and vapor pressures. Because of missing daily weather information for some stations early and late in the irrigation season, reference ET was computed on a monthly basis using mean monthly weather data collected at 5 sites in southern Idaho shown in Figure 2. Information concerning these sites are listed in Table 1.

Observed solar radiation and wind speed data were available from all sites except Hailey. Radiation and wind speed for the Hailey-Silver Creek area were estimated using Kimberly data and relationships developed by USDA-AR researchers at the Snake River Conservation Research Center, Kimberly, Idaho (Wright and Jensen, 1976). Meteorlogical data for the Rexburg station in April and May of 1977 were estimated using Kimberly radiation data and temperatures recorded at Idaho Falls. Wind speed at the Rexburg site during April and May was estimated from wind speeds recorded at Kimberly and Pocatello using wind seep relationships between the three stations developed during periods of recorded measurements at all stations. Reference ET for October for the Wilder and Rupert stations was estimated using Kimberly ET data.

Evapotranspiration of crops grown in each project studied was computed using crop curves developed at the Kimberly Research facility.

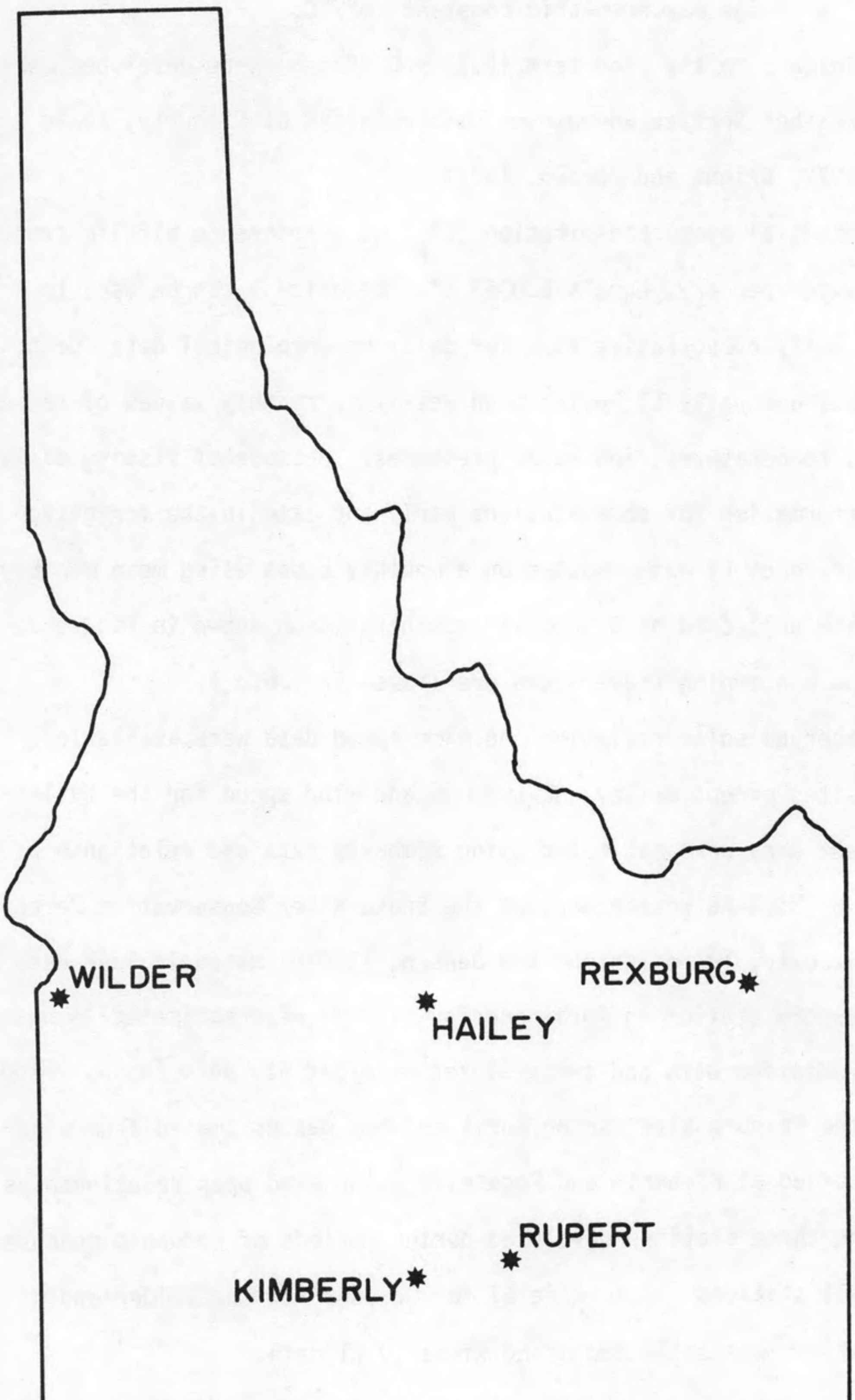


Figure 2. Locations of weather data collection sites which supplied data for evapotranspiration calculations.

Table 1. Collection Sites For Meteorological Data used in Evapotranspiration Estimation, 1977

LOCATION	AGENCY	ELEVATION (FEET)	1977 RECORDED PERIOD	IRRIGATION PROJECTS IN REGION
Rexburg	Rick's College	4871	May 16 - Oct. 31	Enterprise Irr. District Parks & Lewisville Irr. Co. Osgood Canal Co. Idaho Irr. District Danskin Canal Co.
Rupert	USBR	4162	Apr. 13-Sept 20	Burley Irr. District A and B Irr. District
Kimberly	USWSO	3922	Apr. 1-Oct 31	Milner Low Lift Irr. Dist. North Side Canal Co. Salmon River Canal Co. Cedar Mesa Reservoir & Canal Co. Bell Rapids Mutual Irr. Co. King Hill Irr. Dist.
Hailey	USFS	5055	Apr. 1-Oct. 31	Wood River Valley Irr. Dist.
Wilder	USBR	2425	Apr. 8-Sept 21	Settlers Irr. Dist. South Board of Control Owyhee Proj. Little Willow Irr. District

These curves describe crop water use during specific growth stages in relation to evapotranspiration of a reference alfalfa crop (Wright and Jensen, 1977). Use of these curves requires knowledge of crop planting dates or greenup dates for alfalfa, pasture, and winter grains, the date of effective or full cover for each crop, and average dates of harvest. Crop growth stage dates and computed evapotranspiration are listed in Appendix C for irrigation projects evaluated. Crop distribution data and 1977 irrigated acreages were obtained from project personnel and the U.S. Bureau of Reclamation offices in Burley and Boise, Idaho.

Precipitation

Monthly precipitation amounts for the 1977 irrigation season were obtained from the United States Weather Service Organization at Kimberly, Idaho for weather stations across southern Idaho (National Weather Service, 1977). Attempts were made to use precipitation measured at stations in, or adjacent to, each irrigation project evaluated, although in some instances no collection stations exist within short distances of some projects.

Effective precipitation was defined in this study as that precipitation falling upon an actively growing crop. April rainfall was assumed to be zero for fields planted after May 1st, as it was not used to fulfill any crop ET requirements for that particular month. Similarly, rainfall during late season months was recorded only for cropped areas which had not been harvested previous to the date of precipitation.

Changes in Soil Moisture

Most agriculture soils can store significant volumes of water within the root zone of a crop. This form of water storage is required to support corp evapotranspiration and must be replenished by irrigation.

Once a cropped soil is irrigated to field capacity, moisture levels will fluctuate between field capacity and field capacity less evapotranspiration over the course of the irrigation season. However, to properly account for deep percolation losses, soil moisture was assumed to remain constant at field capacity, until shortly before the period of harvest, when soil moisture was depleted by some amount depending upon the particular crop grown. The assumption of continuity of field capacity through the middle part of the growing season seems to be a valid assumption in large land areas and where irrigation of fields is of a random nature.

The fall and winter months of 1976-1977 were characterized by abnormally low amounts of precipitation across the southern portion of Idaho. Amounts and patterns of this precipitation were similar over all irrigation projects evaluated. An estimate of antecedent soil moisture conditions was determined using lysimeter and soil moisture data recorded at the Kimberly research facility from September, 1976 to April, 1977. This data indicated that fall and winter precipitation amounts were balanced by soil evaporation during that time period. Therefore, amounts of soil water depletion for crops at the start of the 1977 irrigation season was set equal to average soil moisture depletions in October, 1976 after crops had been harvested. General crop rotations for irrigated Idaho crops were used to estimate average moisture depletions at the season start for crops listed in Table 2.

Table 2. Estimated Soil Moisture Depletion for Southern Idaho Irrigated Soils, 1976 - 1977.

CROP	%Depletion of available moisture Oct. 31, 1976, 1977	%Depletion of available moisture April 1, 1977	Previous Crop
Alfalfa	40	50	Alfalfa, Peas, Grain
Beans (Dry)	50	55	Beans, Beets, Potatoes, Grain
Corn	60	40	Corn, Beans, Potatoes, Grain
Pasture	40	40	Pasture
Peas	50	50	Beans
Potatoes	30	50	Grain, Alfalfa
Sugar Beets	20	55	Grain, Beans
Spring Grain	70	35	Beans, Potatoes, Beets
Fall Grain	70	50	Grain
Onions	50	40	Onions
Vegetables	40	40	Vegetables
Orchards	40	40	Orchards

Soil moisture depletions of crops in the spring were dependent upon average moisture depletions by crops grown the previous season. Depletions listed in Table 2 were used to calculate changes in soil moisture for all projects. Soil types for projects were obtained from surveys and maps provided by the Soil Conservation Service, i.e., (S.C.S., 1975). Average soil depths and water holding capacties of soils were estimated from these reports.

In most cases it was assumed that soil moisture of project lands for each crop was recharged by irrigations within a 30 day period following the average planting dates, and depletion of moisture was begun 20-30 days before harvest. Preirrigation of fields planted to dry beans was taken into account, and harvesting of sugar beets and potatoes was assumed to occur under relatively moist soil conditions (20-30 percent depletion). Irrigation of fields following harvest of crops was not considered.

Irrigation Requirement

The irrigation requirement of cropped lands was defined in this analysis as that volume of supplementary water required to fulfill evapotranspiration requirements of actively growing, well-watered crops, in excess of effective precipitation and changes in soil moisture. The equation used to compute monthly irrigation requirement is:

$$IR = ET_c - P_e + \Delta S_m \qquad (2)$$

where: IR = Total monthly project irrigation requirement, acre-feet per month

ET_c = Cummulative evapotranspiration requirement of crops, acre-feet per month

P_e = Effective precipitation for actively growing crops, acre-feet per month

ΔS_m = Net monthly change in soil moisture over entire project, acre-feet per month

ΔS_m is positive if the soil moisture reservoir of cropped lands is replenished by irrigation and acquires a negative sign during periods of net soil moisture depletion before harvest. In midseason months, ΔS_m may be comprised of both positive and negative components if, during the same month, some crops (i.e., beans, corn) receive soil moisture replenishment while other cropped areas (i.e., winter grain, peas) undergo soil moisture depletion before harvest. Irrigation water applied to project lands in excess of the irrigation requirement contributed to deep percolation and surface runoff losses.

Distribution System Seepage Losses

Accurate measurement of canal seepage losses for an entire irrigation distribution system is often a difficult and involved operation, due to complexities in measurement of all farm diversions from the system, variation in system flow rates over the period of measurement, and inadequacies in the applicability of current water measurement techniques (Brockway and Worstell, 1970). Seepage rates of many canal systems are also known to vary with flow rate and time of season, necessitating continuous or frequent water measurements to obtain accurate estimates.

In irrigation projects where accurate measurements of all system turnouts and any operational losses are recorded during the season, reasonable estimates of seepage losses can be computed using an inflow-outflow balance. Few projects record all diversions, spills, and farm deliveries, however, necessitating the use of some type of seepage estimation procedure.

A method of estimating system seepage losses based on general soil types, wetted canal area, and system flow rates was described by Claiborn (1974). This procedure was modified for this study by including a time-rate function of seepage in the estimation equation. This modified equation is of the form:

$$S = 0.5\, S_{max} \left(1 + \frac{q_d - q_{min}}{q_{max} - q_{min}}\right) * 2.5\, T^{-0.25} \qquad (3)$$

where:

- S = estimated daily seepage rate, acre-feet/day
- S_{max} = maximum (potential) system seepage rate, acre-feet/day computed using measured wetted canal areas and a seepage coefficient
- q_d = mean system diversion for period evaluated, cfs
- q_{max} = mean system diversion for period of maximum diversions, cfs
- q_{min} = diversion rate, cfs, below which seepage rate remains steady at 0.5 S_{max}. In this study $q_{min} = 0.2q_{max}$
- T = average time, in days after filling of system after season start.

This equation is used with diversion rates greater that q_{min} and less than q_{max}. At rates lower than q_{min}, the $(1 + \frac{q_d - q_d}{q_{max} - q_{min}})$ term should be set equal to 1, which fixes seepage losses at a minimum level, independent of the system diversion rate. Variable T should be limited to periods greater than 40 days, to insure that the $2.5\ T^{-0.25}$ term is less than 1. This time term compensates for reductions in irrigation canal seepage rates caused by sealing of canal bottom substrate by deposited silts and clay particles and decreases in water entering bank storage along the canal system.

Equation 3 was calibrated for use with south Idaho canal systems using seepage measurement data collected by Federal and University researchers at the Snake River Conservation Research Center, Kimberly, Idaho. This equation can be used to estimate canal seepage losses on a daily or monthly basis. In this study seepage was computed for monthly time increments by setting T equal to the average time since filling for the month evaluated, and by substituting the mean monthly diversion rate for q_d in Equation 3. The q_{max} term was used to represent the mean diversion rate for the month during which the maximum monthly volume of water was diverted into the system.

The S_{max} variable in Equation 3 was calculated by multiplying the maximum potential seepage rate coefficient of the canal system, cubic feet per square foot of wetted area per day, by the total wetted area of the open-channel portion of the distribution system, measured in square feet. Seepage rate coefficients for general soil types are discussed by Claiborn (1974). A composite coefficient for projects encompassing multiple soil types can be calculated as a weighted average based on wetted canal areas lying within each soil type. Seepage coefficients used in this study for general soil types ranged from 0.35ft^3/ft^2/day for clays, 0.67 for silty soils, 0.95 for loam soils, and 1.33 ft^3/ft^2/day for soils comprised mainly of sand. Coefficients of other soil types were estimated by averaging between those coefficients listed.

Total wetted canal area of irrigation projects was measured from aerial photos supplied by the Agricultural Stabilization and Conservation Service (ASCS), USDA. A microscope equipped with a calibrated micrometer lens was used to measure top widths of canal sections, and canal length were measured with a map distance meter. Field measurements were used to verify photo measurements and calibration. Actual wetted perimeters of canal sections were computed by multiplying measured top widths by a coefficient describing channel shape (Claiborn, 1974). These coefficients are listed in Table 3.

Table 3. Relationship Between Channel Wetted Perimeters and Measured Top Widths.

Average Channel Top Width (feet)	Wetted Perimeter Coefficient
0 - 12.5	1.30
12.5 - 25.0	1.20
25.0 - 200.0	1.10
- 200.0	1.05

Project Return Flow

Project return flow is defined in this report as the portion of irrigation water leaving a project's boundaries in the form of surface flow. This volume of water is generally comprised of spills from canal systems or surface runoff from on-farm application systems.

Surface flows resulting from springs recharged by distribution system seepage or farm deep percolation losses were not included in this term. Project return flow, as used in this study, does not account for canal spills or surface runoff recycled within project boundaries. Therefore, projects are not penalized for individual farm inefficiencies if resulting runoff is reused by farms at lower elevations.

Few irrigation projects measure return flow or canal spills from the distribution system because of the increased labor and equipment required. This lack of measurement has necessitated the use of various estimation techniques based on project size, shape, and design.

Claiborn (1974) derived coefficients describing biweekly return flows in relation to system diversions for six irrigation projects also evaluated in this study. These 1974 coefficients of return flow (CRF) were used with 1977 project diversions to estimate monthly project return flows from the Enterprise, Idaho, A & B, and Burley Irrigation Districts, Danskin Ditch Company, and the North Side Canal Company projects during the 1977 irrigation season. Estimates of North Side return flows were also adjusted using measurements of various return flow sites taken during 1977.

Return flows from Milner Low Lift, Settlers, and the 'B' portion of A & B Irrigation Districts were measured during 1977 by University of Idaho personnel. Coefficients of return flow computed for sub-drainage areas of these districts were applied over total project areas to estimate total project return flows.

A coefficient of return flow was calculated for Parks and Lewisville Irrigation Company using water use information reported by Brockway and deSonneville (1973) for the 1972 irrigation season. This CRF was used to estimate return flows during 1977. Simularly, monthly 1977 return flows from the South Board of Control were estimated using CRF's calculated from return flow data collected during 1975 and 1976 by project personnel.

Return flow from the Osgood Canal Company system is discharged into waste wells at the system end. Average flow rates discharged into the wells were estimated for the 1977 irrigation season by project management and water control personnel. Flow rates of water in the Little Willow Irrigation System at the lower project boundary was estimated by area users and by measuring the area of land irrigated using Little Willow return flow as a water supply.

Return flow from King Hill Irrigation District, comprised almost entirely of operational wastes and spills, was determined using diversion, farm delivery, and estimated seepage loss information, and performing an inflow-outflow balance.

No significant return flows were reported for 1977 from Wood River Valley Irrigation District, and Salmon River, Cedar Mesa, and Bell Rapids Mutual Irrigation Company lands.

Portions of project return flows originating as farm runoff were determined through interviews with project managers, ditchriders, project farm operators, and University researchers. Runoff was determined for A & B and SBOC projects using recorded operational spills and estimated 1977 project return flows.

<u>Deep Percolation</u>

Deep percolation of water through a soil profile occurs whenever the amount of water applied exceeds the water holding capacity of the crop root zone. In this study deep percolation was assumed to occur whenever monthly farm deliveries exceeded the cummulative project irrigation requirements plus runoff losses. Deep percolation losses were assumed to occur uniformly under all actively growing crops. The equation used to describe deep percolation is:

$$DP = FD - IR - SR \tag{4}$$

where: DP = deep percolation, acre-feet/month

FD = farm deliveries, acre-feet/month

IR = Irrigation requirement, acre-feet/month, as defined by equation (2)

SR = Farm runoff leaving project boundaries, acre-feet/month

Farm deliveries were either obtained from measurements recorded by project ditchriders or were estimated using the equation:

$$FD = TI - S - OL \tag{5}$$

where: TI = total project inflow, acre-feet/month

S = distribution system seepage losses, acre-feet/month

OL = operation spills from distribution system leaving project as return flow, acre-feet/month

Deep percolation losses, as well as seepage losses, were assumed to leave the project through local or regional groundwater systems or as surface water originating from springs.

Water-Use Measurement

Most surface water diverted by irrigation projects in Idaho is measured by personnel of the United States Geological Survey and reported in annual water distribution reports (USGS, 1977). Some projects which pump surface water or projects located on small tributaries often rely upon pump operators or ditchriders to measure or estimate surface diversions.

In projects where pumps are used to supply groundwater to supplement surface diversions, pumping rates are rarely recorded. In these cases, diversions were estimated from power records, total pumping heads, and estimated pump efficiencies, using the equation:

$$Q = \frac{0.99 \text{ kwh } (E)}{h} \qquad (6)$$

where: Q = monthly volume of groundwater pumped, acre-feet

kwh = monthly power use, Kilowatt-hours

E = estimated pump efficiency, decimal

h = total pumping head (average static head + pressure head), feet.

Equation 6 was used to estimate supplementary groundwater diversions for Osgood Canal Company, and Milner Low Lift, Wood River Valley, and Settlers Irrigation Districts during the 1977 irrigation season. Total diversions by Bell Rapids, Cedar Mesa and Little Willow projects were estimated by project management personnel and project ditchriders during the 1977 irrigation season using weirs, flumes, stage recorders, and current meters. Return flow measurements were obtained in the same way, or by using estimation procedures outlined in previous sections of this chapter.

Water-Use Efficiencies

The performance of an irrigation system or activity is often rated using terms developed to indicate relative efficiencies with which irrigation water is applied to a beneficial use such as crop production. System efficiency is often an indication of the adequacy of irrigation system design and management and can be used to describe irrigation operations ranging from individual fields to large river basins. Irrigation efficiency does not necessarily indicate the absolute use or conservation of water. Water "lost" from one operation or project may be recovered and reused by another, thereby increasing over-all efficiency of water use over the larger area (Hammond, 1978; Jensen, 1975, 1976.) In this study three terms, project conveyance efficiency, project application efficiency, and project irrigation efficiency, were used to define the effectiveness of the distribution system, farm systems, and overall project in beneficially using diverted water.

Project conveyance efficiency has been defined as the percent of water supplied to or diverted by a project distribution conveyance system which is delivered to farm turnouts (Jensen, 1967). Project conveyance efficiency, as used in this report, is indicative of the magnitude of seepage, evaporative and operational losses from an open or closed distribution system in proportion to volumes of water conveyed. In equation form, project conveyance efficiency is defined as:

$$E_c = \frac{FD}{TI} \quad (100) \qquad (7)$$

where: E_c = project conveyance efficiency, percent

FD = farm deliveries, volume per unit time period

TI = total system inflow, volume per unit period.

Project application efficiency is used in this report to indicate the portion of farm deliveries used to fulfill the consumptive irrigation requirement of project crops and soils. A high project application efficiency indicates relatively low losses of delivered water to deep percolation and to the runoff portion of return flows, although large volumes of runoff could still occur from individual fields or farms if it is recycled or reused within the system. Large deep percolation losses could also occur from individual fields within a project, although the project application efficiency may indicate relatively low losses on the project level. Project application efficiency is defined as:

$$E_a = \frac{IR}{FD} (100) \quad (8)$$

where: E_a = project application efficiency, percent

IR = irrigation water requirement, defined in equation 2, volume per unit time period

FD = total project farm deliveries, defined in equation 5, volume per unit time period.

Project irrigation efficiency is the percent water diverted by a project used to fulfill consumptive irrigation requirements of irrigated cropland. Project irrigation efficiency has the equation form:

$$E_I = \frac{IR}{TI} (100) \quad (9)$$

where: E_I = project irrigation efficiency, percent

IR = irrigation water requirement, defined in equation 2, volume per unit time period

TI = Total system inflow, volume per unit time period.

Project irrigation efficiency can also be computed as $E_I = (\frac{E_c}{100}) (\frac{E_a}{100}) (100)$.

Project conveyance, application, and irrigation efficiencies were computed for all projects on a monthly basis and for the entire 1977 irrigation season. These efficiencies are listed in Apprendix D and are presented in graphical form in Appendix F.

System Characteristics and Physical Parameters

Physical and operational characteristics of projects were grouped into general categories so that comparisons between projects and relationships among costs and efficiencies could be evaluated.

Project Size

Project land areas irrigated in 1977 were obtained from organization records, 1977 USBR crop reports, and recent University studies. These areas were compared to measurements of 1975 irrigated areas published by the Idaho Department of Water Resources (IDWR, 1978) to verify their accuracy. Assessed acreages of districts were recorded from organization annual reports. Assessed acreages for companies were estimated using the number of company shares and maximum allowed irrigable areas per share.

Crop distributions were obtained from USBR 1977 crop reports for most projects. Distributions for Milner Low Lift, Wood River, Cedar Mesa, Bell Rapids, and Little Willow were determined from estimates by project management and previous research studies. Although the 1977 crop distributions reported are approximations, they are felt to be representative of actual project conditions.

Total project water distribution system lengths recorded and used in parameter analyses include all mainlines and laterals owned, operated and maintained by organization personnel. Underground pipeline mains are also included.

Project perimeters were measured from maps following the general outline of land areas supplied with water. A compactness ratio was then calculated by dividing the project perimeter by the circumference of a circle with an area equivalent to that of the project. The compactness ratio serves as an indication of the proximity of service areas within project boundaries.

Farm and Terrain Information

Project water users, as defined in this report, represent the number of farm operators irrigating total land areas greater than 20 acres in size. City lot users were not included.

Maximum and minimum elevations of irrigable land areas within project boundaries were measured from USGS topographic maps and average land slopes were determined from contour maps and by visual inspection. Slopes were divided into two general classes ranging from 0 - 3% and 3 - 10% slope. General soil types, average depths, and water holding capacities were estimated from SCS soil surveys of counties in southern Idaho. Average farm sizes were determined according to mean areas of land operated by single farm operators or water users.

Project farm application systems were classified into two major groups, namely gravity or surface systems and sprinkler systems. Land areas irrigated with sprinkler systems in 1977 were estimated by project personnel and farm operators.

Distribution System Information

Distribution system type, conveyance channel wetted area, maximum diversion or carrying capacity, and number of turnouts were recorded for each project conveyance system. System types were classified as open channel or pipe, and lengths of concrete lined channel were also delineated. System turnouts reported in this study are those farm turnouts operated or maintained by organization personnel. Turnout structures along user- or association-operated laterals were not included.

Active irrigation production wells operated by delivery organizations were recorded along with pumps operated for surface and groundwater diversion, pipeline pressurization, or as canal relift stations. Individual user-operated wells and pumping systems were not included.

The term ditchrider includes any organization personnel assigned to jobs pertaining to control and delivery of water during the irrigation season. Project watermasters are included as ditchriders, whereas fulltime pumping plant operators are not. Estimates of average daily mileage per ditchrider were obtained from project management.

Projects which have received substantial Federal assistance in initial system construction or post-construction rehabilitation have been classified as 'Federal' projects. Successful Carey Act projects, although constructed on Federal land, are considered to be of private origin insofar as financial backing is concerned.

Information concerning irrigation company and individually-owned water rights was obtained from project records and from the Idaho Department of Water Resources. A weighted water right for each project was computed by multiplying company or individual water right dates by the designated flow rate of each respective right. These products were then added for each project and divided by the total cumulative flow rate of the individual rights. The weighted water right was used as in indicator of project age.

Usable reservoir storage available to irrigation projects evaluated in this study was assumed equivalent to off-project storage contracted from the US Bureau of Reclamation (USBR) and potential storage in privately-owned reservoirs such as Salmon Creek Reservoir. Volumes of reservoir storage available to projects in 1977 were based on April 1, 1977 readings.

Project Costs and Personnel Requirements

Annual costs of operating and maintaining irrigation project systems vary from year to year due to changes in maintenance needs or difficulties in operation, or because of general economic inflation.

All cost data analyzed in this report were collected for years 1974, 1975, and 1976 and adjusted to 1977 cost levels using the equation:

$$C_{1977} = (1.28\ C_{1974} + 1.19\ C_{1975} + 1.09\ C_{1976})\ /\ 3 \qquad (10)$$

Equation 10 was used to smooth out yearly fluctuations in annual costs by averaging data for the three years collected. Coefficients used in equation 10 represent general inflationary increases in irrigation project operation and maintenance costs for USBR projects in the Western United States. These coefficients can be computed using 1974-1976 as base years and calculating the appropriate index to 1977 from cost indices reported in the USBR report on irrigation O & M cost trends (USBR, 1978). These indices are listed in Apprendix H. System costs were adjusted to 1977 to coordinate with water use data collected in 1977.

Power and reservoir O & M costs were analyzed for 1977, only, as these costs are directly related to project water use.

In cases where cost data were missing for one year, an average adjusted cost was computed by deleting the appropriate term in equation 10 and dividing by 2 rather than 3.

Operation and Maintenance Costs

Project O & M costs have been separated in this study into three major categories entitled administrative, water control, and maintenance costs. The following definitions of these costs will be used throughout the remainder of this report.

Administration Costs

Administration costs are those costs associated with the management of a project, including managerial and clerical personnel costs as well as office expenses. Specific items included are director's fees, travel for administrative purpose, office supplies, office machines, building heat, telephone, electricity, accounting, insurance and bonds, election expenses, water and sewer charges, building rental postage, advertising and printing, state, county and city taxes, legal and professional fees, and communications equipment.

Water Control Costs

Water control costs are those costs associated with diverting and delivering water from the inlet of the distribution system to the farmer's headgate. Included in these costs are salaries, wages and personnel benefits, vehicle costs, and housing costs of water masters, ditchriders, and pumping plant operators during the irrigation season. Housing throughout the year for ditchriders is allocated to water control because of the strategic location of these houses. Costs for power and off-project reservoir O & M are not included in water control costs.

Maintenance Costs

Maintenance costs are the costs required to keep a project in operable condition. These cost include the salaries, wages, and personnel benefits of the maintenance force, equipment costs, materials and vehicle costs associated with the upkeep of the district. Functions included as maintenance are structure repairs, cleaning, weed control, canal and lateral shaping, riprapping, painting, pumping plant maintenance including motor rebuilding, drain cleaning and upkeep, building upkeep, and vehicle and equipment repair. Maintenance does not include complete structure replacement.

Most irrigation water delivery organizations do not use a standard form of O & M cost accounting. Therefore, separation of costs listed in annual financial reports into the specific categories common to all projects studied often required approximations by project personnel. Costs were also itemized in this study for personnel costs, material costs, vehicle depreciation, and equipment use for each of the three O & M cost categories.

Estimates of O & M costs for lateral associations operating in Enterprise and Settlers Irrigation Districts and Danskin Ditch Company project lands were included in cost breakdown and labor requirement estimates of these projects.

1977 Power Costs

Cost for electrical power used by project pumping stations during the 1977 irrigation season were obtained from project records and power bills. Monthly power use (kwh) values were used to calculate volumes of ground water pumped by Settlers, Wood River, Milner Low Lift, and Osgood projects using equation 6. Power costs and usage for project activities other than pumping, such as lighting and heating are included as administrative costs and are not included as 1977 power costs.

Reservoir O & M

Reservoir operation and maintenance costs incurred by irrigation projects have been itemized independent of project O & M costs since storage for most projects reported in this study is provided in off-project reservoir systems managed through the USBR. Because the amount of money annually paid to the Bureau for reservoir O & M is proportionate to storage use, reservoir O & M costs were evaluated for 1977 only, to coincide with water usage. Likewise, operation and maintenance costs for project-operated reservoirs such as Salmon Creek, Cedar Creek, Paddock Valley, Lake Walcott, Milner, and Wilson Lake were evaluated for 1977 only.

Vehicle and Equipment Costs

Annual depreciation of project owned vehicles and equipment was calculated using an equivalent annual capital recovery cost (CRC) dependent upon initial cost, salvage value, service life and interest rate. The equation used to compute a CRC is:

$$CRC = (\text{Initial Cost} - \text{Salvage Value})(CRF) + \text{Salvage Value}\,(i) \quad (11)$$

Where CRC = annual capital recovery cost, dollars per year

CRF = capital recovery factor

i = annual interest rate on investments.

The capital recovery cost reflects the cost of capital investments in equipment which could otherwise be used for investment in other activities. An interest rate of 6.0 percent was selected as an average obtainable rate of return on investments for Idaho irrigation projects.

Average expected service lives for project equipment and estimated salvage values are listed in Table 4. No irrigation system equipment such as flumes, turnouts, pumps or small tools were included in capital recovery cost calculations. Miscellaneous equipment listed in Table 4 includes air compressors, portable welders, spraying equipment, etc. Vehicles and equipment of vintages earlier than estimated service lives listed in Table 4 were assumed to have no capital recovery costs.

Table 4. Vehicle and equipment estimated service lives and salvage value.

Category	Est. Service Life (Years)	Est. Salvage Value (Percent)	Cap. Recov. Factor (i = 0.06)
Automobiles	5	25	0.2374
Light Trucks (Pickups)	5	30	0.2374
Trucks	10	10	0.1359
Tractors-Trailers	15	10	0.1030
Drag Lines	20	10	0.0872
Tractors & Backhoes	20	10	0.0872
Misc. Equipment	10	0	0.1359

Depreciation costs were also estimated for vehicles and equipment owned and operated by project personnel and contracted maintenance or construction companies. Depreciation on ditchrider-owned vehicles was calculated at one-third of mileage costs or about $0.05 per mile driven. Machinery and equipment costs for maintenance, machining, or construction services, performed by nonproject personnel including lateral associations, were in most cases estimated at one-third of total outside costs.

Maintenance Materials

Costs for material supplies used in system maintenance were itemized for the years 1974, 1975, and 1976 and adjusted to 1977 cost levels using equation 10. Materials used for repairing of canals, structures, turnouts, pumps, motors, buildings, radios, and shops are included in this itemization along with chemicals used for weed and moss control. However, costs for maintenance and repair of project maintenance equipment and vehicles are not included in the maintenance materials category.

Personnel Costs

Personnel costs include actual salaries and wages paid to organization employees in addition to any contributing FICA payments, State Workmen's Compensation, life, health, accident, and retirement plan costs. Annual costs for the years 1974, 1975, and 1976 were adjusted to 1977 costs levels using USBR irrigation O & M cost indices and equation 10.

Personnel costs were divided into three categories: administrative, water control, and maintenance. In cases where an employee performs duties involving more than one category, his or her wages and benefits were apportioned according to the share of time spent working in each category.

Administrative personnel include the project manager, secretaries, treasurers, accountants, hydrographers, lawyers, and engineers engaged in administrative business and financial affairs. Fees and cost allowances for members of a board of directors were not included as personnel costs.

Wages and benefits, including housing costs, or project watermasters, ditchriders and pumping plant operators were included as water control personnel costs.

All project personnel costs pertaining to system maintenance such as weed spraying, chaining, concrete work, structure repairment, shop work, canal reshaping, and equipment, pump and motor repair were relegated to maintenance personnel costs.

Labor Requirements

Average labor requirements of organizations were measured in terms of man-years, where 1 man/year (MY) is equal to the employment of one person over a full calendar year. Labor requirements of partial-year organization positions, such as ditchriders employed during summer months only, were determined in fractions of man-years.

Total man-years of required labor were calculated for administrative, water control and maintenance personnel. As with personnel costs, organization positions involved in multi-category activities such as both administration and maintenance were split according to the amount of time spent on each activity. A full time employee was assumed to work a minimum of 40 hours per week. A three-year average man-year value was computed for all projects.

A average project personnel cost was computed by dividing total personnel costs by total man-years of labor. This average cost represents average wages plus employee benefits such as insurance, workman's compensation, FICA payments, and housing adjusted to 1977 cost levels.

Gross Crop Value

Average estimated crop yields of irrigated farm land within each project were used with late 1976 crop prices to compute gross crop values. An average crop value was calculated with 1977 crop distribution data. Crop yields, prices, gross crop and values are listed in tables in Appendix B.

Total System Costs

Three total cost definitions were used to describe project organization costs. Relationships between these totals are shown in Figure 3.

"Total O & M Cost" is defined as the sum of project administrative, water control and maintenance costs, and is equal to the total cost of fulfilling system operation and maintenance requirements, not including pumping power and reservoir O & M costs. All costs included in the total O & M cost are average costs for years 1974, 1975 and 1976 adjusted to 1977 cost levels.

Electrical power costs for operation of project pumping plants during the 1977 irrigation season were added to annual total O & M Costs to compute "Total Project Cost." Power used for activities other than pumping and electrical power consumed by private pumping units are included in the administrative cost category.

The term "Total System Cost" is used in this study to reflect annual operation costs of an entire irrigation project system, including operation and maintenance costs of off-project water storage reservoirs and on-project power use.

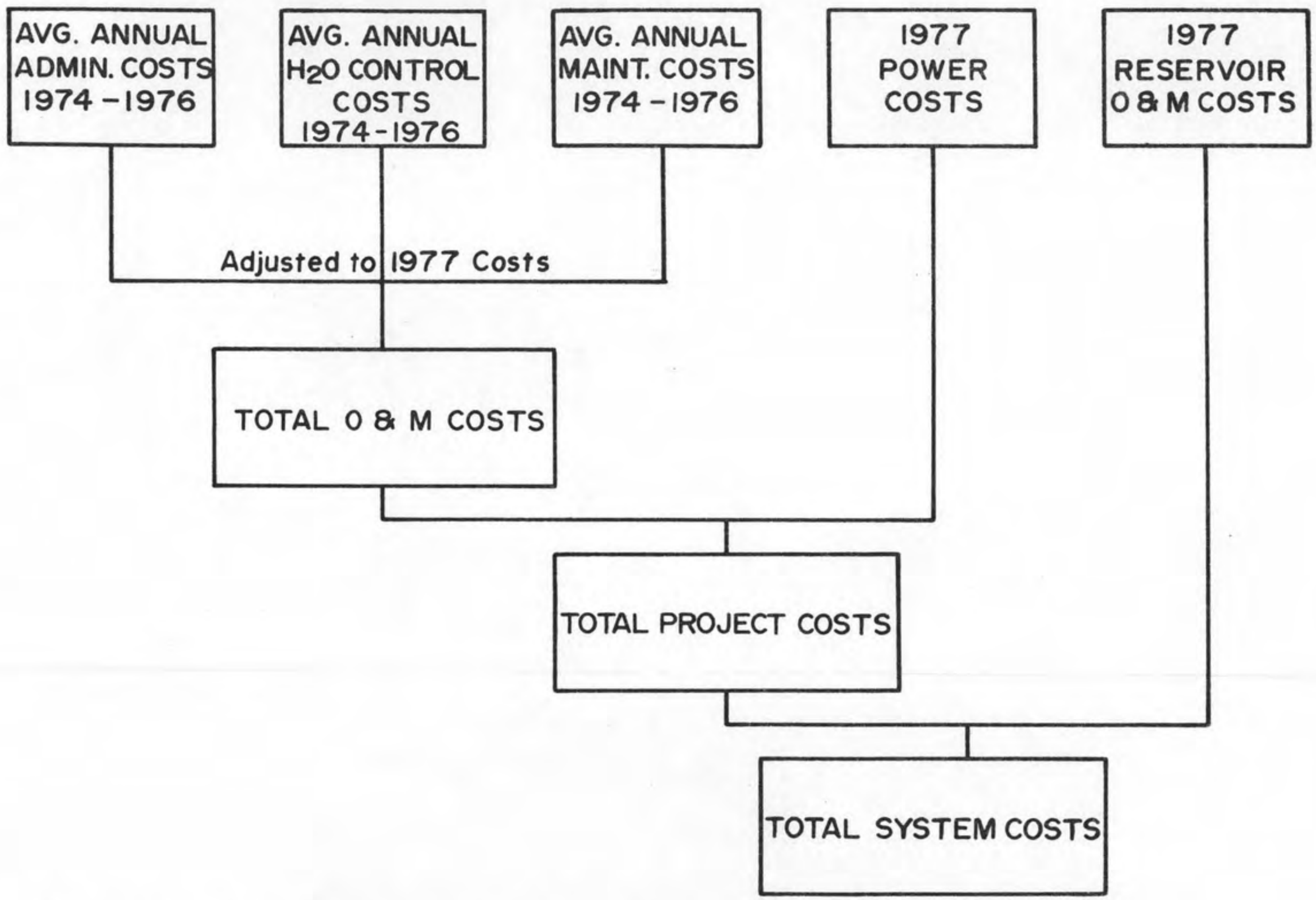


Figure 3. Relationships between Irrigation Project Annual Cost Categories.

CHAPTER IV

ANALYSES OF IDAHO IRRIGATION PROJECTS

The seventeen irrigation projects evaluated for this study supply water to 454,000 acres of irrigated Idaho land, totalling 16 percent of the irrigated land area in the state. These projects vary significantly in size, age, location, organization, and management, providing a representative cross-section of irrigation water delivery entities in Idaho.

Regional Description

The majority of cropped land in Southern Idaho is irrigated with water from the Snake River System and major tributaries. The Snake River originates in south eastern Idaho and western Wyoming and flows in a westerly direction across the south Idaho plain to the Oregon-Idaho border as shown in Firgure 1 in Chapter I. Development of gravity irrigation projects in this region began in the late 1880's along the Snake River in eastern Idaho and followed the river across the state. Later irrigation developments occured on lands north of the Snake river in central Idaho using pumped groundwater from the Snake Plain Aquifer.

Geography

Irrigated agriculture is the predominant industry and water consumer in the southern half of Idaho. The population of the 19 major irrigated counties in this area was 567,000 in 1975, with 195,000 of these people living in rural areas (Idaho Almanac, 1977). The gross value of agricultural goods produced in 1977 from irrigated Idaho farms exceeded 600 million dollars (Idaho Agricultural Statistics). Production of many of these farm goods is dependent on the well-developed network of water storage and hydroelectric power structures along the Snake River system. Farms in irrigated portions of Idaho are typically small, less than two hundred acres. However, larger farm sizes can be found in irrigated areas developed since 1940 where groundwater pumping is the major method of water diversion. Most Idaho farm enterprises are family owned and operated.

Physiography

Beginning in Clark and Fremont counties in eastern Idaho, the Snake River Plain is a long, broad zone of low relief extending across southern Idaho. This moderately level plain, sloping from east to west, consists of a variety of relatively recent basaltic flows of considerable depths. Occasionally the low relief of the Snake River Plain is broken by the occurence of buttes, also of volcanic origin. The Snake River bisects the plain in eastern Idaho and flows through deep, vertical-sided canyons cut through successive basalt flows in the central and western portions of the state.

The Snake River Plain is bounded on the north and south by mountainous terrain of mixed geologic origin, varying from limestone and calcareous sedimentary rocks to silic volcanic rocks such as rhyolite. Granitic formations of the Idaho Batholith are found in the mountains forming the north boundary of the plain. With the exception of the Boise and Payette Rivers in Western Idaho, most tributaries enter the Snake River Plain through deep basaltic canyons.

Underlying the area of the Snake River Plain north and west of the Snake River in the eastern half of the state is the Snake Plain Aquifer. The aquifer is contained within the basaltic flow and interflow sedimentary beds composing the Snake River Plain and is the most prolific water bearing sequence of rocks in Idaho with an estimated annual recharge of 6.5 to 7.5 million acre feet of water. The aquifer provides an abundance of water for irrigation by means of groundwater pumping, and springs from the aquifer are used for power generation and by commercial fisheries. Much of the recharge to the Snake River Aquifer results from irrigated areas in eastern Idaho along Henry's Fork and the Upper Snake River (Brockway et al, 1971).

Soils

The majority of soils comprising the Snake River Plain are of aeolian origin. These loess deposits of silty and loamy soils are from 10 to over 60 inches deep over basaltic bedrock. Along the Snake River and tributary valleys, alluvial soils predominate and vary in texture from deep sandy loams to gravelly loams. Deep layered soils of lacustrine origin are found in the Terreton-Mud lake area and along terraces in the Boise River Valley.

Overall, the major soil types of the Snake River Plain area vary from gravelly and sandy loams to silt loams. Common depths of these soils range from 30 to over 60 inches and average water holding capacities vary from 1.5 to 2.7 inches of water per foot of soil. Infiltration rates are highly variable from soil to soil, ranging from 0.6 to over 6 inches per hour. Most soils are moderately calcareous in subsoil and soils of high sodium content are rare.

Climate

The climate of southern Idaho is characterized by cool winters and hot, dry summers in the western and central portions and moderately cold winters and moderately cool to warm summers in the eastern portion of the state. Precipitation falls mainly during winter months in the entire region, although occasional summer thunderstorms caused by orographic uplift of air masses passing over adjacent mountains are not uncommon in the southwest and southeast areas of the state. Average annual precipitation ranges from about 6 inches in the east to over 12 inches in the southwest.

The frost free season in eastern Idaho along the upper Snake and Henry's Fork is adequate for row crops such as potatoes, but not field corn or beans. However, the frost free season in western and central Idaho is sufficiently long for cultivation of a wide variety of crops.

Crops

Predominate crops grown in western central Idaho include spring and fall planted wheat and barley, alfalfa hay, potatoes, dry and edible beans, grass pastures, field corn, sugar beets, sweet corn, peas, onions, orchards, mint, hops, and melons. Relative crop distributions and varieties grown vary in these areas with location and market prices. Some areas with undependable or inadequate irrigation water supplies are often planted to short season crops such as wheat or barley or to crops with low water requirements or high drought tolerances. An example of a water short area is land irrigated with water supplied by the Salmon River Canal Company, Hollister, Idaho, where grain, dry beans, and alfalfa are the predominate crops.

In eastern Idaho, where the growing season is somewhat shorter due to higher elevation, major crops are limited to potatoes, wheat, barley, alfalfa, pasture, and some sugar beets. Crop distributions also vary in this area, depending on location, irrigation system types, and market trends.

Moderate to high yeilds are achieved for most irrigated crops grown across southern Idaho with variable fluctuations in yields among individual farms and climatic regions.

Farm Development

Sizes of irrigated farms vary across southern Idaho. In eastern Idaho many small farms are operated part time by farmers with off-farm jobs. Most of these farms are original homesteads too small to comfortably support a present day family. The average farm size on older projects in eastern Idaho is generally less than 100 acres, and most are serviced by small, independent water delivery organizations.

Most land in central southern Idaho was brought under irrigation and settled under the Carey Act of 1894 and the Desert Land Act of 1877, where a family could acquire 320 and 640 acres respectively, if they could bring water to it. Farms tend to be larger in size in this region, ranging mostly from 75 to 200 acres with many farm operations in Desert Land Entry areas exceeding 600 acres. The majority of farms in central Idaho are operated by full-time farmers. The size of water delivery organizations in this area are normally somewhat larger than in the eastern portion of Idaho.

Western Idaho farms, many of which lie within U.S. Bureau of Reclamation projects, average less than 100 acres in size. Many of these farms along the lower Snake, Boise and Payette Rivers were settled in the 1890-1910 period and receive water by gravity diversion.

Average farm sizes in southern Idaho have increased since 1940 although most remain family operated. Conversion to sprinkler systems and other modern irrigation practices has brought about changes in management and economics of many irrigated farms, although most farms in the eastern and western portions of southern Idaho are operated and managed much as they were in the early 1900's.

Project Descriptions

Seventeen independent irrigation projects in Idaho have been selected for study and analyses of seasonal water use in relation to annual system O & M costs. Seven projects are managed as private or mutual irrigation or canal companies, and ten projects are organized into quasi-public irrigation districts. Ages of the 17 water delivery organizations studied range from 8 to over 95 years. Management, climate, crops and irrigation systems vary significantly among the projects studied. Table 5 is a list of irrigation water delivery organizations studied, along with headquarters locations, origins, and average elevations of the project lands. Locations and relative boundaries of these projects are shown in Figure 1 in Chapter I. Individual maps of irrigation projects showing boundaries, canal and pipe systems, inflow and return flow gaging stations, and diversion points are included in Appendix A of this report.

Table 5. Origins, average elevations, and headquarters locations of irrigation water delivery organizations evaluated.

Irrigation Project	Headquarters	Year of Origin	Average Elevation
Enterprise Irr. Dist	St. Anthony	1905	5070
Parks & Lewisville Irr. Co, Inc.	Rigby	1888	4800
Osgood Canal Co. (U & I Sugar)	Idaho Falls	1962*	4780
Idaho Irr. Dist.	Idaho Falls	1905	4680
Danskin Ditch Co.	Blackfoot	1883	4460
Burley Irr. Dist.	Burley	1908	4160
A & B Irr. Dists.	Rupert	1954-1971**	4250
Milner Low Lift Irr. Dist.	Murtaugh	1916***	4240
North Side Canal Co., Ltd.	Jerome	1907	3630
Wood River Valley Irr. Dist.	Bellevue	1883	5060
Salmon River Canal Co., Ltd	Hollister	1908	4500
Cedar Mesa Res. & Canal Co.	Castleford	1921	4520
Bell Rapids Mutual Irr. Co.	Hagerman	1970-1974	3270
King Hill Irr. Dist.	King Hill	1908	2670
Settlers Irr. Dists.	Boise	1884	2580
South Board Control, Owyhee	Homedale	1913-1935****	2400
Little Willow Irr. Dist.	Payette	1913	2460

* Initial system originated in 1900. System was rehabilitated to high pressure farm delivery in 1962.
** Constructed by the U.S. Bureau of Reclamation in stages beginning in 1954 with construction of the 'A' portion of the district.
*** Organized and expanded into an irrigation district in 1952.
**** Gem Irrigation District started in 1913; Owyhee project and diversion to Ridgeview District begun in 1935.

Descriptive parameters and costs of the irrigation projects evaluated are listed in tables in this chapter and in the report appendices. A general resume of the irrigation projects is given in the following text. Projects are described in order of general location along the Snake River, beginning in eastern Idaho (Figure 1).

Enterprise Irrigation District

Located in Fremont and Madison counties in eastern Idaho, the Enterprise Irrigation District is comprised of 63 water users and 5970 irrigated acres. A map of the Enterprise project and canal system is shown in Appendix A. Rectangular in shape and oriented north to south, Enterprise users divert water from the Falls River, 8 miles north of the project service area. The unlined delivery system crosses the Teton River north of Newdale through a buried concrete siphon built after the original wood-stave structure was destroyed by the Teton Dam flood in 1976.

Enterprise project lands are serviced by a 15 mile-long unlined main canal system and 12 laterals. The project originated in 1905 by private investment and was constructed with horses and scrapers. The Enterprise District experienced frequent water shortages until the late 1930's, when reservoir storage space was purchased to supplement the Falls River flow right. The project system is managed by a board of 3 directors and a ditchrider is employed to deliver water to 12 user-operated laterals. Maintenance of these laterals is on a volunteer basis by individual water users. Average farm size in the district is 95 acres.

Because of rolling topography of the Enterprise project, 95 percent of the farm land is irrigated with sprinkler systems pressurized by on-farm pumps. Major crops grown on the uniform silt loam soil are potatoes, alfalfa, and spring and winter grain. Gross crop value of crops grown in 1976 averaged $276 per acre.

In 1977 an average of 3.4 acre feet of water per irrigated acre was diverted to the Enterprise District and 2.7 acre feet per acre was delivered to farms. Total project irrigation efficiency during the 1977 irrigation season was 44 percent. Enterprise water users have relatively low system O & M costs, averaging $3.98 per irrigated acre in 1977, including lateral maintenance costs by farmers. The 1977 O & M assessment by the district was $2.00 per irrigated acre, as $1.98 per irrigated acre of system O & M costs was expended directly by farmers for operation and maintenance on user-operated laterals.

Parks and Lewisville Irrigation Company, Inc.

The second oldest canal system in the upper Snake River area, the Parks and Lewisville Irrigation Company was incorporated in 1888 by private funding. The entire Parks and Lewisville project is situated in Jefferson county, south and east of the Snake River. Water is diverted into a system of three canals totaling 33 miles in length from the Great Feeder Canal, also known as the Dry Bed of the Snake River. The North, South, and Missionary Canals in turn deliver water to 8500 acres of irrigated project lands operated by 150 water users. Parks and Lewisville employs one ditchrider to deliver canal water, but owns no water control or maintenance equipment. System maintenance is performed by nonproject personnel as needed.

Parks and Lewisville project lands are quite flat, with farms averaging 57 acres in size. Sandy loam is the major soil type in the area. The main crops of spring grain, potatoes, and alfalfa are surface irrigated by flood and furrow methods. Average gross crop value in late 1976 for this project was $364 per acre.

The canal system of the Parks and Lewisville project cuts into highly previous subsoils, contributing large volumes of diverted water to local and regional groundwater supplies. Large applications of water to project fields also contribute to groundwater recharge with very little runoff leaving farm lands. A total of 12.5 acre feet of water per irrigated acre was diverted into project canals in 1977, and an estimated 6.2 acre feet per acre was delivered to project farms. The Parks and Lewisville Irrigation Project irrigation efficiency indicates that 12 percent of diverted water was used to fulfill crop water requirements in 1977. The lowest system O & M averaged $1.85 per acre per year and the 1977 irrigation assessment totaled $1.70 per irrigated acre.

Osgood Canal Company

The Osgood project is unique among other eastern Idaho irrigation projects in that water is delivered to individual farms at pressures sufficient for sprinkler operation. Located in Bonneville county, the entire project service area of 6220 irrigated acres is owned by a corporation which leases farm land to 17 water users on a sharecropping basis.

Originally constructed in 1900 as a gravity flow system delivering water to small, irregular fields in rolling terrain, the Osgood Canal Company, Inc. canal system was renovated in 1962 by replacing farm gravity laterals with buried high pressure pipelines. Large, rectangular fields were formed by combining smaller fields and farms. Project farm sizes now average 360 acres. Booster pumps along the 7 mile unlined main canal supply pressurized water to farms through 22.6 miles of buried laterals with risers for farm sprinkler system hookups. Thirty pumps with a total of 3625 horsepower lift Snake River water into the Osgood canal and pressurize pipelines in 12 locations along the canal system. Electrical power for pump operation is supplied by a private utility. Two deep wells are also used to produce water for irrigation of 620 acres of Osgood land. Excess water in the canal system is directed into waste wells at the end of the system.

Average slopes of the silt loam soils of the Osgood project are less than 3 percent, although much of the terrain is of a rolling nature. All land is sprinkler irrigated, with potatoes, sugar beets, and spring grain being the major crops.

The Osgood project is also unique in that water users are not assessed for system O & M costs. All power, operation, and maintenance costs, which averaged $27.71 per acre at 1977 prices, are paid by the canal company. Operating revenue is generated through sharecropping agreements with farm operators.

Osgood Canal Company employs 2 ditchrider-pump operators and diverted a total of 2.7 acre feet of water per acre in 1977 from surface and groundwater sources. Farm deliveries in 1977 averaged 2.2 acre feet per acre, and the 1977 total project irrigation efficiency was 53 percent. The gross value in late 1976 of harvested crops was $340 per irrigated acre.

Idaho Irrigation District

The Idaho Irrigation District, privately organized in 1905, is long and narrow in shape, beginning north of Idaho Falls and running south and west through Bonneville and Bingham counties, ending just north of the Blackfoot River. In addition to spring flood waters received, the Idaho system diverts water out of the Snake River to irrigate 35,600 acres through a distribution network of 150 miles of unlined canals and laterals. A map of the Idaho Irrigation project is included in Appendix A.

The Idaho Irrigation District employs a sizable work force, with four ditchriders hired to direct and measure farm deliveries to 540 water users. Average farm size in the district is about 80 acres and average slope of the sandy loam soils is less than 3 percent. The majority of farms in the Idaho Irrigation District are privately owned and operated.

Farmland within the Idaho project boundaries has historically been irrigated by surface methods. However, since 1970, 35 percent of the project land has been converted to sprinkler systems pressurized by on-farm pumping units using canal water. This conversion to sprinkler has taken place largely for more precise control of irrigation water applications on potato crops for increased yields. The major crops grown in the Idaho Irrigation District are potatoes, spring and winter grain, and alfalfa hay. Small acreages of corn, pasture, and sugar beets are also cultivated. The average gross crop value of Idaho District crops was $302 per acre. This high value is due largely to the price of potatoes in late 1976 ($2.90/cwt).

Because of the long length of canal system and sandy loam soils, the Idaho project experiences relatively high volumes of seepage losses and return flows, resulting in a conveyance efficiency of only 54 percent. An average of 8.8 acre feet per acre was diverted to the Idaho project in 1977 and 4.8 acre feet per acre was delivered to project farms. The total project irrigation efficiency in 1977 was 17 percent.

System operation and maintenance costs of the Idaho Irrigation project are quite low. The three year average system O & M costs, computed with 1977 cost indices, averaged $3.77 per acre. The 1977 O & M assessment by the district was $4.00 per irrigated acre. This assessment did not include any construction repayment costs.

Danskin Ditch Company

Lying west of the Snake River in Bingham County, farm lands serviced by the Danskin Ditch Company were among the first lands irrigated in Idaho. The 20 mile long unlined canal and lateral system was created with horses and hand shovels. The Danskin system and project lands are today much the same as when originally settled, although some subdivision of farms and acreages has occured in recent years, reducing the irrigated acreage to about 4730 acres in 1977.

Danskin project canal laterals are operated and maintained by individual groups of farmers along each lateral and lateral water is rotated among the water users of each group. One ditchrider is employed by the company to direct water to the laterals. There are approximately 80 water users in the Danskin Canal Company project, and project farms average less than 75 acres in size.

Border irrigation is the predominate method of irrigation on the loamy project soils, as project terrain is very flat. Less than 10 percent of the area is sprinkler irrigated. Because of the small farm sizes and loam soils, grass pasture is the major crop, with moderate amounts of spring and winter grain, alfalfa, and potatoes also grown. The average gross value of irrigated crops in the project was $189 per acre in late 1976.

During the 1977 irrigation season, 12.6 acre feet of water per irrigated acre was diverted by the Danskin Ditch Company from the Snake River, and about 10.3 acre feet per acre was delivered to project laterals. An average 19 percent of diverted water was used by project water users to fulfill crop water requirements during 1977. Annual system O & M costs, including costs to lateral associations, averaged $2.30 per irrigated acre at 1977 prices. The O & M assessment by Danskin Ditch Company in 1977 was $4.71 per irrigated acre.

Burley Irrigation District

In 1908 lands of the Burley Irrigation District were brought under irrigation as part of the Minidoka Project of the U.S. Bureau of Reclamation. Located in Cassia County, Burley Project lands receive water lifted from the South Side Canal, which originates at the Walcott Reservoir on the Snake River (Figure 1). Three relift pumping stations along the 90 mile main canal are responsible for delivering water to 570 users and 41,440 irrigated acres situated on terraces above the Snake River. The total length of the Burley water distribution system, including laterals, is 267 miles, all of which is unlined open channel.

Fifteen pumps, totalling about 13,000 horsepower, elevate canal water 30 feet at each lift. The total lifting capacity of the initial relift station is about 1000 cubic feet per second. All pumps are of a centrifugal design and are original equipment. All pump maintenance and repair is performed by Burley project personnel. Power for Burley is generated by facilities at the Minidoka Dam of Lake Walcott, also a part of the Minidoka project. Generating facilities at the dam are maintained with funds supplied mostly by the Burley District, which also shares profits from the sale of excess power generation. The Burley Irrigation District employs 10 ditchriders and 8 full-time pump operators during the regular irrigation season.

Farms in the Burley Irrigation District average 75 acres in size and are 99 percent surface irrigated. Silt loams, loams, and sandy loams are evenly distributed throughout the irrigated lands on slopes of zero to four percent. The distribution of crops grown in the Burley project are listed in Table 6 of Appendix C. Major crops are beans, alfalfa hay, spring and winter grain, sugar beets, corn for silage and grass pasture. The weighted average gross value of these crops in late 1976 was $208 per acre.

Water diverted into the Burley Canal sytem in 1977 totalled 5.7 acre feet per acre, with 4.2 acre-feet per acre delivered to project farms. The average project irrigation efficiency during the 1977 season was 30 percent. System O & M costs, averaged for 1974, 1975, and 1976 and adjusted to 1977 prices totalled $13.70 per irrigated acre per year. The O & M assessment of the Burley Irrigation District was $14.23 in 1977.

A & B Irrigation District

Located in Minidoka and Jerome Counties north of the Snake River, the A & B Irrigation District is one of only a few Federal irrigation projects which pump a major portion of their water from a system of deep wells. The A & B Project is comprised of two separate land areas with differing water sources and distribution systems. The 'A' portion of the project diverts water from the Snake River above Milner Dam, lifting water 150 feet into a 64 mile long canal and lateral system to irrigate 14,570 acres of farm land. The first portion of the A & B

District to be constructed, Unit A began operation in 1954.

Using turbine pumps to lift water 200 feet from wells drilled into the Snake Plain Aquifer, the U.S. Bureau of Reclamation began irrigating sections of Unit B in 1961. Final construction of canal laterals and well systems in Unit B was completed in 1971, although management of the A & B Irrigation District was relegated to the private water users by the Bureau in 1966.

A total of 166 miles of unlined canals and laterals are used in the total A & B project to convey irrigation water to 516 farm operators farming a total of 73,850 irrigated acres. A total of 191 pumps with 34,500 combined horsepower are used to lift water from the Snake River in Unit A and from 177 deep irrigation wells in Unit B. Forty-four full-time employees operate project equipment, including eleven ditchrider-pump operators and two watermasters.

Farms in the A & B Irrigation District average 149 acres in size and are about 90 percent surface irrigated with the balance irrigated with sprinklers. The terrain of the project is mostly rolling with slopes averaging greater than 3 percent. Soils of the area are loams and silt loams greater than 60 inches deep. Crops grown on A & B project lands include spring grain, alfalfa, sugar beets, dry beans, potatoes, and winter grain. The gross value of these crops averaged $259 per acre in late 1976.

The A & B project is unique among most projects evaluated in that an additional water charge is assessed against users demanding annual farm deliveries in excess of 3 acre feet per acre. This charge by the district managment is felt to deter wasteful use of pumped water. An average of 3.8 acre feet of water per irrigated acre was diverted by Units A and B during the 1977 irrigation season and farm deliveries averaged 3.4 acre feet per acre, indicating a project conveyance efficiency of 90 percent. Total project irrigation efficiency during 1977 averaged 41 percent. With the aid of low cost Federal power, A & B has been able to hold down total system O & M costs to a three year average of $16.33 per irrigated acre in 1977. The O & M assessment by the district in 1977 averaged $14.50 per irrigated acre. All routine system and pump maintenance is performed by project personnel.

Milner Low Lift Irrigation District

Originated in 1916 and incorporated into an irrigation district in 1952, the Milner Low Lift project lifts water from Lake Milner on the Snake River to irrigate 13,480 acres of farm land. The 50 mile long unline canal system is located in Cassia and Twin Falls Counties south of the Snake River and supplies water to 85 farm operators. Fifty pumps with a total of 5510 horsepower are located at Milner Lake and at one relift point along the main canal system. Power for pumping is supplied through the Bonneville Power Administration. A small irrigation well is occasionally used to supplement canal flows near the system end. Two ditchriders are employed by the district to measure and deliver canal water.

The terrain of the Milner Low Lift District is of a rolling nature with slopes averaging greater than 3 percent. The main soil type of project lands is silt loam. Project farms average 163 acres in size and are 99 percent surface irrigated. The major crops grown on the Milner project are dry and edible beans, spring and winter grains, and alfalfa hay, with lesser amounts of peas, potatoes, and sugar beets. The gross crop income of project farmers in late 1976 averaged $243 per irrigated acre.

Snake River diversions in 1977 totalled 4.2 acre feet per acre, with 3.5 acre feet per acre delivered to project farms. The average project irrigation efficiecny in 1977 was 32 percent. The system O & M cost for Milner Low LIft District members for the years 1974, 1975 and 1976 averaged $14.40 per irrigated acre at 1977 price levels. The 1977 O & M assessment to water users was $11.94 per irrigated acre.

North Side Canal Company, Ltd.

Located in Jerome, Gooding, and Elmore Counties, the North Side irrigation project is one of the largest irrigation entities in Idaho, encompassing 340 square miles. The Northside Canal Company, Ltd. was incorporated in 1907 as part of an ambitious effort to open up new farm land north of the Snake River in central Idaho through provisions of the Federal Carey Act. Construction of the 755 mile network of main canals and laterals was accomplished with horses and steamshovels and explosives in areas of basalt outcroppings. This distribution system presently delivers water to 1100 water users on 149,340 acres. Lands served by the North Side Pumping Company (12,200 acres) were not included as a part of the North Side project during this study.

North Side project farms average 136 acres in size and are 70 percent surface irrigated, with 30 percent of the project irrigated by sprinkler. Eighty percent of the project is rolling terrain with slopes greater than 3 percent and frequent areas of rock outcroppings exist in the loam soils. Major crops grown in the North Side project are alfalfa hay, spring and winter grain, dry and edible beans, grass pasture and potatoes. Small amounts of field corn, sweet corn, dry peas, and sugar beets are also harvested. The gross value of these crops, calculated for late 1976 prices in proportion to acreages planted, averaged $275 per acre.

Because of the extensive canal network and large areas of permeable soils, the conveyance efficiency of the North Side canal system was 64 percent in 1977. The majority of system losses were due to canal seepage, with small amounts of operational waste returning to the Snake River through return flow points along the canyon rim. The North Side Canal Company diverted 5.3 acre feet of Snake River water per irrigated acre in 1977 and delivered 3.4 acre feet per acre to project farms. Total project efficiency for 1977 was 38 percent.

Total system operation and maintenance costs of the North Side project are relatively low, averaging $6.00 per irrigated acre in 1977. Part of this cost is for maintenance of Milner Dam and Wilson Lake. The 1977 O & M assessment of the North Side Canal Company was $5.99 per irrigated acre.

Wood River Valley Irrigation District

Because it has no reservoir water storage system to store spring river flows, the Wood River Valley Irrigation District is often subjected to late summer surface water shortages, especially in years of low winter precipitation. Located in a wide, flat, mountain valley in Blaine County near Bellevue, Idaho, this organization of 32 water users has diverted water from the Big Wood River for purposes of irrigation since 1883.

In addition to the absence of surface water storage facilities, Wood River Valley Irrigation District is plagued with highly permeable and shallow gravelly silt loam soils and a high seepage loss conveyance system. The area does have, however, groundwater system within 10-60 feet of ground surface which is being developed by individual farmers as a supplemental source of irrigation water.

The district conveyance system is a series of unlined canals and laterals totalling 22 miles in length. Over 8000 acres of district lands are potentially irrigable, although less than 7200 are normally irrigated due to subdivision and residential development of some project areas. Because 1977 was anticipated as a water short year, only 4850 acres of Wood River Valley District lands were irrigated and farmed. Sprinkler systems were used to irrigate 42 percent of farmed land in 1977 and groundwater pumped by individual farmers compose 43 percent of project diversions. Although fewer acres were farmed in 1977, project operation procedures and irrigation efficiencies did not significantly vary from 1976 to 1977 (Worstell, 1970).

One project ditchrider is employed to measure and deliver canal water to farms averaging about 200 acres in size. No equipment or vehicles are owned by the irrigation district.

Alfalfa hay is the major crop grown in the Big Wood River Valley, with two thirds of the crop harvested twice each season. About one third of the alfalfa crop of the Wood River Valley District is cut only once. Considerable amounts of spring grain are grown in the valley and some land is used for pasture for grazing. The average gross crop value in the Wood River Valley Irrigation District was $167 per acre in late 1976.

An average of 9.6 acre feet of water per acre was diverted to district lands during 1977, with 4.1 acre feet per acre of the diverted water pumped from the shallow aquifer system. Farm deliveries averaged 7.3 acre feet per acre and total project irrigation efficiencies averaged 21 percent for the season. Actual canal conveyance efficiencies of the district system were only 58 percent, although a composite conveyance efficiency, considering water delivered by on-farm pumps, averaged 76 percent. On-farm pumps in the irrigation district consumed about four million kilowatt-hours of electrical power during the 1977 season.

Wood River Valley Irrigation District total system costs averaged $2.91 per 1977 irrigated acre and the 1977 O & M assessment by the district was $1.88 per acre irrigated that year. A map of the Wood River project is included in Appendix A.

Salmon River Canal Company, Ltd.

The Salmon Falls Development began in 1908 in southern Twin Falls County under the Carey Act, and water was first delivered to Salmon Tract lands in 1911.

Initial project development plans were to irrigate 130,000 acres; however, because of low watershed yields and high conveyance system losses, the project service area of the Salmon River Canal Company was reduced to 72,000 acres around 1915 and further reduced to 35,000 acres in 1918 by a Federal Court decree. Of these 35,000 acres, about 31,000 are classified as arable. As shown on the map of the Salmon River Canal Company system in Appendix A, project service areas are widely separated from one another by unfarmed land created by the initial acreage reduction. During a number of years since 1918, less than the potentially irrigable 30,000 acres in the Salmon tract were planted due to low reservoir levels and low precipitation amounts. Forecasts of seasonal water supplies and corresponding maximum irrigable acreages are annually estimated for project users by the Soil Conservation Service.

Project irrigation water is stored in a 180,000 acre feet capacity reservoir located behind a concrete arch dam built in 1910 on the Salmon Falls creek. System diversions are made through a quarter-mile-long tunnel extending through a canyon wall alongside the 210 foot structure.

The 109 mile long system of canals and laterals of the Salmon Tract is 90 percent unlined channel, with about 10 miles of lateral pipelines. Salmon River Canal Company shareholders have, in the past, had to call upon U.S. Bureau of Reclamation assistance and Federal funding for renovation of project conveyance and delivery systems to increase water use efficiencies and to line and rechannel canal sections with high water losses.

Farms of the 174 Salmon Tract Water users average 170 acres in size and are comprised mainly of silt loam soils less than 35 inches deep. One half of the project lands have slopes exceeding 3 percent. Seven ditchriders are employed by the company to measure and regulate system deliveries. Dry and edible beans, spring grain and alfalfa are the primary crops grown on the Salmon Tract, with small acreages of corn, peas, alfalfa seed, and potatoes also harvested. Gross value of these crops averaged $195. per acre in late 1976.

The amount of project lands planted to and irrigated in 1977 was estimated by the USBR to total 19,770 acres, due to lack of precipitation the previous winter and low reservoir levels. Of these 19,770 acres, 9 percent were watered with sprinkler systems. Salmon River Canal Company diverted 3.8 acre feet of reservoir water per 1977 irrigated acre in 1977 and delivered 2.4 acre feet per acre to project farms. The project conveyance efficiency in 1977 averaged 63 percent, and the resulting project irrigation efficiency averaged 36 percent. System O & M costs averaged for the years 1974, 1975, and 1976 equalled $9.80 in 1977, as did the Company's 1977 O & M assessment.

Cedar Mesa Reservoir and Canal Company

Located in western Twin Falls County, the Cedar Mesa Reservoir and Canal Company (CMRCC) delivers water to 4030 irrigated acres on a parcel of land referred to as the Roseworth Tract. Water is supplied to the

Tract through unlined canals and natural stream beds from the Cedar Creek Reservoir financed and built in 1921 by private investors. Original development plans were to irrigate 14,000 acres with Cedar Creek waters. However, the reservoir water supply was soon found to be adequate for irrigation of only 4030 acres of actual farmland. Having changed ownership several times during the first 20 years of operation 60 percent of the CMRCC is presently controlled by one private interest, with the land leased to tenant farmers. In total, 10 water users operate Roseworth Tract farms averaging 400 acres in size.

Irrigation water released from the Cedar Creek Rservoir is controlled by the company ditchrider using a regulating reservoir adjacent to project lands to adjust daily flow rates. The project conveyance system below the regulating reservoir consists of 9 miles of unlined canal and laterals, one half mile of line laterals, and one and a half miles of buried pipeline. All farm deliveries are delivered by gravity flow through concrete constant head orifice turnouts. A map of CMRCC project system is included in Appendix A.

Silt loam is the major soil type of the Roseworth Tract and the project terrain has a uniform slope of less than 3 percent. Alfalfa hay and spring and fall grain are the chief crops on the Roseworth Tract and the project terrain has a uniform slope of less than 3 percent. Alfalfa hay and spring and fall grain are the chief crops on the Roseworth Tract and the project terrain has a uniform slope of less than 3 percent. Alfalfa hay and spring and fall grain are the chief crops on the Roseworth Tract and lesser amounts of dry beans, sweet corn, pasture and field corn are grown. The average gross crop value is $231 per acre.

In 1977 project diversions from the Cedar Creek Rservoir averaged

4.2 acre feet per acre with 2.9 acre feet per irrigated acre delivered to project turnouts. The seasonal project irrigation efficiency in 1977 was 40 percent. The project conveyance efficiency averaged 69 percent in 1977, reflecting relatively high seepage from the canal system. Part of these losses occured from the Cedar Creek stream bed below the Cedar Creek Reservoir. Total system operation and maintenance cost the reservoir and canal company an average $4.92 per irrigated acre per year between 1974 and 1976. The 1977 company O & M assessment was $7.44 per irrigated acre.

Bell Rapids Mutual Irrigation Company

Bell Rapids Mutual is a privately operated irrigation company which supplies Snake River water to irrigation systems on a plateau high above the Snake River canyon. Located in western Twin Falls and eastern Elmore counties, the Bell Rapids project is a recent irrigation development, having delivered water to project lands for the first time in 1970. Construction of the entire pumping and canal system was completed in 1974, with 25,520 acres of land irrigated with pressurized water supplied by system pumps. Project lands were developed by a group of 75 individual investors in compliance with criteria set forth under the Federal Desert Land Act. A map of the Bell Rapids Project in included in Appendix A.

Snake River water is diverted into the Bell Rapids canal system atop the Bruneau Plateau by a bank of 22, 1500 horsepower pumps at two locations along the Snake River with total pumping lifts of over 550 and 625 vertical feet. Two canals atop the plateau convey pumped water by gravity means to boosting stations situated along the canals where water is pumped into buried pipe mains under pressures sufficient for sprinkler operation. The irrigation company owns and maintains 9600 risers situated along the 110 miles of buried pipeline. These risers are designed for hookup of quarter-mile long sprinkler lines. Three holding ponds are used at canal termination points to supply additional booster pumps and also to eliminate system spillage. Ninety pumps, in total, are operated by Bell Rapids Project with a combined power rating of 50,835 horsepower.

Many of the 320 acre farms on the Bell Rapids project are operated by common farming enterprises. Total farm systems on the 25,520 acre project total only 15, with farm sizes ranging from 320 to 5000 acres and averaging 1700 acres. Because of the large farm sizes and vast number of sprinkler lines on the Bell Rapids Project, farms are quite labor intensive with large numbers of nonresident help hired during the irrigation season to move sprinkler pipe.

Because of difficulties in maintaining smooth, continuous deliveries of water throughout the canal and pipe system, water users are limited to operation of 16 quarter-mile handlines or 20 quarter-mile solid-set lines per 320 acre farm. In addition, nearly all sprinkler heads operated on project lands are equipped with flow-control orifices to regulate non-uniform sprinkler rates caused by rolling terrain and the specific location within the project system. Fines are levied against system users for negligent misuse of irrigation water.

Six company ditchriders are employed by the irrigation project to check and regulate booster pumps atop the plateau on a 24-hour basis during the irrigation season. Each pump is checked at least once every three hours. The two river stations are manned on a continuous basis by 2 pump station operators.

Bell Rapids project users irrigate with relatively high efficiencies.

Total project irrigation efficiency in 1977 averaged 55 percent. The major loss of water was through deep percolation losses from project farms. Snake River diversions by Bell Rapids average 2.62 acre feet per acre in 1977, and farm deliveries totalled about 2.41 acre feet per acre.

Most of the terrain of the Bell Rapids Project slopes at more than 3 percent, and silt loam is the predominate soil texture. Potatoes have been the major crop grown on project lands, with about 12,000 acres annually planted. Other crops grown in rotation on the project are dry edible beans, spring and winter grain, and small amounts of alfalfa hay and sugar beets. Because of the large proportion of potatoes grown, the gross value of crops grown on the project averaged $590 per acre in late 1976.

Due to the tremendous pumping lifts involved on the Bell Rapids Project and because electrical power is purchased from a private utility, system users must pay a substantial fee for irrigation pumping costs. In 1977, costs for electrical power totalled $49.22 per irrigated acre. Combined with total O & M costs of $12.16 per acre, the total cost of system operation and maintenance of the Bell Rapids Mutual Irrigation Project averaged $61.38 in 1977. The company assessed users $65.78 for system operation.

King Hill Irrigation District

The early economic history of the King Hill Irrigation Project was like some of its sister projects in that it was plagued with financial difficulties. The King Hill development began in 1908 as a Carey Act Project; however, the Carey Act contractor went broke in 1915 with the project partially completed, at which time the State of Idaho organized the project into an irrigation district and transferred all control to the United States Government. Additional improvement and repair of irrigation works in the district system necessitated the expenditure of over 2 million dollars by the Federal government between 1919 and 1923.

King Hill Irrigation District lands consist of 11,000 irrigated acres located along a main canal system extending down the Snake River Valley from near Hagerman to Hammett, a distance of over 50 miles. The long, narrow shape of the project is shown in Appendix A. Most of the project system was constructed in difficult, steep terrain along the Snake River Canyon, necessitating the use of many wood stave siphons and flumes later replaced with concrete structures by the Bureau of Reclamation.

Initially, 16,000 acres were to be irrigated in the King Hill Project; however, since the district was organized in 1917, some 5000 acres of land with gravelly soils and steeper slopes have been eliminated from the project. As a result of this elimination, project service areas are somewhat scattered, with many dry and broken areas between farms. This applies especially to the first 15 miles from the head of the canal, where there are only a few farms. A brief history of the King Hill Project is described in detail in a report submitted to the 84th congress (King Hill Irrigation District, 1962).

The present King Hill distribution system consists of 60 miles of unlined canal, about 16 miles of line canal and concrete flumes, and over 7 miles of pipelines and siphons. System diversions were made from the Malad River east of the Snake, where it was conveyed across the Snake through an inverted siphon originally constructed by the Idaho

Power Company as part of a water use agreement with the irrigation district. The 83 mile long system serves 65 major water users (farm operators) on farms averaging 150 acres in size. Three ditchriders are employed by the district to regulate and record farm deliveries from the canal systems.

Because of extensive damage to the diversion siphon across the Snake River below Hagerman in September, 1978, King Hill water users elected to abandon the upper end of the canal system and Malad River diversion in favor of diverting Snake River water using four separate pumping stations constructed along the Snake River below the canal system during the spring of 1979. These pump installations located on pier systems extending into the river channel began diverting water into the King Hill system May 4, 1979. Total power requirement of the 25 turbine pumps installed along the system is about 12,000 horsepower. Total pumping heads from the river into the canal system range from 176 to 266 feet. Cost of the project exceeded 1.9 million dollars. Annual system O & M cost including construction repayment for the pumping project are expected to cost users about $35 per acre per year. Because Idaho Power Company is now able to generate electrical power with Malad River water historically diverted by the King Hill project, the power company has agreed to supply the King Hill Irrigation District pumping plants 14 million Kilowatt-hours of electrical power annually at no charge.

Because farms are comprised mostly of sandy loam soil and many fields slopes are much greater than 3 percent, sprinkler systems are the predominate on-farm irrigation method used in the King Hill District, covering 80 percent of all irrigated land.

During the 1977 irrigation season, about 11,000 acres of King

Hill project lands were under irrigation. Major crops grown on these lands were alfalfa hay, spring grain, grass pasture, with lesser amounts of sugar beets, corn silage, potatoes, and sweet corn. Gross crop value in late 1976 averaged $245 per acre. King Hill Irrigation District diverted an average of 10.2 acre feet of Malad River water per irrigated acre in 1977 and delivered about 5.8 acre feet per acre to system users. An estimated 27 percent of all water diverted into the King Hill system in 1977 was lost as canal seepage, and about 16 percent of system diversions were spilled from the long, winding system due to bottlenecks at various control structures and a long lag time in system response to changes in diversion or delivery rates. Even though project lands were 80 percent sprinkler irrigated in 1977, on-farm application efficiencies averaged only 43 percent. Deep percolation losses from project farms were estimated to be over 3 acre feet per acre. Total project irrigation efficiency of the King Hill Irrigation District in 1977 was 24 percent.

Because of the extensive length of the King Hill System and problems in maintenance and water control schedules, annual total system O & M costs of the King Hill project average $12.76 per irrigated acre. The 1977 O & M assessment was $12.88 per irrigated acre. Future costs to King Hill users will probably increase substantially due to abandonment of the damaged diversion siphon and construction and operation of the four pumping stations during 1979.

Settlers Irrigation District

Organized into an irrigation district around 1884, the Settlers Project was among the first major canal systems built in the Boise River Valley. Located in western Ada County, south of the Boise River, Settlers Irrigation District originated through private finance and was incorporated into the Arrowrock Division of the Boise Project of the U.S. Reclamation Service in the early 1900's.

The Settlers District lies on silt loam soils with slopes less than one percent. Farm sizes in the district are quite small, averaging 56 acres, and are irrigated entirely with surface methods. The total conveyance system of the Settlers District, including laterals, is comprised of 55 miles of unlined canal. The system originates inside Boise city limits and delivers water to 170 system users. Because of residential development of some land within district boundaries and gradual exclusion of subdivisions from the district, the amount of land irrigated within Settler's Irrigation District in 1977 was only 9440 acres.

Maintenance and water control is performed by Settlers personnel upon the main canal system only. Water is controlled along system laterals by water users through lateral associations. These associations are also responsible for upkeep and maintenance of each specific lateral. One ditchrider measures and delivers Settlers water to the head end of each lateral system. Two small wells are occasionally used to supply groundwater to a small area within the district.

Crops grown on district farms include alfalfa hay, grass pasture, corn silage, and field corn, and small amounts of sugar beets, spring grain, sweet corn, spearmint and peppermint. The late 1976 gross crop value of the project was $185 per acre.

Settlers District diverted 5.0 acre feet of Boise River water per irrigated acre in 1977. System farms utilized 3.8 acre feet per acre of this water. Total project irrigation efficiency in 1977 average 47 percent. District members were assessed $5.36 per irrigated acre for system O & M costs in 1977, while actual total system costs averaged $7.44 per acre during 1974, 1975, and 1976. These costs include average O & M costs incurred by lateral associations.

South Board of Control, Owyhee Project

Situated in Idaho's Owyhee County and Oregon's Malheur County, the Owyhee Project South Board of Control is responsible for supplying 38,000 irrigated acres with water from the Snake and Owyhee River. Composed of two separate irrigation districts, (Gem and Ridgeview) the South Board of Control (SBC) diverts water from two different sources and delivers this water through two different canal systems to system users.

Water was first delivered to SBC users in 1913 by pumping out of the Snake River near Marsing, Idaho, with thirteen centrifugal pumps totalling 6560 horsepower. This pumped water is distributed through the 'A', 'B', and 'C' canals to the old portion of the Gem Irrigation District. In 1935, the U.S. Bureau of Reclamation completed construction of the Owyhee Rservoir in Malheur County, Oregon on the Owyhee River. Water is diverted from the reservoir to SBC lands through a system of tunnels and inverted siphons. From the western project boundary, Owyhee water is conveyed along the western and southern edge of SBC lands by the South Canal constructed by the USBR around 1935, and is delivered to SBC users in the Ridgeview and newer portions of the Gem Irrigation districts. Control of the Owyhee Project was relegated to system users by the USBR in 1952.

In total, 194 miles of canal and lateral systems are used in the SBC project. Five percent of the system is lined open channel and six percent is in the form of tunnels, siphons, or pipelines. The balance of the system is earthen canal. Six ditchriders are employed by the project to regulate farm deliveries. Farms in the SBC project average 77 acres in size, with about 500 farms in total. The western half of the SBC project is in rolling terrain with slopes greater than 3 percent. The eastern and older portion of the project slopes fairly uniformly at less than 3 percent. Project lands are 90 percent surface irrigated. Alfalfa hay, spring grain, alfalfa seed, grass pasture, and corn are the major crop types grown in the SBC project, with small acreages of potatoes winter grain, and sugar beets. The gross value of these crops in 1976 averaged $226 per acre.

Total SBC diversions from the Snake River and Owyhee Rservoir averaged 6.4 acre feet per irrigated acre in 1977, and farm deliveries to 38,030 irrigated acres averaged 4.3 acre feet. Total project irrigation efficiency in 1977 was 32 percent. The project management does administer a penalty for farm deliveries exceeding 4.0 acre feet per acre.

Because of relatively low cost power supplied through the Federal BPA, the South Board of Control has been able to hold total system O & M costs down to an average of $12.45 per irrigated acre. The 1977 O & M assessed by the project averaged $12.12 per irrigated acre.

Little Willow Irrigation District

The smallest and most efficient project studied, Little Willow Irrigation District is comprised of 25 farm operators irrigating a total of 2370 acres. As shown on the map in Appendix A, Little Willow project is located along a narrow mountain valley above the Payette River in Payette County. Water is supplied to the 1913 vintage project from Paddock Reservoir on Little Willow Creek.

Using the Little Willow Creek stream bed as the main conveyance system, water is delivered to district members through a series of five laterals paralleling the stream. Because of the topography and geology of the conveyance system and valley, no net seepage loss of water actually occurs from the Little Willow system. Subsurface flows from canal seepage and deep percolation are recharged back into the stream bed as springs. The stream bed and lateral systems total about 51 miles in length.

The majority of irrigated land along the Little Willow Creek slopes at greater than 3 percent, and sprinkler systems are used to irrigate 40 percent of district farms. The predominate soil of the Little Willow District is loam, and farms average 170 acres in size. One ditch-rider is employed to measure and regulate farm deliveries.

The 1977 irrigation season was drier than average in the Little Willow area; however reservoir supplies proved to be sufficient for normal system operation. Available storage in the 29,000 acre foot capacity Paddock Reservoir was about 19,000 acre feet at the start of the 1977 irrigation season. Reservoir releases averaged 3.8 acre feet per irrigated acre during 1977, and farm deliveries were estimated to be about 3.3 acre feet per acre. Total project irrigation efficiency of the Little Willow Irrigation District in 1977 was 59 percent. Some operational waste from the conveyance system occured near the lower end of the project system.

One half of Little Willow land is normally planted to alfalfa hay and another one fourth of the district is used to grow spring grain. Other crops raised in the project include corn for silage and grass pasture. Gross value of crops in the district averaged $236 per acre in 1976. Total system operation and maintenance by the project, including reservoir O & M cost averaged $11.89 per irrigated acre during 1974, 1975 and 1976. The 1977 O & M assessment by the district was $10.00 per irrigated acre.

CHAPTER V

PROJECT PARAMETERS, WATER USAGE, AND O & M COSTS

Information and data collected for the seventeen irrigation projects evaluated were analyzed and formulated according to procedures discussed in Chapter III. Much of this information is presented in table form in this chapter.

Project Parameters

Irrigation projects in Idaho vary widely in size, shape, and form, as do the projects evaluated in this study. Table 6 is a list of projects studied and their corresponding acreages, system lengths, number of users and turnouts, and project shape factors.

Irrigated areas of the projects vary from 2370 to 149,340 acres. Total conveyance system lengths including project laterals range from 11 miles to 755 miles, and average 125 miles.

The ratio of total irrigated acres to total distribution system length indicates the density of the project conveyance system network in relation to the area served. The ratio is expressed as irrigated areas per system mile of total conveyance system. Of irrigation projects studied, Little Willow Irrigation District has the most efficiently designed conveyance system. The mean in this study is 230 acres per system mile.

Project water users operating farms larger than 20 acres average 242 per project and range from 10 to 1100. System turnouts number from 12 lateral turnouts in the Enterprise system to 2970 farm turnouts operated by the Northside Canal Company with an average of 450.

Table 6. Irrigation project physical characteristics

Project	1977 Irrigated Acres	1977 Assessed Acres	Miles of Distribution System*	Water Users**	System Turnouts	Irrigated Acres/ Sys Mile	(Shape Factor) Compactness Ratio
Enterprise	5970	5980	15	63	12	398	1.96
Parks & Lewisville	8500	8700	35	150	153	243	1.93
Osgood	6220	6220	30	17	13	207	1.57
Idaho	35600	35600	150	540	800	237	2.51
Danskin	4730	6060	20	80	22	237	1.87
Burley	41440	47204	267	570	850	155	1.62
A & B	73850	76796	166	516	700	445	2.40
Milner Low Lift	13480	13524	50	85	260	270	1.84
North Side	149340	149340	755	1100	2970	198	2.15
Wood River Valley	4850	8010	22	34	42	220	1.54
Salmon River	19770	33400	109	174	520	181	2.02
Cedar Mesa	4030	5000	11	10	30	366	1.76
Bell Rapids	25520	25827	119	15	41	214	1.75
King Hill	11000	10321	83	65	128	133	4.17
Settlers	9440	9440	55	170	66	172	1.80
S. Board of Control	38030	39841	194	496	959	196	1.55
Little Willow	2370	2865	51	25	100	46	2.31

* Includes main system and laterals

** Users operating farm enterprises larger than 20 acres

A type of project shape factor was used in this study to describe the compactness of project service areas in relation to relative boundary parameters. Of the projects studied, Osgood, Wood River, and South Board of Control have the most compact service areas, and the King Hill Project is the most spread out and elongated.

Project Distribution Systems

Five of the seventeen projects studied relied on the Federal govenment for assistance in partial or complete construction of the project distribution system. Table 7 is a list of project origins and distribution system characteristics.

Two projects, Osgood and Bell Rapids, are composed mainly of high pressure pipelines supplied with unlined canals, whereas most projects in this report and in Idaho are predominately unlined canal systems. Groundwater is used as a major water supply by the A & B and Wood River Valley Districts. Elevation differences listed in Table 7 describe vertical distances between highest and lowest irrigated points within each project. This difference divided by the total conveyance system length ranges from 0.2 to 30 feet per mile with a mean of 4.5.

Maximum system capacities shown in Table 7 are the maximum combined diversion rates at all points of water diversion within each project system. Total irrigated area divided by maximum system capacity was computed during this study to indicate the relative duty of water within each project. Duties ranged from 7.9 acres per cfs for Wood River Valley project to over 59 acres per cfs for Osgood and Bell Rapids. The project mean was 36.4 irrigated acres per cfs at maximum system capacity.

Table 7. Irrigation project distribution system.

Project	Origin*	% Open Channel	% Lined Channel	% Pipe	Maximum Diversion Cap. (cfs)	Ground Water %	Elevation Difference (feet)	Elevation Difference (ft/sys mile)
Enterprise	Private	100	0	0	154	0	35	2.33
Parks & Lewisville	Private	100	0	0	512	0	72	2.06
Osgood	Private	24	0	76	105	9	80	2.67
Idaho	Private	100	0	0	1540	0	195	1.30
Danskin	Private	100	0	0	302	0	32	1.60
Burley	Federal	100	0	0	1325	0	40	0.15
A & B	Federal	99	0	1	1320	81	200	1.20
Milner Low Lift	Private	92	0	8	296	0	222	4.44
North Side	Private	99	0	1	4050	0	1014	1.34
Wood River Valley	Private	100	0	0	615	43	75	3.41
Salmon River	Federal	91	1	9	705	0	985	9.04
Cedar Mesa	Private	88	5	12	105	0	325	29.55
Bell Rapids	Private	9	0	91	432	0	470	3.95
King Hill	Federal	92	19	8	350	0	395	4.76
Settlers	Private	100	0	0	205	4	150	2.73
S. Board of Control	Federal	94	5	6	825	0	350	1.80
Little Willow	Private	100	0	0	60	0	170	3.33

* Main source of system construction finance

Table 8. Irrigation project farm and soils information

Project	Ave. Farm Size* (Acres)	% Surface Irrigated	% Sprinkler Irrigated	Land Slope (%) (0-3%)	(3-10%)	Average Soil Type	Average Soil Depth (inches)	Average WHC** (in/ft)	1977 Crop Value ($/A)***
Enterprise	95	5	95	0	100	silt loam	48	2.4	276
Parks & Lewisville	57	100	0	100	0	sandy loam	36	1.7	364
Osgood	360	0	100	100	0	silt loam	48	2.7	340
Idaho	80	65	35	100	0	sandy loam	36	1.8	302
Danskin	75	90	10	100	0	loam	60	2.1	189
Burley	75	99	1	50	50	loam	48	2.2	208
A & B	149	90	10	0	100	loam	60	2.2	259
Milner Low Lift	163	99	1	0	100	silt loam	48	2.4	243
North Side	136	70	30	20	80	loam	48	2.0	275
Wood River Valley	204	58	42	100	0	silt loam	30	2.4	167
Salmon River	170	91	9	50	50	silt loam	35	2.5	195
Cedar Mesa	500	100	0	100	0	silt loam	35	2.5	231
Bell Rapids	1700	0	100	0	100	silt loam	35	2.5	590
King Hill	150	20	80	33	67	sandy loam	60	1.7	244
Settlers	56	100	0	100	0	silt loam	48	2.3	185
S. Board of Control	77	90	10	50	50	loam	48	2.2	226
Little Willow	170	60	40	20	80	loam	40	2.1	236

* Average land area operated per water user
** Water holding capacity
*** Gross crop value, $/1977 irrigated acre

Project Farms and Soils

Average farm sizes of projects covered in this report range from 56 to 1700 acres, with a mean size of 250 acres. Farms also vary with age, type of management, and type of irrigation method used. Three projects evaluated are irrigated entirely by surface irrigation and two projects are completely under sprinkler. The average areal coverage of surface systems on a project is about 67 percent with the balance irrigated by sprinkler.

General project field slopes range from moderately flat to rolling, and general soil types of the projects are mostly sandy loams, loams, and silt loams.

Crop values computed for late 1976 / early 1977 prices are listed in Table 8 for each project. These values represent an average of gross values for all crops grown within each project with the average weighted in proportion to relative acreages planted. The values listed range from a low of $167 per acre for Wood River Valley to a high of $590 per acre for Bell Rapids. Those projects with higher than average crop values had higher proportions of potatoes raised on project farms in 1977. The average gross crop value of projects evaluated was $277 per acre. General crop and price information for all projects has been included in Appendix C in this report.

Ditchrider and Turnout Information

The number of ditchriders employed by an irrigation project is largely dependent on the area served by the project system. Other considerations involved in selecting the size of the water control force are the type and degree of water control required, system age and design, and means of water diversion. The average irrigated area served by ditchriders among projects studied is about 5500 acres per ditchrider. This value ranges from 2370 to 9440.

Actual daily mileage driven by ditchriders is also dependent upon system type and degree of control required, as well as the system length relative to irrigated area. Because of continuous surveilance of booster pumps along the main canal system, Bell Rapids ditchriders travel an estimated 115 miles per day. However, on a project similar to the Bell Rapids Project, Osgood ditchriders travel an estimated distance of 25 miles per day. Of all projects studied, ditchriders average about 63 miles per day for water control purposes.

Miles of project conveyance system per ditchrider varies as shown in Table 9. These values range from 11 miles of actual project system per rider on the Cedar Mesa Project to 55 miles of system per rider in the Settlers Irrigation District.

In the Bell Rapids and Osgood systems, turnouts were defined as system delivery points operated and maintained by project personnel; in these cases, turnouts are booster pumps situated along canal systems which supply pressurized water to buried steel pipelines. Risers from these main pipelines function as hookups for sprinkler operation and are operated as a part of the farm system by the water user. Therefore, lateral risers on these mainline systems were not included as turnouts. In the Enterprise system, turnouts include only ditchrider-operated control structures at the head of each multi-user operated lateral.

Turnouts under supervision of each project ditchrider averaged 78 among all projects, and ranged from 7 to 200, as shown in Table 9.

Project Water Rights and Reservoir Storage

Most irrigation companies or districts using water from rivers and

Table 9. Ditchrider and Turnout Information

Project	Number of Ditchriders*	Miles/Day per D.R.**	Irrigated Acres per D.R.	System Miles per D.R.	Turnouts per D.R.	System Turnouts per Mile	Turnouts Measured (%)	Turnouts Checked Daily (%)
Enterprise	1	50	5970	15	12	0.8	0	0
Parks & Lewisville	1	50	8500	35	153	4.4	0	100
Osgood	2	25	3110	15	7	0.4	0	100
Idaho	4	60	8900	38	200	5.3	100	100
Danskin	1	30	4730	20	22	1.1	23	50
Burley	10	70	4144	27	85	3.2	48	100
A & B	11	60	6714	15	64	4.2	100	100
Milner Low Lift	2	45	6740	25	130	5.2	98	100
North Side	22	45	6788	34	135	3.9	100	100
Wood River Valley	1	60	4850	22	42	1.9	100	100
Salmon River	7	43	2824	16	74	4.8	100	100
Cedar Mesa	1	100	4030	11	30	2.7	100	100
Bell Rapids	6	115	4253	20	7	0.3	0	100
King Hill	3	65	3667	28	43	1.5	73	100
Settlers	1	35	9440	55	66	1.2	100	100
S. Board of Control	6	55	6338	32	160	4.9	74	100
Little Willow	1	47	2370	51	100	2.0	100	100

* Includes project watermasters
** Ditchrider

streams in Idaho hold legal rights to that water. Date of initial appropriation of water used by a project can be indicative of the priority of the user in the use of natural flows and the certainty of an adequate irrigation water supply. Table 10 includes a list of the earliest water right date held by each project or project members. These dates also serve as an approximation of the date of initial project conception.

Average water right dates shown in Table 10 were computed by weighting individual dates of water rights according to the flow rate of each right. Weighted dates among the projects vary from May, 1886 to February, 1964 with a mean date of 1903. Total water rights recorded for each project are also listed.

An average water right duty was calculated for projects by dividing the total 1977 irrigated area of each project by the total recorded water rights. The large water right duty of the A & B project is due to the large volume of groundwater diversion used to irrigate the project's service area. The Cedar Mesa project has a relatively insufficient flow right to irrigate the project's service area; however, water supplied from on-stream storage fulfills project water requirements.

The last three columns of Table 10 list reservoir storage available to projects through contracts for off-project storage or through reservoir facilities owned and operated by the projects. The final column lists reservoir storage available for project use at the start of the 1977 irrigation season.

Electrical Power Consumption

Six irrigation projects operated pumping systems requiring substantial amounts of electrical power. A summary of electrical power consumed by project-owned pumps during the 1977 irrigation season is included in Table 11. Power consumption of on-farm pumps, such as in the Wood River

Table 10. Project Water Rights and Reservoir Storage

Project	Earliest Water Right	Average Water Right	Total Right (cfs)	Right Duty (A/cfs)*	Reservoir Storage (af)	Reservoir Storage (af/A)**	Reservoir Storage (1977) (af/A)
Enterprise	6-12-1903	7-15-1910	199	30.0	16071	2.69	1.96
Parks & Lewisville	6 -1-1883	6-10-1890	433	19.6	15250	1.79	0.65
Osgood	6 -1-1885	8-10-1893	232	26.8	21230	3.41	5.11
Idaho	8-13-1888	2-15-1889	1000	35.6	94941	2.67	2.39
Danskin	6 -1-1886	6-10-1904	276	17.1	2350	0.50	0.50
Burley	3-26-1903	12-12-1909	1197	34.6	197142	4.76	3.47
A & B	4 -1-1939	4 -1-1939	267	276.6	138393	1.87	1.66
Milner Low Lift	11-14-1916	9-15-1930	307	43.9	90187	6.69	5.54
North Side	10-11-1900	4-15-1910	4560	32.8	546987	3.66	3.83
Wood River Valley	6-10-1880	1-10-1909	623	7.8	0	0.00	0.00
Salmon River	12-29-1906	2-15-1908	2850	6.9	180000	9.10	4.05
Cedar Mesa	5 -1-1894	5 -1-1894	9	467.5	30000	7.44	4.23
Bell Rapids	2 -3-1964	2 -3-1964	573	44.5	0	0.00	0.00
King Hill	6 -1-1908	7-10-1908	300	36.7	0	0.00	0.00
Settlers	6 -1-1864	5-15-1886	187	50.5	2398	0.25	1.99
S. Board of Control	4-15-1919	6-15-1927	324	117.4	208500	5.48	5.50
Little Willow	12-29-1913	12-29-1913	50	47.4	29000	12.24	8.17

* 1977 irrigated acres / total water right, cfs
** per 1977 irrigated acre

Valley Irrigation District, was not considered to be project-consumed power.

Power consumption has been divided by project irrigated area, total length of conveyance system, and acre-feet of water pumped during 1977 to create a common format for means of comparison. Because of the high lift (600 feet) required to supply water to Bell Rapids users, the Bell Rapids project invests much more power into each acre foot pumped than any other system studied.

The 'Private' power sources listed in Table 10 signify the purchase of electrical power from private or public utilities, namely Utah Power and Light and Idaho Power Companies. 'Federal' power is purchased through the Bonneville Power Administration (BPA) and may be wheeled to the project by private utilities. On the average, power purchased from private utilities in southern Idaho costs between three and eight times power purchased through the BPA.

Seasonal Water Use

Total water diversions and usage of projects were measured, computed, or estimated using procedures and techniques presented and discussed in Chapter III. Project water usage during 1977 is presented in tabular form on a monthly basis in Appendix D of this report. Graphical representations detailing the relative breakdown of water diverted into project systems are included in Appendix E for each irrigation project evaluated.

A seasonal summary of project water use for the 1977 irrigation season is presented in Table 12 on a per irrigated acre basis. The 1977 irrigation season extended from April 1 to October 31, although upper Snake projects did not begin water diversion until after May 1, 1977, and several systems studied were shut off before October 1.

Table 11. 1977 Electrical Power Consumption*

Project	kwh	kwh per acre	kwh per mile	kwh per af Pumped	Power Source**
Enterprise	0	0	0	0	
Parks & Lewisville	0	0	0	0	
Osgood	4207100	676	140236	248	Private
Idaho	0	0	0	0	
Danskin	0	0	0	0	
Burley	27470400	663	102885	117	Federal
A & B	86011800	1165	518143	304	Federal
Milner Low Lift	10682200	792	213644	189	Federal
North Side	0	0	0	0	
Wood River Valley	0	0	0	0	
Salmon River	0	0	0	0	
Cedar Mesa	0	0	0	0	
Bell Rapids	80285600	3146	674668	1200	Private
King Hill	0	0	0	0	
Settlers	89077	9	1620	189	Private
S. Board of Control	11260000	296	58041	105	Federal
Little Willow	0	0	0	0	

* By project pumping plants, only
** Federal power purchased through BPA

Table 12. 1977 Seasonal Project Water Use

Project	Total Inflow (AF/A)	Seepage Losses (AF/A)	Farm Deliv. (AF/A)	Crop ET (AF/A)	Irrig. Reqmt (AF/A)	Deep Perc. (AF/A)	Project Runoff (AF/A)	Conv. Eff. (%)	Proj.App. Eff. (%)	Proj.Irr. Eff. (%)
Enterprise	3.37	0.45	2.69	1.92	1.47	0.76	0.46	80	55	44
Parks & Lewisville	12.46	1.15	6.23	2.04	1.55	4.68	0.00	50	25	12
Osgood	2.72	0.32	2.16	1.80	1.44	0.72	0.00	79	67	53
Idaho	8.83	1.71	4.78	1.93	1.52	3.13	0.13	54	32	17
Danskin	12.55	1.56	10.30	2.92	2.34	7.95	0.00	82	23	19
Burley	5.69	1.12	4.22	2.09	1.70	2.41	0.12	74	40	30
A & B	3.83	0.32	3.44	1.97	1.56	1.37	0.51	90	45	41
Milner Low Lift	4.20	0.63	3.45	1.61	1.33	1.80	0.32	82	38	32
North Side	5.32	1.92	3.39	2.25	2.01	1.21	0.17	64	59	38
Wood River Valley	9.60	2.28	7.32	2.43	2.00	5.32	0.00	76	27	21
Salmon River	3.84	1.41	2.43	1.61	1.37	1.06	0.00	63	56	36
Cedar Mesa	4.23	1.31	2.92	2.15	1.71	1.21	0.00	69	59	40
Bell Rapids	2.62	0.21	2.41	1.61	1.44	0.97	0.00	92	60	55
King Hill	10.18	2.74	5.83	2.67	2.49	3.34	0.00	57	43	24
Settlers	4.98	1.02	3.79	2.61	2.33	1.45	0.00	76	62	47
S. Board of Control	6.42	1.26	4.33	2.39	2.06	1.33	0.94	67	47	32
Little Willow	3.78	0.00	3.28	2.53	2.23	1.06	0.00	87	68	59

Project Inflow

Total volumes of water diverted per irrigated acre into project systems in 1977 varied substantially. Five irrigation projects diverted eight acre feet per acre or more, and two companies, Parks & Lewisville and Danskin, diverted about 12.5 acre feet per irrigated acre during 1977. On the Osgood and Bell Rapids projects, where diverted water is supplied to system users at high pressures, seasonal diversions averaged 2.62 and 2.72 acre feet per acre . Diversions abong the seventeen projects averaged 6.2 acre feet per acre, with a standard deviation of 3.3. A weighted average diversion based on actual project acreages was calculated at 5.5 acre feet per irrigated acre.

Conveyance System Performances

Seepage losses from project conveyance systems varied from no net seepage from the Little Willow system to an estimated 2.5 acre feet of seepage per irrigated acre from the King Hill main canal and laterals. The mean project seepage loss in 1977 was about 1.1 acre feet per acre, with a standard deviation among projects of 0.8. Seasonal seepage losses are included in Table 12.

Operational losses from canal systems normally occur as spills along the system through control structures or as excess water at the system end. Monthly volumes of operational losses from project distribution systems are presented in Appendix D of this report. Seasonal values for 1977 range from no operational spills from the Wood River Valley, Salmon, Cedar Mesa, and Bell Rapids systems to over 5 acre feet per irrigated acre from Parks and Lewisville canals. The project average was 0.7 feet per acre for the 1977 season.

Project conveyance efficiencies were computed in this study by dividing farm deliveries by project diversions and multiplying by 100. Monthly conveyance efficiencies are included in Appendix D, and seasonal project conveyance efficiencies are listed in Table 12. These efficiencies range from a low of 50 percent for the Parks and Lewisville system to a high of 92 percent on the Bell Rapids project. Conveyance efficiencies averaged 73 percent among the projects with a standard deviation of 12 percent.

On-farm Application of Project Water

Water deliveries to farms on all projects averaged 3.77 acre feet per acre during 1977, computed on a weighted basis. Average farm deliveries of projects averaged 4.3 acre feet per irrigated acre, ranging from 2.2 acre feet per acre on the Osgood project to 10.3 acre feet per acre for Danskin users. All deliveries were by means of gravity flow, except for the Bell Rapids and Osgood projects, where farm operators received water from high pressure pipelines, and Wood River Valley, where 43 percent of on-farm irrigation water in 1977 was pumped directly from groundwater supplies.

Evapotranspiration rates of project crops were estimated based on averaged planting dates, crop types, and climatic and meteorological data collected during 1977. A modified Penman-type combination equation was used to compute reference ET rates, and crop coefficients were used to caluculate evapotranspiration rates of individual crops. This procedure is described in detail in Chapter III. The crop ET listed in Table 12 is the average project seasonal evapotranspiration per acre calculated by averaging composite crop ET use in accordance with respective acreages grown. Because of variance in crop distributions, season lengths, and 1977 weather conditions, average project seasonal rates ranged from a low of

1.61 acre feet per acre for Milner Low Lift, Salmon River, and Bell Rapids to a high value of 2.92 acre feet per acre for the Danskin Ditch Company. The lower ET values are due, in large part, to large acreages of dry beans having relatively low ET rates. Danskin water users grow large amounts of alfalfa and grass pasture, both of which consume significant amounts of water. Also, the irrigation season on the Danskin project was long, stretching from April 1 to October 31. Monthly evapotranspiration rates calculated for specific crops are listed in Appendix C. Evapotranspiration rates of crops grown on the Bell Rapids, Cedar Mesa, Salmon River and King Hill projects were calculated using weather data collected at Kimberly, Idaho. Because daily wind run and vapor pressure deficits of the air in these project areas is often greater than for the Kimberly area, evapotranspiration and irrigation requirements calculated for these four projects may be low (Burman et. al., 1975).

Irrigation requirements listed in Table 12 represent actual volumes of irrigation water required by actively growing crops, considering precipitation and antecedent soil moisture, to fulfil evapotranspiration needs. The irrigation requirement is the total amount of water required from an irrigation system operating at 100 percent efficiency. Irrigation water requirements of projects during 1977 ranged from 1.33 acre feet per acre on the Milner Low Lift Project to 2.49 acre feet per acre on the King Hill project. The average irrigation requirement among projects equalled 2.15 acre feet per acre.

Irrigation water from farms was assumed to leave project boundaries as evapotranspiration, as the surface runoff portion of return flow, or as deep percolation entering some type of groundwater system. Estimated deep percolation losses from project farms averaged 2.3 acre feet per acre during 1977, with a standard deviation of 2.0 acre feet. Deep percolation losses in 1977 from the Bell Rapids, Cedar Mesa, Salmon River and King Hill projects may have been lower than estimated if estimates of evapotranspiration used are lower than ET which actually occured.

Project runoff ranged from zero for over half of the projects to 0.94 acre feet per acre from the South Board of Control. Projects averaged only 0.16 acre feet of runoff per acre in 1977. Small values of project runoff do not necessarily indicate low amounts of surface runoff from individual farms, but only that small amounts of this runoff actually left project boundaries as runoff or through surface drains. Large portions of the surface runoff portion of farm deliveries may be recycled within the farm or project system.

Project application efficiencies, computed as average irrigation requirements divided by average farm deliveries and multiplied by 100, ranged between 23 and 68 percent for the 1977 irrigation season. The mean application efficiency of projects studied was 47 percent. Little Willow Irrigation District had the highest application efficiency, even though only 40 percent of the project is irrigated with sprinklers.

Project Irrigation Efficiencies

A project irrigation efficiency term is often used to indicate the relative performance of an irrigation water delivery organization and member farms in applying diverted water resources to the beneficial use of fulfilling crop water requirements. However, low project efficiencies do not necessarily indicate losses of diverted water to other instream or offstream uses, as project return flows are often returned to rivers or drains for reuse, and deep percolation losses may reappear into surface systems through springs or may be reclaimed through groundwater pumping. These losses can represent a net loss of energy and soil nutrients, although in some regions of the state, namely the Upper Snake Region, deep percolation from irrigation projects constitutes valuable recharge to the Snake River Plain Aquifer system.

Project irrigation efficiencies computed on a monthly basis are listed in water use tables in Appendix F. Seasonal efficiencies are listed in Table 12 for the seventeen projects studied. Project irrigation efficiencies, defined as the crop irrigation requirements divided by total project diversions, ranged from 12 percent on the Parks and Lewisville Project to a high of 59 percent on Little Willow District for the 1977 season. The mean of all projects was 35 percent, with a standard deviation of 13 percent.

Annual Project Costs

Administrative, water control, and maintenance costs reported in this study are three year averages for the calendar years 1974, 1975 and 1976. These costs were adjusted to 1977 prices using the procedure discussed in Chapter III. Electrical power and reservoir O & M costs were evaluated for 1977, only. In many cases, assumptions were required concerning breakdown of project costs into appropriate categories. Cost summaries are presented for individual projects in Appendix B of this report and are tabulated for purposes of comparison in the following tables.

O & M Costs of Systems

Table 13 lists total O & M costs of systems in terms of administrative, water control, maintenance, power, and reservoir costs. By definition, total O & M costs are the sum of administrative, water control and maintenance costs, and total project costs are equal to total O & M costs plus power costs (see Figure 3). Total system costs include power and reservoir costs and total O & M costs.

Table 13. Annual Irrigation Project Costs

Project	Administrative* ($)	Water Control* ($)	Maintenance* ($)	Total O&M* ($)	1977 Power** ($)	Total Project ($)	1977 Res.*** ($)	Total System ($)
Enterprise	1183	4470	17283	22936	0	22936	805	23741
Parks & Lewisville	2462	3871	9119	15452	0	15452	232	15684
Osgood	10169	16935	36372	63476	107795	171271	1064	172335
Idaho	29353	27022	73486	129861	0	129861	4296	134157
Danskin	1548	2061	7156	10765	0	10765	99	10864
Burley	58369	116252	283199	457820	87630	545450	22472	567922
A & B	116410	167271	493840	777521	422731	1200250	5650	1205900
Milner Low Lift	18294	20508	93074	131876	58858	190734	3331	194065
North Side	91688	176297	592020	860005	0	860005	34749	894754
Wood River Valley	1028	4761	8319	14108	0	14108	0	14108
Salmon River	54165	33451	99316	186932	0	186932	6700	193632
Cedar Mesa	4502	9191	5724	19417	0	19417	400	19817
Bell Rapids	60015	68612	181687	310314	1256140	1566450	0	1566450
King Hill	21155	22207	97046	140408	0	140408	0	140408
Settlers	14759	9080	44609	68448	1398	69846	406	70252
S. Board of Control	72309	76030	263815	412154	39208	451362	22071	473433
Little Willow	2477	5567	19898	27942	0	27942	228	28170

* 1974,1975,and 1976 average costs adjusted to 1977
** 1977 costs, only
*** Reservoir costs include only O&M costs.

Tables 14, 15 and 16 present an analysis of system costs in terms of cost per 1977 irrigated acre, system mile, and system water user farming more than 20 acres. Table 17 expresses the cost categories as percentage of total costs.

There is considerable variation in total O & M costs among the projects when compared on a cost per unit basis (Table 14). The average total O & M cost per 1977 irrigated acre is $7.70, ranging from $1.82 to $12.76. Total system costs, which include power and reservoir O & M costs in addition to total O & M costs averaged $12.56 per irrigated acre, and ranged from $1.85 for Parks and Lewisville to $61.38 for Bell Rapids. Total O & M costs per system mile averaged $1647 and ranged from $441 to $4684. When power and reservoir costs were included, costs averaged $2766 per mile of distribution system and ranged from $448 to $13,164. Total O & M costs per system user varied substantially, averaging $2226 and ranging from $103 to $20,688. Total system costs averaged $7649 and ranged from $105 per Parks and Lewisville user to $104,430 per farm operator on the Bell Rapids Project in 1977. The tremendous cost to Bell Rapids users is due to large farm operations (1700 acres) on the project and the total pumping head of 750 feet required for system operation.

Project administrative costs were found to average 16 percent of total O & M budgets and range from 5 percent to 29 percent (Table 17). Water control costs averaged 22 percent of total O & M costs and ranged from 13 percent to 47 percent, while project maintenance costs averaged 62 percent of the total O & M budgets and ranged from 29 percent to 75 percent.

Personnel Costs and Labor Requirements

The number of personnel and annual costs of personnel required to operate project systems were analyzed. Work forces were measured in

Table 14. Annual Irrigation Project Costs per Acre

Project	Administrative* ($/A)	Water Control* ($/A)	Maintenance* ($/A)	Total O&M* ($/A)	1977 Power** ($/A)	Total Project ($/A)	1977 Res.*** ($/A)	Total System ($/A)
Enterprise	0.20	0.75	2.89	3.84	0.00	3.84	0.13	3.98
Parks & Lewisville	0.29	0.46	1.07	1.82	0.00	1.82	0.03	1.85
Osgood	1.63	2.72	5.85	10.21	17.33	27.54	0.17	27.71
Idaho	0.82	0.76	2.06	3.65	0.00	3.65	0.12	3.77
Danskin	0.33	0.44	1.51	2.28	0.00	2.28	0.02	2.30
Burley	1.41	2.81	6.83	11.05	2.11	13.16	0.54	13.70
A & B	1.58	2.27	6.69	10.53	5.72	16.25	0.08	16.33
Milner Low Lift	1.36	1.52	6.90	9.78	4.37	14.15	0.25	14.40
North Side	0.61	1.18	3.96	5.76	0.00	5.76	0.23	5.99
Wood River Valley	0.21	0.98	1.72	2.91	0.00	2.91	0.00	2.91
Salmon River	2.74	1.69	5.02	9.46	0.00	9.46	0.34	9.79
Cedar Mesa	1.12	2.28	1.42	4.82	0.00	4.82	0.10	4.92
Bell Rapids	2.35	2.69	7.12	12.16	49.22	61.38	0.00	61.38
King Hill	1.92	2.02	8.82	12.76	0.00	12.76	0.00	12.76
Settlers	1.56	0.96	4.73	7.25	0.15	7.40	0.04	7.44
S. Board of Control	1.90	2.00	6.94	10.84	1.03	11.87	0.58	12.45
Little Willow	1.05	2.35	8.40	11.79	0.00	11.79	0.10	11.89

* 1974,1975,and 1976 average costs adjusted to 1977- 1977 irrigated acres
** 1977 costs, only
*** Reservoir costs include only O&M costs.

Table 15. Annual Irrigation Project Costs per System Mile

Project	Administrative* ($/mi)	Water Control* ($/mi)	Maintenance* ($/mi)	Total O&M* ($/mi)	1977 Power** ($/mi)	Total Project ($/mi)	1977 Res.*** ($/mi)	Total System ($/mi)
Enterprise	79	298	1152	1529	0	1529	54	1583
Parks & Lewisville	70	111	261	441	0	441	7	448
Osgood	339	565	1212	2116	3593	5709	35	5745
Idaho	196	180	490	866	0	866	29	894
Danskin	77	103	358	538	0	538	5	543
Burley	219	435	1061	1715	328	2043	84	2127
A & B	701	1008	2975	4684	2547	7230	34	7264
Milner Low Lift	366	410	1861	2638	1177	3815	67	3881
North Side	121	234	784	1139	0	1139	46	1185
Wood River Valley	47	216	378	641	0	641	0	641
Salmon River	497	307	911	1715	0	1715	61	1776
Cedar Mesa	409	836	520	1765	0	1765	36	1802
Bell Rapids	504	577	1527	2608	10556	13163	0	13163
King Hill	255	268	1169	1692	0	1692	0	1692
Settlers	268	165	811	1245	25	1270	7	1277
S. Board of Control	373	392	1360	2125	202	2327	114	2440
Little Willow	49	109	390	548	0	548	4	552

* 1974,1975,and 1976 average costs adjusted to 1977
** 1977 costs, only
*** Reservoir costs include only O&M costs.

Table 16. Annual Irrigation Project Costs per System User

Project	Administrative* ($/user)	Water Control* ($/user)	Maintenance* ($/user)	Total O&M* ($/user)	1977 Power** ($/user)	Total Project ($/user)	1977 Res.*** ($/user)	Total System ($/user)
Enterprise	19	71	274	364	0	364	13	377
Parks & Lewisville	16	26	61	103	0	103	2	105
Osgood	598	996	2140	3734	6341	10075	63	10137
Idaho	54	50	136	240	0	240	8	248
Danskin	19	26	89	135	0	135	1	136
Burley	102	204	497	803	154	957	39	996
A & B	226	324	957	1507	819	2326	11	2337
Milner Low Lift	215	241	1095	1551	692	2244	39	2283
North Side	83	160	538	782	0	782	32	813
Wood River Valley	30	140	245	415	0	415	0	415
Salmon River	311	192	571	1074	0	1074	39	1113
Cedar Mesa	450	919	572	1942	0	1942	40	1982
Bell Rapids	4001	4574	12112	20688	83743	104430	0	104430
King Hill	325	342	1493	2160	0	2160	0	2160
Settlers	87	53	262	403	8	411	2	413
S. Board of Control	146	153	532	831	79	910	44	955
Little Willow	99	223	796	1118	0	1118	9	1127

* 1974,1975,and 1976 average costs adjusted to 1977
** 1977 costs, only
*** Reservoir costs include only O&M costs.

Table 17. Annual Irrigation Project Costs, Percent of Total

Project	Admini-strative* (%O&M)	Water Control* (%O&M)	Mainte-nance* (%O&M)	Total O&M* (%O&M)	Total O&M* (%tot)	1977 Power (%tot)	Total Project (%tot)	1977 Res.*** (%tot)	Total System (%tot)
Enterprise	5	19	75	100	97	0	97	3	100
Parks & Lewisville	16	25	59	100	99	0	99	1	100
Osgood	16	27	57	100	37	63	99	1	100
Idaho	23	21	57	100	97	0	97	3	100
Danskin	14	19	66	100	99	0	99	1	100
Burley	13	25	62	100	81	15	96	4	100
A & B	15	22	64	100	64	35	100	0	100
Milner Low Lift	14	16	71	100	68	30	98	2	100
North Side	11	20	69	100	96	0	96	4	100
Wood River Valley	7	34	59	100	100	0	100	0	100
Salmon River	29	18	53	100	97	0	97	3	100
Cedar Mesa	23	47	29	100	98	0	98	2	100
Bell Rapids	19	22	59	100	20	80	100	0	100
King Hill	15	16	69	100	100	0	100	0	100
Settlers	22	13	65	100	97	2	99	1	100
S. Board of Control	18	18	64	100	87	8	95	5	100
Little Willow	9	20	71	100	99	0	99	1	100

* 1974,1975,and 1976 costs adjusted to 1977

** 1977 costs, only

*** Reservoir costs include only O&M costs.

man-years defined as the work of one man for one year. Administrative personnel include the manager (or that portion and cost of the manager's time devoted to administration), secretaries, clerks, and bookkeepers. Watermasters, ditchriders, and pump operators comprise water control personnel. The maintenance category includes laborers, equipment operators, pump maintenance crews, etc. In most projects, ditchriders may work on both water control and maintenance.

Personnel costs and labor requirements of projects have been tabulated in Table 18. Costs for personnel include salaries and wages, housing benefits, FICA, insurance, and retirement funds paid by the project. Personnel costs per acre, mile of distribution system, and system user are presented in Tables 19, 20, and 21. A relative breakdown of the cost categories as percentages of total personnel costs and personnel costs as a percent of total O & M costs are included in Table 22 along with labor requirements. Administrative personnel costs of projects averaged 14 percent of total personnel costs, ranging from 5 percent to 25 percent, whereas water control accounted for an average 36 percent of total costs of personnel and ranged from 17 percent to 70 percent. Maintenance costs ranged from 17 percent on the Cedar Mesa Project to 67 percent in the Settlers Irrigation District and averaged 50 percent of total project personnel costs. Thirty eight percent of the total annual O & M budget was spent for employment of personnel by the Enterprise District and 67 percent was apportioned for personnel costs on the Danskin and Settlers projects. Personnel costs averaged 54 percent of total O & M expenditures for the seventeen projects evaluated. These expenditures did not include reservoir O & M or electrical power costs. As for actual personnel activities, an average of 12 percent of a project's working force was used for administrative purposes. Water control and maintenance activities required an average of 31 percent

Table 18. Irrigation Project Personnel Costs and Labor Requirements

Project	Personnel Costs*				Personnel Labor			
	Admini-strative ($)	Water Control ($)	Mainte-nance ($)	Total ($)	Admini-strative (m-y)**	Water Control (m-y)**	Mainte-nance (m-y)**	Total (m-y)**
Enterprise	576	3358	4734	8668	0.15	0.42	0.28	0.85
Parks & Lewisville	594	2727	3247	6568	0.08	0.35	0.42	0.85
Osgood	8045	10877	13508	32430	0.33	0.64	1.06	2.03
Idaho	12625	24367	39811	76803	1.20	2.40	4.50	8.10
Danskin	881	5032	1255	7168	0.10	0.20	0.32	0.62
Burley	38116	101498	149050	288664	3.00	11.00	12.30	26.30
A & B	79754	130502	261004	471260	6.00	8.20	29.80	44.00
Milner Low Lift	7019	17942	41246	66207	0.40	1.30	2.80	4.50
North Side	38832	130083	337361	506276	3.50	19.70	30.90	54.10
Wood River Valley	355	4164	3202	7721	0.05	0.50	0.26	0.81
Salmon River	23563	24141	50848	98552	2.00	3.63	4.87	10.50
Cedar Mesa	2058	6024	1632	9714	0.25	0.50	0.15	0.90
Bell Rapids	11783	58579	53168	123530	0.60	4.10	5.25	9.95
King Hill	14808	15473	47911	78192	1.20	1.60	3.67	6.47
Settlers	7422	7683	30880	45985	1.00	0.70	3.45	5.15
S. Board of Control	54905	60535	152401	267841	3.80	5.50	14.10	23.40
Little Willow	1524	3888	6871	12283	0.25	0.42	0.65	1.32

* 1974,1975,and 1976 costs adjusted to 1977

** man-years

Table 19. Irrigation Project Personnel Costs and Labor Requirements per Acre

Project	Personnel Costs*				Personnel Labor			
	Administrative ($/A)	Water Control ($/A)	Maintenance ($/A)	Total ($/A)	Administrative (m-y/t)**	Water Control (m-y/t)**	Maintenance (m-y/t)**	Total (m-y/t)**
Enterprise	0.10	0.56	0.79	1.45	0.25	0.70	0.47	1.42
Parks & Lewisville	0.07	0.32	0.38	0.77	0.09	0.41	0.49	1.00
Osgood	1.29	1.75	2.17	5.21	0.53	1.03	1.70	3.26
Idaho	0.35	0.68	1.12	2.16	0.34	0.67	1.26	2.28
Danskin	0.19	1.06	0.27	1.52	0.21	0.42	0.68	1.31
Burley	0.92	2.45	3.60	6.97	0.72	2.65	2.97	6.35
A & B	1.08	1.77	3.53	6.38	0.81	1.11	4.04	5.96
Milner Low Lift	0.52	1.33	3.06	4.91	0.30	0.96	2.08	3.34
North Side	0.26	0.87	2.26	3.39	0.23	1.32	2.07	3.62
Wood River Valley	0.07	0.86	0.66	1.59	0.10	1.03	0.54	1.67
Salmon River	1.19	1.22	2.57	4.98	1.01	1.84	2.46	5.31
Cedar Mesa	0.51	1.49	0.40	2.41	0.62	1.24	0.37	2.23
Bell Rapids	0.46	2.30	2.08	4.84	0.24	1.61	2.06	3.90
King Hill	1.35	1.41	4.36	7.11	1.09	1.45	3.34	5.88
Settlers	0.79	0.81	3.27	4.87	1.06	0.74	3.65	5.46
S. Board of Control	1.44	1.59	4.01	7.04	1.00	1.45	3.71	6.15
Little Willow	0.64	1.64	2.90	5.18	1.05	1.77	2.74	5.57

* 1974,1975,and 1976 costs adjusted to 1977

** man-years per ten thousand acres irrigated in 1977

Table 20. Irrigation Project Personnel Costs and Labor Requirements per System Mile

Project	Personnel Costs*				Personnel Labor			
	Administrative ($/mi)	Water Control ($/mi)	Maintenance ($/mi)	Total ($/mi)	Administrative (m-y/mi)**	Water Control (m-y/mi)**	Maintenance (m-y/mi)**	Total (m-y/mi)*
Enterprise	38	224	316	578	0.010	0.028	0.019	0.057
Parks & Lewisville	17	78	93	188	0.002	0.010	0.012	0.024
Osgood	268	363	450	1081	0.011	0.021	0.035	0.068
Idaho	84	162	265	512	0.008	0.016	0.030	0.054
Danskin	44	252	63	358	0.005	0.010	0.016	0.031
Burley	143	380	558	1081	0.011	0.041	0.046	0.099
A & B	480	786	1572	2839	0.036	0.049	0.180	0.265
Milner Low Lift	140	359	825	1324	0.008	0.026	0.056	0.090
North Side	51	172	447	671	0.005	0.026	0.041	0.072
Wood River Valley	16	189	146	351	0.002	0.023	0.012	0.037
Salmon River	216	221	466	904	0.018	0.033	0.045	0.096
Cedar Mesa	187	548	148	883	0.023	0.045	0.014	0.082
Bell Rapids	99	492	447	1038	0.005	0.034	0.044	0.084
King Hill	178	186	577	942	0.014	0.019	0.044	0.078
Settlers	135	140	561	836	0.018	0.013	0.063	0.094
S. Board of Control	283	312	786	1381	0.020	0.028	0.073	0.121
Little Willow	30	76	135	241	0.005	0.008	0.013	0.026

* 1974,1975,and 1976 costs adjusted to 1977

** man-years per system mile

Table 21. Irrigation Project Personnel Costs and Labor Requirements per System User

Project	Personnel Costs*				Personnel Labor			
	Administrative ($/user)	Water Control ($/user)	Maintenance ($/user)	Total ($/user)	Administrative (m-y/u)**	Water Control (m-y/u)**	Maintenance (m-y/u)**	Total (m-y/u)**
Enterprise	9	53	75	138	0.002	0.007	0.004	0.013
Parks & Lewisville	4	18	22	44	0.001	0.002	0.003	0.006
Osgood	473	640	795	1908	0.019	0.038	0.062	0.119
Idaho	23	45	74	142	0.002	0.004	0.008	0.015
Danskin	11	63	16	90	0.001	0.003	0.004	0.008
Burley	67	178	261	506	0.005	0.019	0.022	0.046
A & B	155	253	506	913	0.012	0.016	0.058	0.085
Milner Low Lift	83	211	485	779	0.005	0.015	0.033	0.053
North Side	35	118	307	460	0.003	0.018	0.028	0.049
Wood River Valley	10	122	94	227	0.001	0.015	0.008	0.024
Salmon River	135	139	292	566	0.011	0.021	0.028	0.060
Cedar Mesa	206	602	163	971	0.025	0.050	0.015	0.090
Bell Rapids	786	3905	3545	8235	0.040	0.273	0.350	0.663
King Hill	228	238	737	1203	0.018	0.025	0.056	0.100
Settlers	44	45	182	271	0.006	0.004	0.020	0.030
S. Board of Control	111	122	307	540	0.008	0.011	0.028	0.047
Little Willow	61	156	275	491	0.010	0.017	0.026	0.053

* 1974,1975,and 1976 costs adjusted to 1977

** man-years per water user > 20 acres

Table 22. Irrigation Project Personnel Costs and Labor Requirements, Percent of Total

Project	Personnel Costs*				Personnel Labor**			
	Administrative (%)***	Water Control (%)***	Maintenance (%)***	Total (%O&M)****	Administrative (%)	Water Control (%)	Maintenance (%)	Total (%)
Enterprise	7	39	55	38	18	49	33	100
Parks & Lewisville	9	42	49	43	9	41	49	100
Osgood	25	34	42	51	16	32	52	100
Idaho	16	32	52	59	15	30	56	100
Danskin	12	70	18	67	16	32	52	100
Burley	13	35	52	63	11	42	47	100
A & B	17	28	55	61	14	19	68	100
Milner Low Lift	11	27	62	50	9	29	62	100
North Side	8	26	67	59	6	36	57	100
Wood River Valley	5	54	41	55	6	62	32	100
Salmon River	24	24	52	53	19	35	46	100
Cedar Mesa	21	62	17	50	28	56	17	100
Bell Rapids	10	47	43	40	6	41	53	100
King Hill	19	20	61	56	19	25	57	100
Settlers	16	17	67	67	19	14	67	100
S. Board of Control	20	23	57	65	16	24	60	100
Little Willow	12	32	56	44	19	32	49	100

* 1974,1975,and 1976 costs adjusted to 1977
** percent total project labor requirement
*** percent total personnel costs
**** percent total project O&M costs

and 57 percent of the project labor force, respectively.

Project personnel costs averaged $4.16 per 1977 irrigated acre over a three year period, ranging form $0.77 for the Parks and Lewisville system to $7.10 per acre for King Hill users. Personnel costs per system mile averaged $895 and ranged from $188 to $2839 expended by the A & B District. Project water users paid an average of $1028 per year for personnel costs, ranging from $44 on the Parks and Lewisville system to $8235 per user on the Bell Rapids system.

Project Material and Equipment Costs

Average annual expenditures for project maintenance materials are presented in Table 23. Also included are estimated costs of equipment depreciation. Annual depreciation costs on a per unit basis indicate the modernization and relative size of project machinery and vehicle fleets. Depreciation of pumps and water control structures were not included in the depreciation calculation. Costs for maintenance materials varied from $25 to $818 per mile of distribution system for projects, averaging $276. Material costs comprised an average 15 percent of the total O & M budget, and equipment depreciation costs accounted for an average of 9 percent of O & M costs. Depreciation costs ranged from $41 to $370 per system mile per year and averaged $138.

Table 23. Annual Project Material and Equipment Costs

Project	Maintenance Materials* ($)	($/A)***	($/mi)	(%O&M)	Equipment Depreciation** ($)	($/A)	($/mi)	(%O&M)
Enterprise	3647	0.61	243	15.9	3339	0.56	223	14.6
Parks & Lewisville	2385	0.28	68	15.4	4043	0.48	116	26.2
Osgood	19806	3.18	660	31.2	4725	0.76	158	7.4
Idaho	15842	0.45	106	12.2	8973	0.25	60	6.9
Danskin	852	0.18	43	7.9	1000	0.21	50	9.3
Burley	100081	2.42	375	21.9	15755	0.38	59	3.4
A & B	124081	1.68	747	16.0	55185	0.75	332	7.1
Milner Low Lift	20856	1.55	417	15.8	18476	1.37	370	14.0
North Side	90101	0.60	119	10.5	58672	0.39	78	6.8
Wood River Valley	551	0.11	25	3.9	1650	0.34	75	11.7
Salmon River	25375	1.28	233	13.6	20022	1.01	184	10.7
Cedar Mesa	1386	0.34	126	7.1	1446	0.36	131	7.4
Bell Rapids	97391	3.82	818	31.4	11649	0.46	98	3.8
King Hill	16115	1.47	194	11.5	11367	1.03	137	8.1
Settlers	8871	0.94	161	13.0	5478	0.58	100	8.0
S. Board of Control	55921	1.47	288	13.6	27895	0.73	144	6.8
Little Willow	3784	1.60	74	13.5	2087	0.88	41	7.5

* Includes weed control supplies
** Includes depreciation of leased machinery and private vehicles used for water control
*** per 1977 irrigated acre

CHAPTER VI

PROJECT WATER USE AND COST RELATIONSHIPS

Statistical analyses were performed on relationships between various items of quantitative information collected from the irrigation projects evaluated during this study. In all, 213 different parameters describing system costs, water use, and system information were correlated and used in regression analyses. These parameters are listed in Appendix G of this report. A statistical analysis computer package SAS76 (Barr et al, 1976) supported on the University of Idaho IBM 370-145 computer was used to perform all statistical analyses using data stored on magnetic disk.

Correlation Analysis

The CORR procedure of SAS76 was used to output simple linear correlation coefficients for each pair of the 213 parameters gathered. In all, over 22,000 correlation coefficients were evaluated. Meaningful relationships with significantly high correlation coefficients have been selected for presentation. The hypothesis tested during the correlation analyses was H_0: $\rho = 0$, where ρ is the population correlation coefficient. A coefficient of determination (r^2) equal to 0.232 (n = 17) marked the 95% level of confidence that the hypothesis was false, or that $\rho \neq 0$. An r^2 equal to 0.367 or greater was classified as highly significant at a 99% level of confidence ($\alpha = 0.01$). Meaningful relationships with significant linear correlations (relationships) have been presented in Tables 24-29 in this chapter. Unless footnoted, these relationships are all highly significant ($\alpha < 0.01$). Most terms listed in these tables are defined in Chapter III.

Water Use Efficiencies

Listed in Table 24 are significant relationships between efficiency terms and cost and parameter terms. As shown in this table, annual project irrigation efficiencies were found to be directly proportional to conveyance and application efficiencies, water control and maintenance material costs, and soil texture; whereas, irrigation efficiencies were inversely related to the project system diversion capacity and farm deliveries of water. In other words, projects with relatively high farm deliveries per unit generally had lower than average project irrigation efficiencies. No significant relationship was found between efficiency and the portion of project area irrigated with sprinkler systems.

Conveyance efficiencies were significantly higher than average on systems with high power consumption and in areas of heavy soils (high water holding capacity). Also, projects with earlier water rights had lower conveyance efficiencies. Conveyance efficiencies were statistically unrelated to project application efficiencies, project diversions per acre, and total operation and maintenance costs per irrigated acre.

Average seasonal application efficiencies were directly proportional to soil texture and amounts of money spent on water control and maintenance. One interesting relationship concerning application efficiency indicates that Idaho projects with greater dependence on reservoir storage for project diversions have higher application efficiencies. Also, project systems with large diversion capacities

TABLE 24. Relationships between 1977 water use efficiencies and system characteristics for selected Idaho projects.

	Directly Related[1]	Inversely Related[1]	Unrelated[3]
Project Irrigation Efficiency	Project conveyance eff. Project application eff. Water control costs, $/ac Maintenance materials, $/ac Silt faction of soil	System capacity, cfs/ac Farm deliveries, af/a	% sprinkler Project terrain Elevation differential Power cost $/ac Reservoir cost $/ac Average water right date
Project Conveyance Efficiency	Total system costs, $/mi[2] Power consumption, kwh/mi % of diversions pumped Maintenance cost, $/ac inflow Water holding capacity, in/ft	Average water right date	Project application eff. Project diversions, af/ac Total O & M costs, $/ac Power costs, $/ac % sprinkler
Project Application Efficiency	Water control, $/af inflow Maintenance, $/af inflow Water control costs, $/ac Silt faction of soil 1977 reservoir storage, af/af 1977 inflow	Project diversions, af/ac Farm deliveries, af/ac System capacity, cfs/ac	Project conveyance eff. Power Costs, $/ac Return flow % sprinkler Average water right date

1 highly significant relationships at 99% confidence level
2 significant relationships at 95% confidence level
3 relationship is not significant at 95% confidence level ($r^2 < 0.232$)

per unit area are apt to be less efficient in water application. Project application efficiencies for the Idaho projects studied were inversely proportional to project diversions and farm deliveries, but unrelated to sprinkler irrigated area or water right priorities.

Project Water Use

Relationships between various uses of diverted water and system cost and characteristics are presented in Table 25. Project diversions per unit area in 1977 are seen to have significantly affected canal seepage losses, deep percolation and return flow from project lands. Diversions were lower for projects with fine-textured soils and high water holding capactities. Also, projects spending more money on water control activities diverted less water per irrigated acre. Project size, length, shape, number of users, and types of crops grown had no significant impact on system diversions per unit area.

Canal seepage was shown to have a negative effect on conveyance and irrigation efficiencies. Also, in systems where greater amounts of money were spent on water control and system maintenance per unit of water conveyed through the system, seepage losses were lower. The average project soil type, system age or project compactness had no significant effect on seepage losses.

Farm runoff leaving project boundaries, per irrigated acre, was proportional to operational spills and losses from project conveyance systems. Projects with low volumes of farm surface runoff generally had relatively low volumes of operational spills. Surface runoff losses were not found to significantly affect project application efficiencies.

Deep percolation of proejct water did significantly affect project

TABLE 25. Relationships between 1977 water use and system characteristics for selected Idaho projects.

	Directly Related[1]	Inversely Related[1]	Unrelated[3]
1977 Project diversions, af/ac	System capacity, cfs/ac Canal seepage, af/ac Deep percolation, af/ac Return flow, af/ac	Project irrigation eff. Project application eff. Silt faction of soil Water holding capacity Water control, $/ac Maintenance materials, $/mi	Potato acreage, % Alfalfa acreage, % Project size System length Number of users Project compactness
Canal Seepage, af/ac	Project diversions, af/ac	Project conveyance eff. Project Irrigation eff. O & M costs, $/af inflow Water control, $/af inflow Maintenance, $/af inflow	Soil type Project age Project compactness Irrigated acres per mile of system
Project Surface runoff, af/ac	Operational waste af/ac		Project Application efficiency
Deep percolation af/ac	Project diversions, af/ac Farm deliveries, af/a System capacity, cfs/ac Average crop ET, af/a Water control personnel costs, % total personnel[2]	Project Irrigation eff. Project application eff. Water control, $/af inflow Maintenance, $/af inflow O & M costs, $/af inflow[2]	Soil type % sprinkler Cropping pattern Return flow Water holding capacity

1 highly significant relationships at 99% confidence level
2 significant relationships at 95% confidence level
3 relationship is not significant at 95% confidence level ($r^2 < 0.232$)

irrigation and application efficiencies in a negative manner ($\alpha = 0.01$). Percolation losses were lower from projects with high water control and maintenance costs per unit volume of diversion. These losses were also found to be directly dependent on the magnitude of project diversions and farm deliveries, and system capacity per 1977 irrigated acre. Deep percolation losses were greater on projects where high water-use crops such as alfalfa, pasture, sugar beets, and potatoes were grown, and on projects where a large proportion of labor is spent on water control activities. No significant relationships were found between deep percolation losses and soil type, water holding capacity or degree of sprinkler irrigation.

Total System and O & M Costs

Significant and meaningful relationships between O & M and total system costs of projects and other costs and characteristics are presented in Table 26. Total O & M costs, defined in Chapter III as the composite of administrative, water control and maintenance costs, were found to be higher on projects of Federal origin, even though these federally assisted projects did not have significantly higher water use efficiencies. O & M costs were also found to increase as personnel requirements, equipment depreciation, pump horsepower or power consumption per irrigated acre increased. Projects with early flow rights or large diversion capacities relative to irrigated areas had significantly lower O & M costs per irrigated acre. Also, projects along the higher stretches of the Snake River and its tributaries (eastern Idaho) were found to have lower O & M costs and systems with high water-user/ditchrider ratios had low O & M costs. No significant correlations were found between O & M costs and project size, efficiencies, total

TABLE 26. Relationships between total O & M and system costs and system characteristics for selected Idaho projects.

	Directly Related[1]	Inversely Related[1]	Unrelated[3]
Total O & M costs, $/ac	Federal origin[2]	Earliest water right date	Project size
	Project terrain[2]	Maximum irrigable elevation	% pipe
	Personnel requirement m-y/a	System capacity, cfs/ac	% sprinkler
	Power consumption, kwh/a	System users per ditchrider[2]	Project irrigation eff.
	Project equip. deprec. $/ac[2]		System length
	Project pump horsepower, hp/ac		Project diversions, af/a
Total System Costs, $/ac	Project power costs, $/ac		Project size
	Project irrigation eff.[2]	Earliest water right date	System length
	Project conveyance eff.[2]	Open channel, %	% sprinkler
	Gross crop value, $/ac	Alfalfa and Grain Acreage, %	Project terrain
	Maintenance materials, $/ac	Project diversions, af/ac	Project equip. deprec. $/ac
	Ditchrider mileage, mpd	Personnel costs, % sys. costs	Project compactness
	Project farm size		
	Irrigated area/canal area		
	Pipe system, %		
	Project pump horsepower/ac		
	Potato acreage, %		
	Farm deliveries, % diversions		

1 highly significant relationships at 99% confidence level
2 significant relationships at 95% confidence level
3 relationship is not significant at 95% confidence level ($r^2 < 0.232$)

system length or seasonal diversion. O & M costs were also unrelated to the proportions of pipe used in water conveyance systems and percentages of sprinkler systems used in water application.

Total system costs were defined to include project O & M costs, project reservoir O & M costs and electrical power costs for water pumping. As shown in Table 26, total system costs were significantly related to project irrigation and conveyance efficiencies (r^2 =0.50 and 0.56) due in part to high power costs and the amount of pipe used in the Bell Rapids and Osgood systems. Projects raising high value crops (more potatoes) had relatively high system costs. Ditchrider mileage and maintenance material costs were high for projects with high system costs per acre, and farm sizes were larger than average. The amount of land irrigated per unit area of canal was also higher for high system cost projects. In projects with high total system costs, alfalfa and grain acreages were generally low and more pipe was used for water conveyance. These projects also had later than average water rights, and are located in areas away from early obtained water supplies. Most of the projects with high total system costs pump some portion of their water supply. High total system costs did not significantly correlate with project size or system length and were not related to the percentage of project land irrigated with sprinkler systems. Project terrain and compactness were also unrelated to total system costs per irrigated acre.

O & M Cost Breakdown

Administrative costs, $ per irrigated acre, were significantly greater for projects of Federal origin and for projects with conveyance systems having higher portions of lined channel or pipe, as shown in

Table 27. Administrative costs were lower for projects with greater diversion capacities per unit area or larger proportions of alfalfa and grain. Water use in the form of project diversions was found to be greater for systems with less management (lower administrative costs). Costs for system management were unrelated to project size, length, percent sprinkler and gross crop value.

Project irrigation and application efficiencies were higher for projects spending more money per acre for water control. These water delivery organizations were found to also use more materials for system maintenance and operated larger portions of pipe and lined channels within their conveyance systems. Project diversions, farm deliveries and deep percolation per acre were lower for projects with higher per acre water control costs. It is interesting to note that conveyance efficiencies, equipment use and system length were not significantly related to degree of water control costs.

Irrigation projects in steeper terrain and those with higher than average efficiencies were found to have higher maintenance costs per irrigated acre. High costs for maintenance were also significantly related to costs for water control, management, materials and equipment use. Eastern Idaho projects spent less money on maintenance than did projects evaluated in the central and western areas of the state. Projects which were privately financed and constructed also spent less for system maintenance than did Federal projects. Maintenance costs per irrigated acre were not found to vary with project conveyance efficiency, size, length or compactness.

Relationships between personnel costs per irrigated acre and system parameters are listed in Table 28. Total personnel costs are greater for Federal projects and less for projects along the Upper Snake. These costs

TABLE 27. Relationships between O & M cost categories and system characteristics for selected Idaho projects.

	Directly Related[1]	Inversely Related[1]	Unrelated[3]
Administrative costs, $/ac	Project equipment deprec. $/ac	System capacity, cfs/ac[2]	Project size
	Federal origin[2]	Alfalfa & Grain acreage, %[2]	System length
	Lined channel & pipe, %[2]	Project diversions, af/ac[2]	% sprinkler
	Maintenance materials, $/ac	Farm deliveries, af/ac[2]	Gross crop value, $/ac
		Deep percolation, af/ac[2]	
Water control costs, $/ac	Project Irrigation eff.	Project diversions, af/ac	Project conveyance eff.
	Project application eff.[2]	Farm deliveries, af/ac[2]	Project equip. deprec.
	Lined channel & pipe, %	Deep percolation, af/ac[2]	System length
	Maintenance materials, $/ac		Project size
Maintenance costs, $/ac	Project terrain	Maximum irrigable elevation	Project size
	Admin. costs, $/ac	Deep percolations, af/ac[2]	System length
	Water control costs, $/ac	Private origin[2]	% lined channel
	Project irrigation eff.[2]	System capacity, cfs/ac	% pipe
	Maintenance materials, $/ac		Project conveyance eff.
	Project equipment deprec. $/ac		Project compactness

1 highly significant relationships at 99% confidence level
2 significant relationships at 95% confidence level
3 relationship is not significant at 95% confidence level (r^2 <0.232)

TABLE 28. Relationships between various system costs and system characteristics for selected Idaho projects.

	Directly Related[1]	Inversely Related[1]	Unrelated[3]
Total Personnel Costs, $/ac	Federal origin Maintenance materials, $/ac Project equip. deprec. $/ac Administrative costs, $/ac Water control costs, $/ac Maintenance costs, $/ac Total O & M costs, $/ac	Maximum irrigable elevation Water control pers. costs. % total personnel costs	Project efficiencies Project diversions, af/ac Power consumption, kwh/ac Project size System length % sprinkler Project terrain Gross Crop value, $/ac
Average Personnel cost $/my	% Pipe Maintenance materials, $/ac Power costs, % system costs Total system costs, $/ac	Alfalfa & Grain acreage, %	Project efficiencies Project size System length Origin
Maintenance Material costs, $/ac	Project irrigation eff. Total O & M costs, $/ac Total Personnel costs, $/ac Power costs, $/ac Power Price, $kwh % Pipe Farm size Gross crop value/af inflow	Earliest water right date Alfalfa & Grain acreage, % % open channel Project diversions, af/ac Canal seepage, af/ac	Project size System length Project conveyance eff. Operational losses Return flow Project compactness
Project Equip. Depreciation $/ac	Administrative costs, $/ac Maintenance costs, $/ac Personnel costs, $/ac		Project efficiencies Project size System length

1 highly significant relationships at 99% confidence level
2 significant relationships at 95% confidence level
3 relationship is not significant at 95% confidence level ($r^2 < 0.232$)

correlate quite well with other categories in the total O & M cost breakdown. Total costs per acre for personnel were not significantly related to project water use efficiencies, power consumption or system size and length.

An average personnel cost calculated for each project included the average salary and benefits paid to organization employees. Average costs for full time project employees were found to be directly related to costs of maintenance materials and proportions of pipe in the conveyance system, and inversely related to the relative amounts of grain and alfalfa grown on project farms. High wages and benefits did not correlate with water use efficiencies, project size, length or financial origin.

Costs per acre for maintenance materials were greater for projects with more efficient use of water, more pipe and larger farms. Projects with early flow rights and large acreages of alfalfa and grain generally spent less money on maintenance materials. Costs for maintenance materials did not significantly relate to operational losses, return flow volumes or project compactness.

Water delivery organizations with large costs per acre for equipment depreciation generally spent more money for administration and system maintenance.

Power Costs and Consumption

Relationships between 1977 power costs, $ per acre, and system characteristics and costs are summarized in Table 29. Irrigation projects with high expenditures for electrical power invested larger amounts of money in system maintenance than did projects with low power demands. The gross crop value and potato acreages on pumping projects was higher

TABLE 29. Relationships between power use and system capacities and system characteristics for selected Idaho projects.

	Directly Related[1]	Inversely Related[1]	Unrelated[3]
1977 Power costs, $/ac	Maintenance costs, $/ac Maintenance costs, $/mi Gross crop value, $/ac % pipe Project farm size Potato acreage, % Irrigated area/canal area Maintenance materials, $/ac	% open channel % surface systems Earliest water right date Alfalfa & Grain acreage, %[2]	Project efficiencies Project size System length Project diversions, af/ac Soil type
1977 Power Consumption, kwh/ac	Project conveyance eff. Gross crop value, $/ac Total System costs, $/ac Water control costs O & M assessment, $/ac Ditchrider mileage, mpd % pipe Project farm size	Earliest water right date Alfalfa acreage, %	Project Irrigation eff. Project application eff. % sprinkler Project terrain Project compactness
Irrigated area/ system capacity a/cfs	Water right duty, a/cfs Project irrigation eff. Project application eff. Maintenance costs, $/ac	Deep Percolation, af/ac Alfalfa and Grain, % Farm deliveries, af/a Project diversions, af/a Project terrain[2]	Project conveyance eff. Reservoir storage, af/ac Project size System length % sprinkler

1 highly significant relationships at 99% confidence level
2 significant relationships at 95% confidence level
3 relationships not significant at 95% confidence level ($r^2 < 0.232$)

than average, possibly to offset costs of electrical energy. The ratio of irrigated land to canal wetted area was higher among large power users, partially due to more efficient canal designs and the use of pipe for conveyance in some areas. Projects with high power costs per acre in 1977 used more sprinkler systems for water application and have later water rights than non-power users. However, costs for power did not significantly relate to system efficiencies, project size or length, seasonal diversions or soil type. Only six of seventeen projects studied used significant amounts of electrical power.

Actual consumption of electrical power in 1977 in kwh per acre did coincide with conveyance efficiencies of water delivery systems ($r^2 = 0.56$) as shown in Table 29. Average farm sizes and daily ditchrider mileage increased as power consumption increased, and costs for water control were also higher. Contrary to costs for power, actual power consumption per acre was not related to use of sprinklers. This contradiction can be explained by the difference in the price of electrical power from private utilities and Federal utilities (BPA). Average slopes of project farms and project compactness did not correlate significantly with power consumption.

Irrigated area/system capacity, a/cfs, serves as an indication of a water delivery system's diversion capacity relative to irrigated land served. This parameter correlated highly with irrigated acres/water right, a/cfs, as shown in Table 29. Water delivery organizations with efficiently sized conveyance systems had higher than average project irrigation and application efficiencies and project seasonal diversions, farm deliveries and deep percolation losses were lower. However, efficiently sized conveyance systems did not necessarily induce high conveyance efficiencies and were unrelated to project size, length, and percentage of sprinklers used on project farms.

Project Water Availability

Two of seventeen project studied, Salmon River Canal Company and the Wood River Irrigation District, have been historically plagued with irrigation water shortages caused by seasonal droughts, low late summer stream flows and high conveyance system or water storage losses. These two projects, located on tributaries of the Snake River, were subjected to water shortages during the 1977 irrigation season, resulting in reduced irrigated acreages. These projects are described in Chapter IV. Water use, efficiencies and operations procedures of the Salmon River and Wood River projects were evaluated for the 1976 and 1977 seasons by Worstell (1978). No significant differences in these parameters for the water short year (1977) were found. However, correlation analysis of project parameters in this study did reveal relationships between irrigated acreage reduction and some system characteristics as shown in Table 30. The variable labeled as "1977 irrigated acreage/ assessed acreage" was used as an indicator of reduced project acreage in 1977 due to water shortages. Values for this variable were computed by dividing values of irrigated acreage listed in Table 6 in Chapter V by values of assessed acreage in the same table. Calculation of the acreage parameters is discussed in Chapter III. In addition to Salmon River and Wood River projects, Danksin, Cedar Mesa and Little Willow projects also had much lower irrigated acreages than recorded assessed acreages. However, these project acreages were not reduced because of water shortages, although Cedar Mesa and Little Willow projects did experience lower than normal water years in 1977. These three projects were assessed for larger acreages than are actually irrigable within project boundaries. Even with the low values for the Danskin, Cedar Mesa and Little Willow projects (0.78, 0.81 and 0.83), the ratio of 1977 irrigated acreage to assessed acreage is still considered to be a fair indicator of project water availability in 1977. Ratios for the Salmon River and Wood River projects were 0.59 and 0.61, respectively. Most relationships listed in Table 30 were significant at the 90% confidence level, only.

As indicated in Table 30, the ratio of irrigated to assessed acreage was directly related to the percent of return flow from the projects, although project efficiencies were apparently not related to shortages of water. Lower percentages of potatoes and higher percentages of alfalfa were grown on water short projects than on other projects evaluated, resulting in a lower gross crop value in 1977. The size of area served per project ditchrider was smaller than average for water short areas. This relationship could indicate an increased degree of water control on water deficient projects. Projects with a low acreage ratio did spend a larger than average portion of personnel costs for water control and smaller portions for maintenance, reflecting a concern for good management of limited water.

Conveyance systems of the Salmon River and Wood River projects are subject to high seepage losses as reflected in the statistical analysis by the seepage rate term. These two projects have higher than average system capacities, cfs/ac, and have less than average area served per unit of water right (Table 30). The Salmon River and Wood River projects also have shallow soils with average depths less than 35 inches, resulting in high deep percolation losses, especially within the Wood River District.

Table 30. Relationships between ratio of irrigated acreage to assessed acreage and system costs and charactistics for selected Idaho projects.

	Directly Related[1]	Inversely Related[1]	Unrelated[3]
1977 Irrigated Acreage/ Assessed Acreage	Return flow, % inflow	System capacity, cfs/ac[2]	Project irrigation eff.
	Irrigated acres/ditchrider	Conv. system, seepage, cfs/ft^2/day	Project conveyance eff.
	Water right duty, ac/cfs[2]	Alfalfa acreage, %	Project application eff.
	1977 crop value, $/ac	Water control pers. costs, % total pers. costs	Project evapotranspiration, af/ac
	Potato acreage, %		% sprinkler
	Project soil depth, inches		Compactness ratio
	Maintenance personnel costs, % total personnel costs		Project power costs, $/ac
			Project O & M costs, $/ac

[1]Highly significant relationships at 90% confidence level

[2]Significant relationships at 99% confidence level

[3]Relationship is not significant at 90% confidence level

Regression Analysis

A major objective of this research study was to determine common relationships between costs of irrigation water delivery and various system characteristics and water usage. Mathematical equations were developed which relate project parameters to system cost and efficiencies. These equations are presented mainly to show relationships governing system costs, although they can be used to a limited extent to estimate O & M costs for other Idaho irrigation projects.

Selected variables were regressed into equation form using a forward selection stepwise multiple linear regression procedure supported by the University of Idaho Computer Services as part of the SAS76 computer routine. The maximum R-square improvement option of the stepwise procedure was used to build the regression models. Seventeen observations were entered into the analysis for each system variable selected from the variable list presented in Appendix G. Two forms of regression equations were developed during the regression analyses. A multiple linear equation of the form:

$$Y = b_0 + b_1 X_1 + b_2 X_2 \; . \; . \; . \; . \; b_k X_k \qquad (12)$$

was used to describe project relationships, and an exponential-type equation used by Brockway and Reese (1973) to describe irrigation project O & M costs was also applied during this analysis. This equation is the form:

$$Y = b_0 X_1^{b_1} X_2^{b_2} \; . \; . \; . \; . \; X_k^{b_k} \qquad (13)$$

where: Y = the dependent variable representing O & M costs

X_k = an independent variable related to Y

b_k = a coefficient computed by regression

k = the total number of independent variables included in the regression equation

and b_o = the Y-intercept in equation 12.

Equation 13 was regressed in the stepwise procedure using log transformations of all variabes. However, the multiple linear equation (12) was more successful in describing relationships among system costs and parameters and was therefore selected to model these relationships.

Equations presented in the following text and figures have highly significant R-square values ($\alpha = 0.01$). Standard errors of estimate describing the error term of each regression are presented. The standard error of estimate is defined as:

$$Sy.1....k = \left\{\frac{\Sigma (y - \hat{y})^2}{(n - k - 1)}\right\}^{\frac{1}{2}} \qquad (14)$$

where: Sy.1....k = standard error of estimate of the populations of Y values

y = observed value

$\hat{y}$ = calculated value

n = number of observations

and k = number of independent variables in the regression equation.

The standard error of estimate is presented mainly to indicate the average deviation of costs or efficiencies calculated by equation 12 from actual observations.

Total O & M Cost Equations

Five equations describing total annual project O & M costs are presented in this section. These equations were regressed using project cost data obtained from project records for the years 1974, 1975, and 1976 and adjusted for 1977 prices. Water use analyses were performed for the 1977 irrigation season only.

As in any type of descriptive equation, the fewer variables included in the equation, the simpler and more understandable the equation. In describing total O & M costs, the most significant one-variable model developed by the regression analyses is the following:

$$Y = 0.75 + 1.67\ X_1 \tag{15}$$

where Y = total annual project O & M costs, \$/acre (1977)

and X_1 = total annual personnel costs, \$/acre (1977).

Equation 15 is essentially a generalized relationship between project personnel costs and total project O & M costs. The r^2 value of this equation is 0.877, indicating that 88 percent of the sum of squares of O & M costs among irrigation projects evaluated can be explained by regression. The standard error of estimate of equation 15 is \$1.39 per irrigated acre for the seventeen observations.

Equation 15 was modified to improve its accuracy in estimating O & M cost with the addition of a second variable, gross crop value, shown in the following equation:

$$Y = -0.14 + 1.59X_1 + 0.20\ X_2 \tag{16}$$

where: Y = total annual project O & M costs, \$/acre (1977)

X_1 = total annual personnel costs, \$/acre (1977)

and X_2 = gross crop value, \$/af of 1977 project inflow.

The gross crop value in equation 16 is an average value of crops grown within each project based on estimated acreages and yields of each crop. Prices used are for late 1976 - early 1977. This value was divided by the total volume of water diverted by the project in 1977 resulting in a parameter with dimensions of \$ per acre feet of inflow. This parameter seems to function as a fairly good indicator of system O & M costs, as high O & M assessments would induce farm

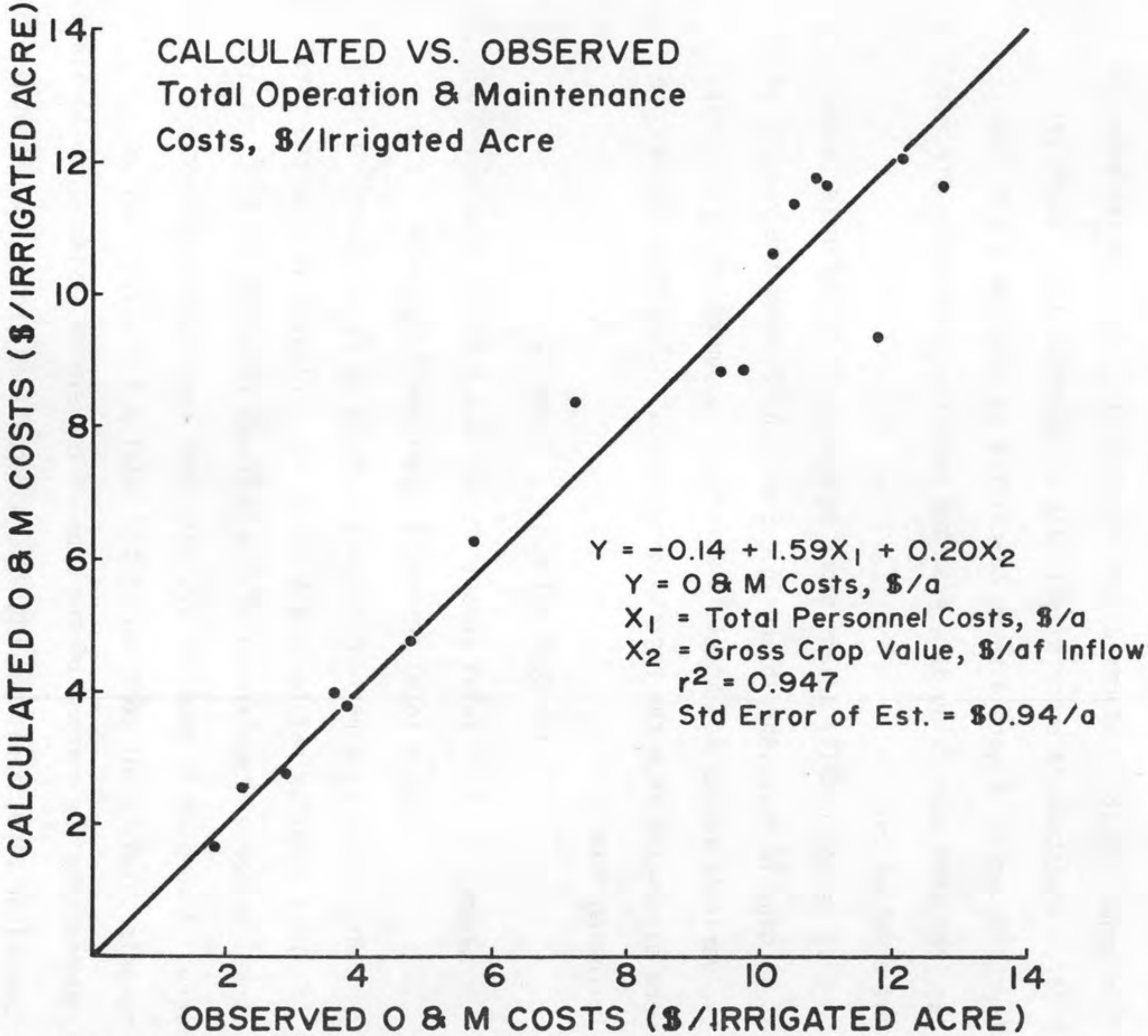


Figure 4. Comparison of observed O & M costs and O & M costs calculated using a two-variable regression model and personnel costs for seventeen Idaho irrigation projects.

operators to grow high valued crops to offset project operating costs. Likewise, cultivation of some high-value crops such as potatoes may place greater demands on project conveyance systems for more frequent and controlled water delivery, necessitating higher O & M costs. The r^2 of equation 16 is improved over equation 15, with a value equal to 0.947. The standard error of estimate of equation 16 is $0.94 per irrigated acre. Figure 4 shows calculated vs observed O & M costs per irrigated acre using data from the seventeen irrigation projects and equation 16.

It is not usually advantageous to use costs to estimate costs, as is done in equations 15 and 16. Equation 17 shows the results of a two-variable regression model in which all components of O & M costs were eliminated from the regression analysis. This equation has the following form:

$$Y = 0.55 + 16601X_1 + 0.058\ X_2 \qquad (17)$$

where: Y = total annual project O & M costs, $/acre (1977)

X_1 = total personnel requirement, my/acre

and X_2 = percent of system which is lined channel or pipe.

This equation relates O & M costs per irrigated acre to the total annual personnel requirement of the delivery organization per irrigated acre. According to equation 17, personnel requirements of projects comprise significant portions of the total O & M costs. Variable X_2, representing the percent of the project conveyance system which is lined channel or pipe, indicates higher O & M costs on projects with higher capital investments in the conveyance system. In reality, systems with large percentages of lined channel or pipe should require less system maintenance than unlined channel, provided the degree of water control is unchanged. However, for projects evaluated, the relative amount of lined channel and pipe in the system serves more as an indicator of the degree or integrity of system maintenance and water control practiced. In equation 17, the percent of lined channel and pipe is calculated over the entire conveyance system, including project-operated laterals. The r^2 value of equation 17 equals 0.895 and the standard error of estimate is $1.33 per irrigated acre. O & M costs calculated with equation 17 have been plotted against observed O & M costs and are presented in Figure 5.

An attempt was made to develop equations to estimate O & M costs using parameters which can be readily determined or estimated. By eliminating various cost parameters and parameters describing personnel requirements from the regression analysis, other parameters were included in the regression models. These parameters, however, are not as proficient in describing O & M costs, necessitating the inclusion of more than two variables in the regression models to enable reasonable estimates to be made. Data is generally available for equation 18, a four variable model. The equation is:

$$Y = 3.83 + 5.07X_1 + 0.13X_2 - 0.012X_3 + 2.36X_4 \tag{18}$$

where: Y = total annual project O & M costs, \$/acre (1977)

X_1 = 1 if Federal origin; 0 if private origin

X_2 = project irrigation efficiency, %

X_3 = irrigated acres per mile of total system

and X_4 = project pump horsepower per acre.

Irrigation projects were designated as being of Federal origin if, at sometime in the project's history, significant assistance was given to water users by the Federal government, usually through the U.S. Bureau of Reclamation, to renovate or finish construction of the conveyance system. These projects normally supply detailed annual crop distribution and water

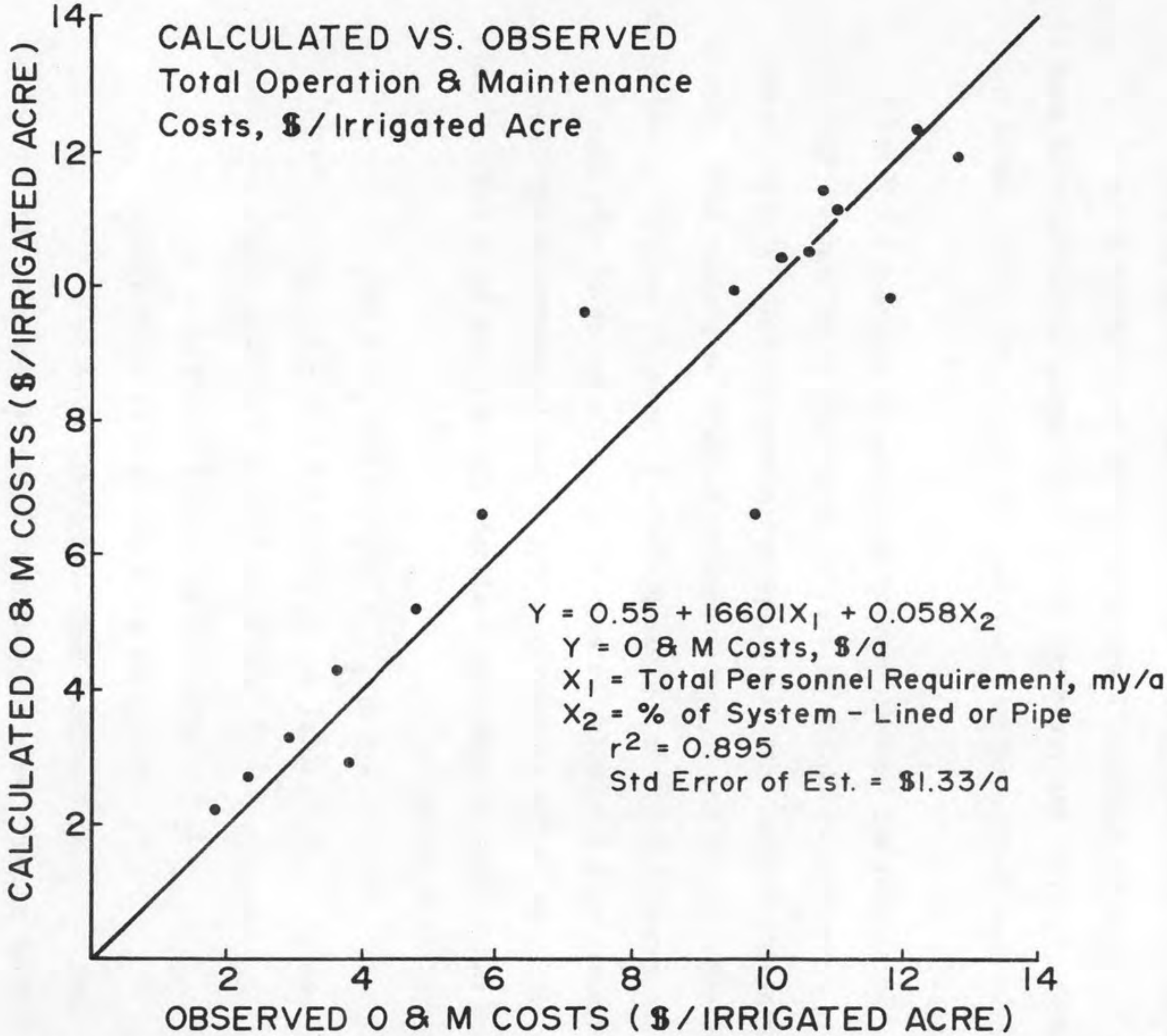


Figure 5. Comparison of observed O & M costs and O & M costs calculated using a two-variable regression model and personnel requirements for seventeen Idaho irrigation projects.

use reports to the Bureau of Reclamation. Five projects, Burley, A & B, Salmon River, King Hill and the South Board of Control were considered to be of Federal origin in this study. According to equation 18, these projects have higher O & M costs, other variables held constant. These higher costs may be due to a higher degree of water control practiced in these projects, more rigorous maintenance schedules, or because of more difficult terrain. Three of the five Federal projects, Burley, A & B and SBOC pump large amounts of project water and therefore incur added pump O & M costs.

The seasonal project irrigation efficiency term in equation 18 can be estimated or calculated using probable crop distributions, climatic data and total project diversions. This term is defined as the total project irrigation requirement/total project diversions times 100 and is discussed in detail in Chapter III. The inclusion of the efficiency variable in equation 18 indicates that the more efficient projects (i.e., those diverting lower volumes of water per irrigated acre) have greater water control and system maintenance costs. Variable X_3 in equation 18, irrigated acres per system mile, can be readily computed if actual irrigated areas and lengths of project conveyance systems are known. In Idaho, irrigated areas of projects have been measured and recorded by the Idaho Department of Water Resources (IDWR, 1978). Again, the total system length portion of X_3 includes all main canals and laterals operated or owned by the water delivery organization. Inclusion of variable X_3 in the regression model is logical in the sense that the greater the acreage served per system mile is, the lower the per acre O & M costs should be.

Project pump horsepower, variable X_4, is the cummulative power rating of all project operated pumps, including groundwater and relift pumps. On-farm pumps operated by individual water users were not included. Variable X_4 reflects higher total O & M costs due to pump operation and maintenance costs and possibly increased water control and conveyance system maintenance costs to control conveyance losses of pumped water. The r^2 value of equation 18 is 0.860, indicating a reasonably good fit of data. The standard error of estimate for this equation is \$1.66 per irrigated acre. Figure 6 is a plot of calculated vs. observed values of O & M costs using equation 18. The considerably underestimated point on this figure represents O & M costs for Milner Low Lift Irrigation District. Actual costs for Milner were higher than costs estimated by equation 18, due in part by the low project irrigation efficiency of this project which pumps all of its diversion and in part by high O & M costs for a non-Federal project. However, this project has received limited Federal assistance in the past and does purchase BPA power.

A five-variable model is presented in this section which estimates total O & M costs per irrigated acre using parameters which can be readily obtained or estimated. This model developed by the regression analysis is :

$$Y = 6.25 - 0.032X_1 + 0.029X_2 + 4.45X_3 + 3.30X_4 + 0.022X_5 \qquad (19)$$

where Y = total annual project O & M costs, \$/acre (1977)

X_1 = irrigated acres per mile of total system

X_2 = irrigated acres per acre of wetted canal area

X_3 = 1 if Federal origin; 0 if private origin

X_4 = terrain code, 0 = 0-3% slope; 1= 3-10% slope

and X_5 = percentage of system turnouts measured.

As in equation 18, the magnitude of the ratio of irrigated acres per mile of total system signifies a negative effect on total O & M costs per

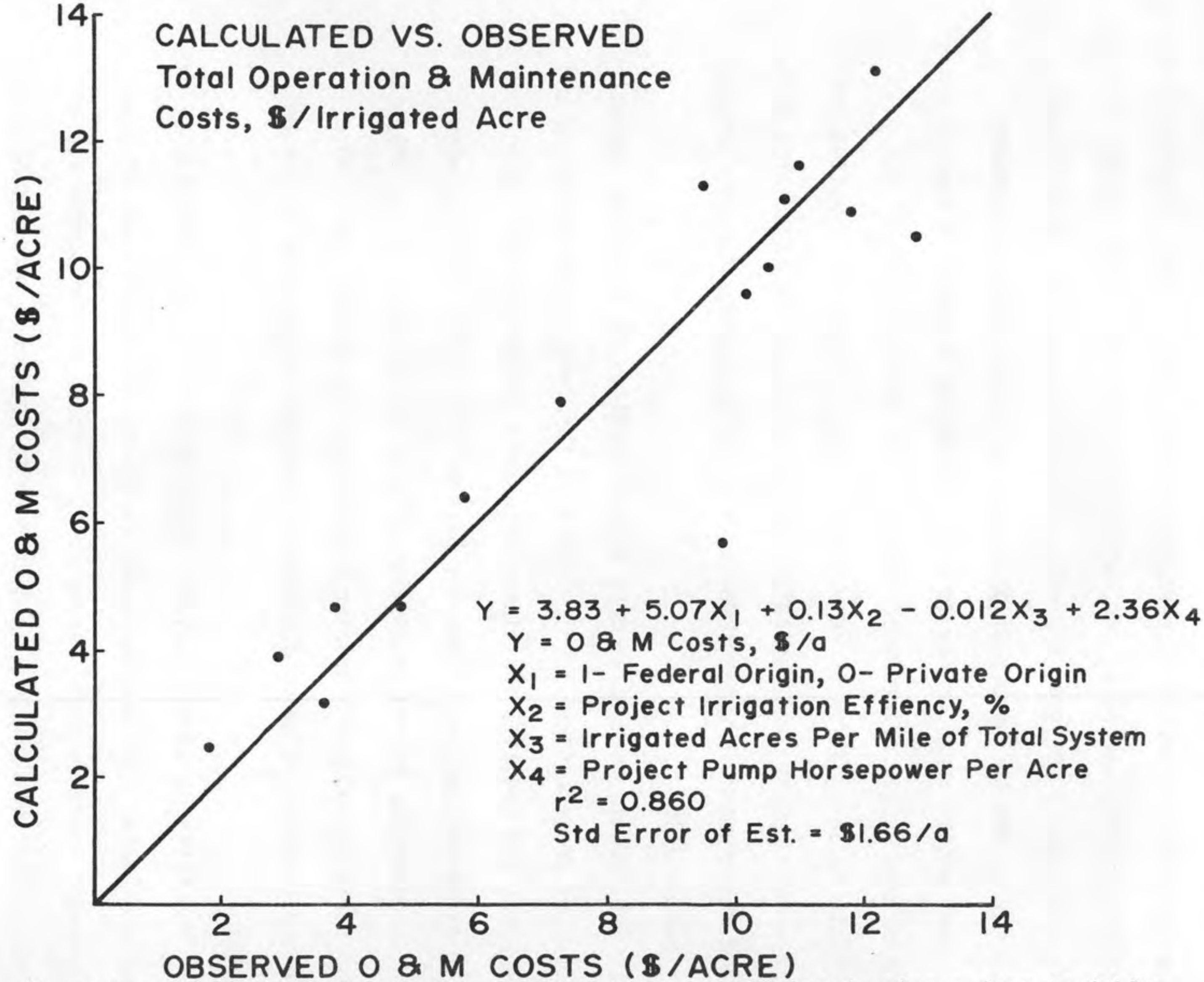


Figure 6. Comparison of observed O & M costs and O & M costs calculated using a four-variable regression model for seventeen Idaho irrigation projects.

irrigated acre. Variable X_2, irrigated acres per acre of wetted canal area can be indicative of an efficient conveyance system design, with more service area irrigated per acre of canal wetted area. However, the positive coefficient of X_2 indicates that O & M costs are greater for more efficiently designed systems, all other variables held constant. This may be due to the use of more pipe in these systems, decreases in canal wetted area, or may be a reflection of a higher degree of water control and system maintenance practiced on these projects. Use of variable X_2 in equation 19 necessitates measurement of the wetted area of all main canals and laterals. Wetted areas may be calculated using field measurements or measurements from aerial photographs as discussed in Chapter III.

The terrain code parameter, X_4, in equation 19 describes general slopes of project farms. This term is 0 for land slopes between 0 and 3 percent and equals 1 for slopes between 3 and 10 percent. Projects with mixed and varying slopes may have a code with a value between 0 and 1, depending on the proportion of each slope class in the project. This variable indicates greater O & M costs for projects with more sloping terrain, assuming all other variables in equation 19 are held constant.

The fifth parameter included in equation 19 is an indicator of the degree of water control practiced, so far as the measurement of farm deliveries is concerned. Parameter X_5 is based on the percentage of actual measuring devices placed on farm turnouts and measured by project personnel. No means of measuring high pressure farm deliveries exist on the Bell Rapids and Osgood projects; therefore X_5 was set equal to 0 for these projects.

The r^2 value of equation 19 is equal to 0.937, indicating that 94 percent of the total variation in O & M costs among the seventeen projects evaluated was explained using the five variables in equation 19. The standard error of estimate of this regression model in \$1.16/irrigated acre. Calculated vs. observed values of O & M costs using equation 19 are plotted in Figure 7. This equation functioned well in describing O & M costs per acre for projects evaluated, although five variables were required in the regression model.

Total System Cost Equation

Total system costs include O & M costs, reservoir operation and maintenance costs and costs for electrical power consumed by project operated pumps. An equation developed during the regression analysis to estimated total system costs is of the form:

$$Y = 0.98 + 20.3X_1 + 0.155X_2 + 12230X_3 \qquad (20)$$

where: Y = total project system costs, \$/acre

X_1 = project pump horse power per acre

X_2 = percent of system which is line channel or pipe

and X_4 = total personnel requirement, my/acre.

Equation 20 is presented mainly to indicate which system parameters have the greatest potential describing total system costs for the project evaluated. Because costs for power comprise a major share of total system costs for several projects especially Osgood and Bell Rapids, total system costs for these projects are much greater than for projects in which no power is used to pump water. The large variation in total system costs of projects is shown by Figure 8 where calculated vs. observed values of total system costs per irrigated acre are plotted. Equation 20 produced a high r^2 value (0.991), due mainly to the large mean square in the regression analysis. The standard error of estimate

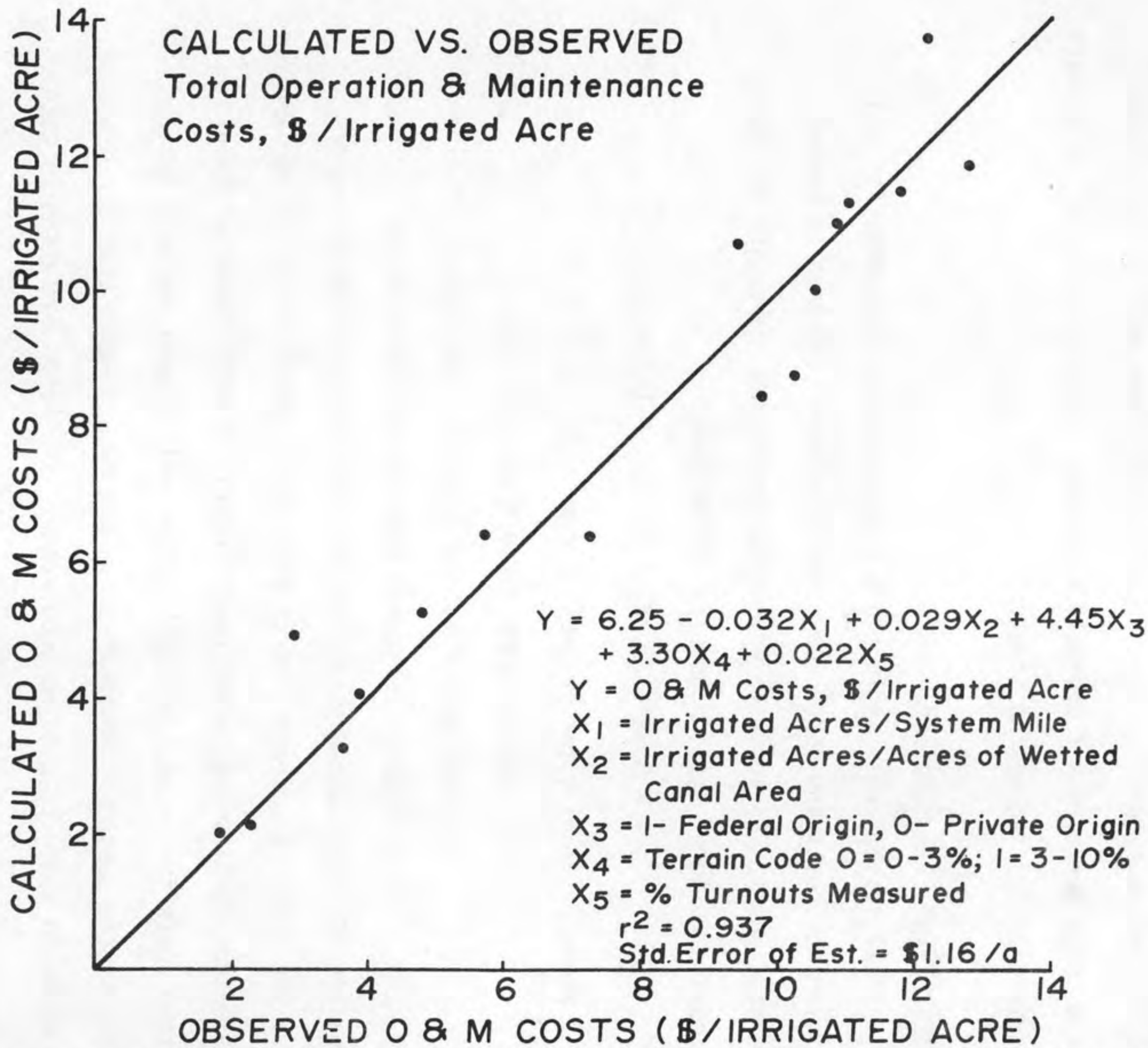


Figure 7. Comparison of observed O & M costs and O & M costs calculated using a five-variable regression model for seventeen Idaho irrigation projects.

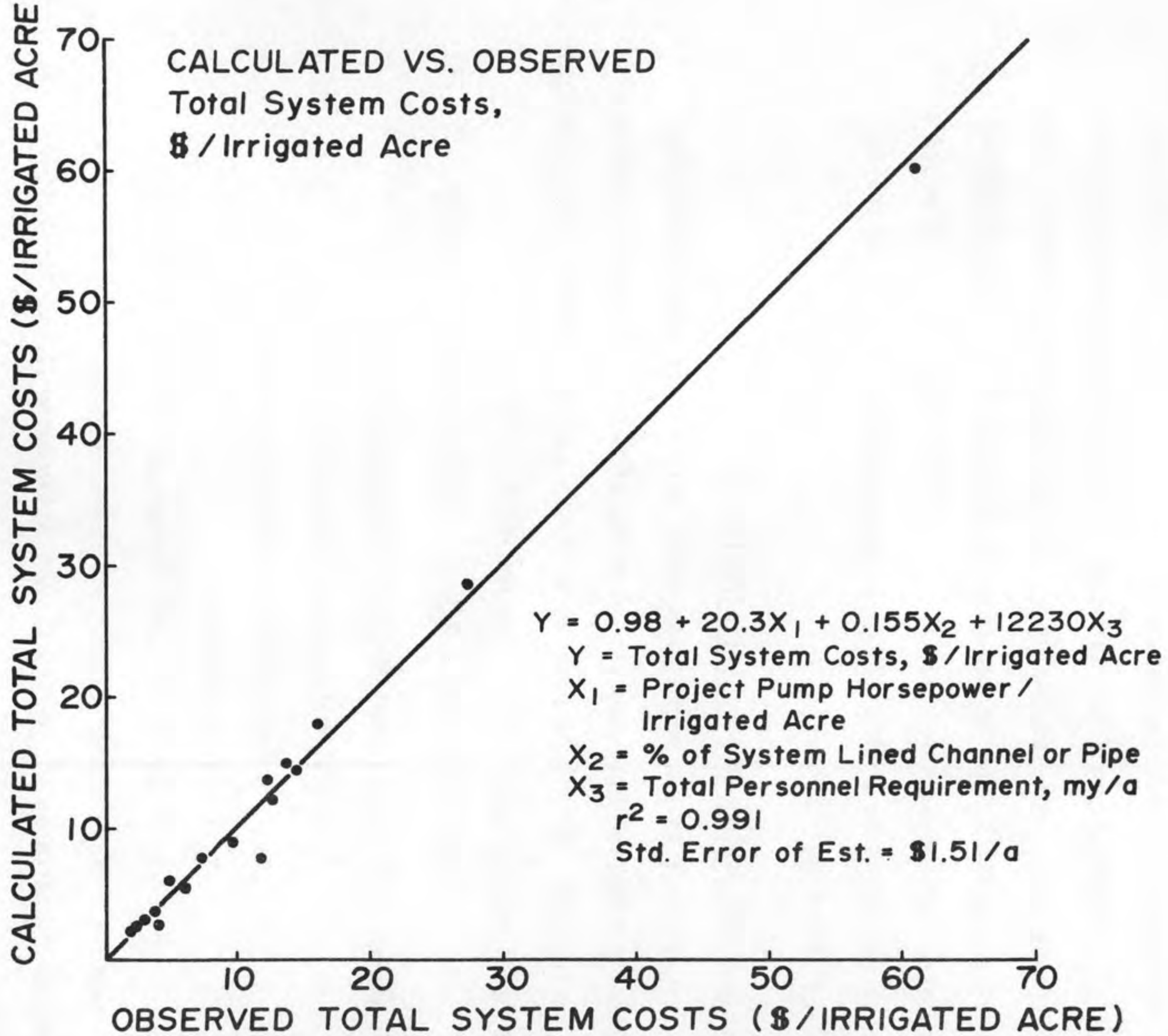


Figure 8. Comparison of observed total system costs and total system costs calculated using a three-variable, regression model for seventeen Idaho irrigation projects.

of this equation is \$1.51 per irrigated acre. All variables in equation 20 have been discussed in the O & M cost equation section of this chapter.

The equation presented here may be used to estimate total system costs of irrigation projects, although a more accurate method would be to estimate power costs according to seasonal water use, pumping lifts and price schedules, and to add this value to an O & M costs estimate calculated using equations 16, 17, 18, or 19. Reservoir costs would also be best estimated on an individual project basis and added to the sum of O & M and power costs.

Equations Describing Project Efficiencies

Equation 21 is the regression model selected to describe project seasonal irrigation efficiencies in terms of physical system parameters and is included in this chapter to indicate apparent effects these variables have upon project water use. This equation is:

$$Y = 17.8 - 5.07X_1 - 240X_2 + 8.59X_3 + 706X_4 + 0.078X_5 \qquad (21)$$

where: Y = seasonal project irrigation efficiency, %

X_1 = system turnouts/system mile

X_2 = maximum system capacity, cfs/acre

X_3 = soil type code

X_4 = system turnouts/irrigated acre

and X_5 = number of project-operated pumps.

Equation 21, with an r^2 of 0.923, does estimate well the irrigation efficiencies of projects evaluated, although five variables are required. This equation does include somewhat of a contradiction, however, in that variables representing system turnouts per system mile and turnouts per irrigated acre have coefficients of opposite sign. According to these coefficients, the seasonal irrigation efficiency is higher on projects with few turnouts along each mile of conveyance system but with many turnouts in total. This phenomenon would seem to relate higher efficiencies with projects with long, extensive channel or pipe systems.

Variable X_2 in equation 21 indicates that projects with high diversion capacities in relation to irrigated areas of the projects use these large capacities to divert large amounts of water per acre, resulting in lower project irrigation efficiencies. Variable X_3, a code describing soil texture, estimates higher efficiencies for projects with fine textured soils. The codes used in the regression analyses were: 1 - sand, 2 - sandy loam, 3 - loam, and 4 - silt loam. The fifth variable X_5 indicates higher efficiencies for projects which operate large numbers of pumps, thereby biasing higher efficiencies toward large projects which pump significant volumes of water. Calculated vs. observed values of project irrigation efficiencies are shown in Figure 9 for equation 21. The standard error of estimate for this equation is 4.6 percent.

An equation describing conveyance efficiencies of projects studied was regressed as:

$$Y = -626 + 0.355X_1 + 8.03X_2 - 0.0173X_3 \qquad (22)$$

where: Y = seasonal project conveyance efficiency, %

X_1 = average water right data, years

X_2 = soil type code

and X_3 = irrigable elevation difference, feet.

The negative Y - intercept of this equation, -626, is due to large positive values of variable X_1, the average water right date. This date is a weighted average value calculated according to dates of all water flow rights held by the water delivery organization or individual water users. For instance, the average water right date of the Enterprise District has the value 1910.54, meaning July 15, 1910. According to

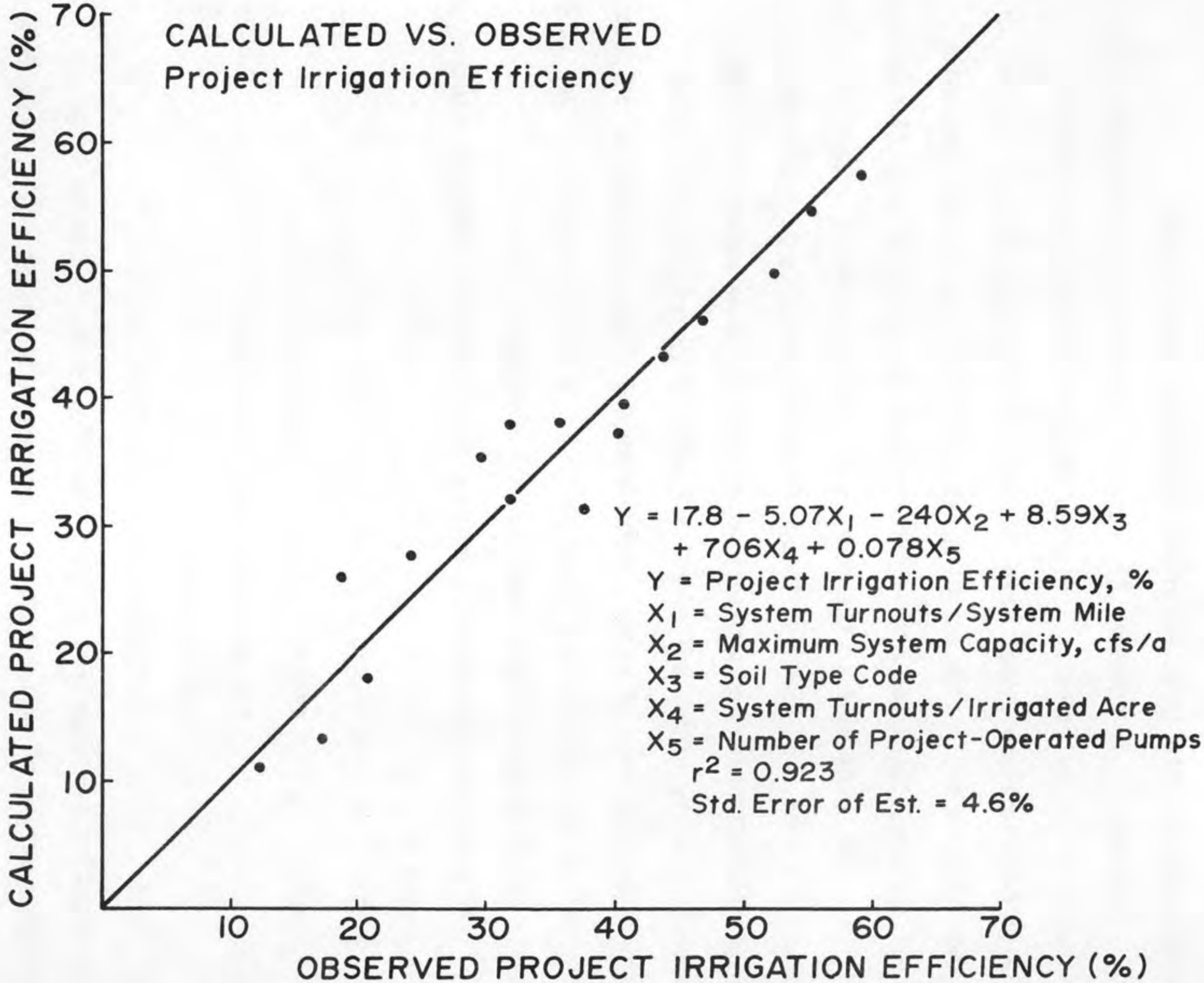


Figure 9. Comparison of observed project irrigation effeciencies and project irrigation effiencies calculated using a five-variable regression model for seventeen Idaho irrigation projects.

the coefficient of X_1 in equation 22, irrigation projects with later water rights are more apt to have higher conveyance efficiencies, possibly due to more efficiently designed distribution systems, lower seepage rates, or increased degrees of water control necessitated by pumping of water or smaller total flow rights. As in equation 21, a fine-textured soil is conducive of high conveyance efficiencies. Variable X_3 in the model, elevation difference in feet, is the vertical distance between the highest and lowest irrigable elevations within project boundaries. This variable would seem to indicate lower conveyance efficiencies for projects with large variations in elevation along the water distribution system attributed by steep terrain or large project size. As shown by Figure 10, equation 22 does not accurately estimate conveyance efficiencies of all projects. The r^2 value of this model is 0.750 and the standard error of estimate equals 6.9 percent.

Seasonal application efficiencies of irrigation projects were related to system parameters by equation 23 of the form:

$$Y = 27.7 - 553X_1 + 0.745X_2 + 0.186X_3 + 6.03X_4 \qquad (23)$$

where: Y = seasonal project application efficiency, %

X_1 = maximum system capacity, cfs/acre

X_2 = percent of project planted to alfalfa

X_3 = percent of farm deliveries at high pressure

and X_4 = soil type code.

As with project irrigation efficiencies, project application efficiencies were lower for projects with high diversion capacities per irrigated acre. Farms within these projects were apparently supplied with volumes of water larger than required. Equation 23 indicates that fine-texture soils are conducive to high application efficiencies, due to greater water holding capacities of these soils or lower infiltration rates. Variable X_2, the percentage of alfalfa grown on project farms, indicates more efficient

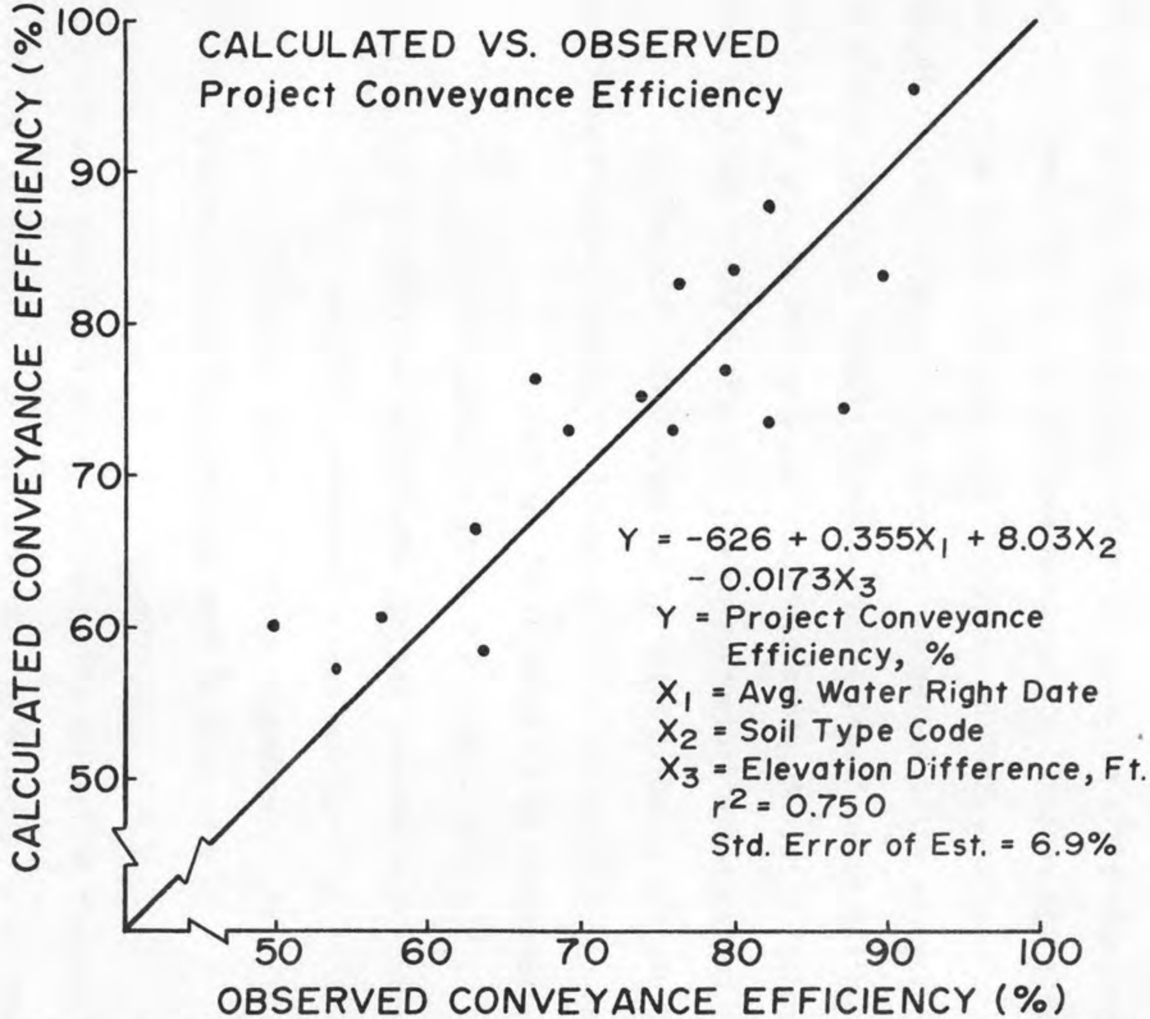


Figure 10. Comparison of observed project conveyance efficiencies and project conveyance efficiencies calculated using a three-variable regression model for seventeen Idaho irrigation projects.

use of on-farm water when more alfalfa was grown. This relationship is most probably due to relatively deep root zones of alfalfa crops which help to reduce deep percolation losses, and high seasonal irrigation requirements of this crop caused by a long growing season and high evapotranspiration rates.

Projects with high-pressure deliveries to farms had higher application efficiencies, as indicated by variable X_3. However, the two high-pressure projects studied, Osgood and Bell Rapids, had lower than average acreages of alfalfa, thereby partially counteracting higher efficiencies predicted by variable X_3. The r^2 value of equation 23 is 0.866, and the standard error of estimate of this equation is 6.2 percent. Calculated vs. observed values of application efficiency are shown in Figure 11. There is noticeable scatter among points between 40 and 60 percent efficiencies.

Equations Describing System Water Losses

Relationships were developed to estimate water losses from projects as percentages of water diverted. Of these losses, only return flow was adequately described in linear form. The resulting regression equation is expressed as:

$$Y = 0.182X_1 - 0.157X_2 - 0.0037X_3 + 5.35X_4 \qquad (24)$$

where: Y = seasonal project return flow, % diversions

X_1 = system turnouts per ditchrider

X_2 = system turnouts measured, %

X_3 = total water rights, cfs

and X_4 = project compactness ratio

The Y - intercept of this equation is zero. According to equation 24, the percent of diverted water leaving project boundaries as surface return flow is greater from projects in which large numbers of turnouts are serviced by each ditchrider. This relationship would indicate that

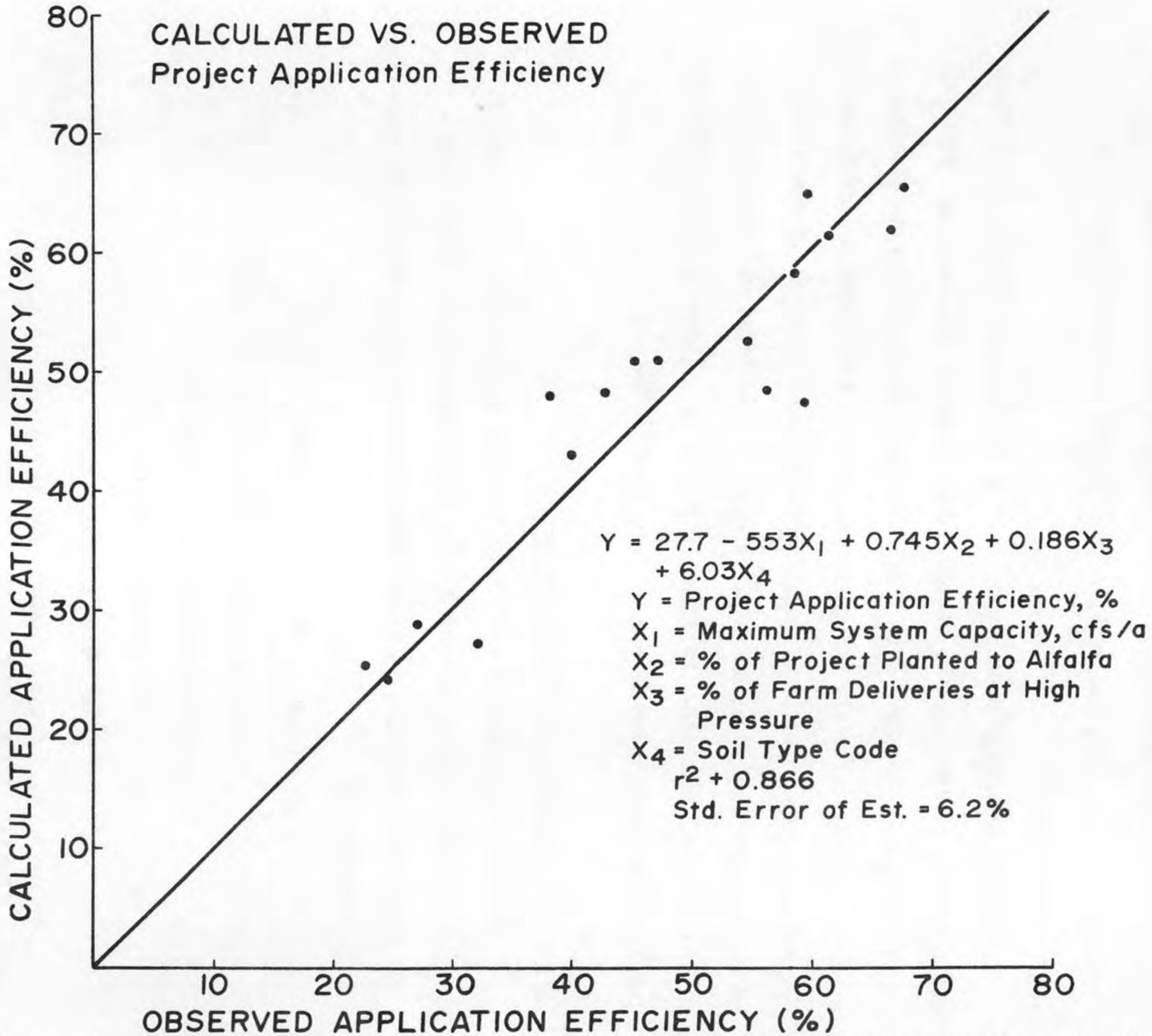


Figure 11. Comparison of observed project application efficiencies and project application efficiencies calculated using a four-variable regression model for seventeen Idaho irrigation projects.

the degree of water control attainable in any particular project decreases as the area covered per ditchrider is increased. Variable X_2 indicates that projects in which a majority of turnouts are measured have lower levels of return flows. This phenonmenon would result if the measurement of system turnouts provided ditchriders with information on necessary diversions required to fulfill farm needs. Also, projects with marginal water supplies are more likely to measure all farm deliveries and are likely to place greater emphasis on limiting operation spills from project conveyance systems. Measurement of turnouts would also likely result in a daily check on turnout settings and adjustment by ditchriders, thereby reducing the chance of uncontrolled runoff from farm systems.

Variable X_3, the total project water right in cubic feet per second, is the cummulative value of all individual rights by the water delivery organization or individual water users. The coefficient of this term suggests that projects with legal rights to divert large volumes of surface water may have lower percentages of diversions leaving the project as return flow. Variable X_3 adds a bias toward the larger projects evaluated, most of which has relatively low percentages of return flow. The coefficient variable X_4 indicates the compactness of a project influences return flow, with projects with elongated or discontinuous service areas having larger return flow volumes relative to diversions. A small compactness ratio indicates a more compact project. This ratio, defined in Chapter III, ranged from 1.54 for Wood River Irrigation District to 4.17 for King Hill Irrigation District.

A plot of calculated vs. observed percentages of return flow is shown in Figure 12. Large amounts of scatter exist among the data points, resulting in a r^2 value of only 0.854 and a standard error of estimate equal to 5.2 percent.

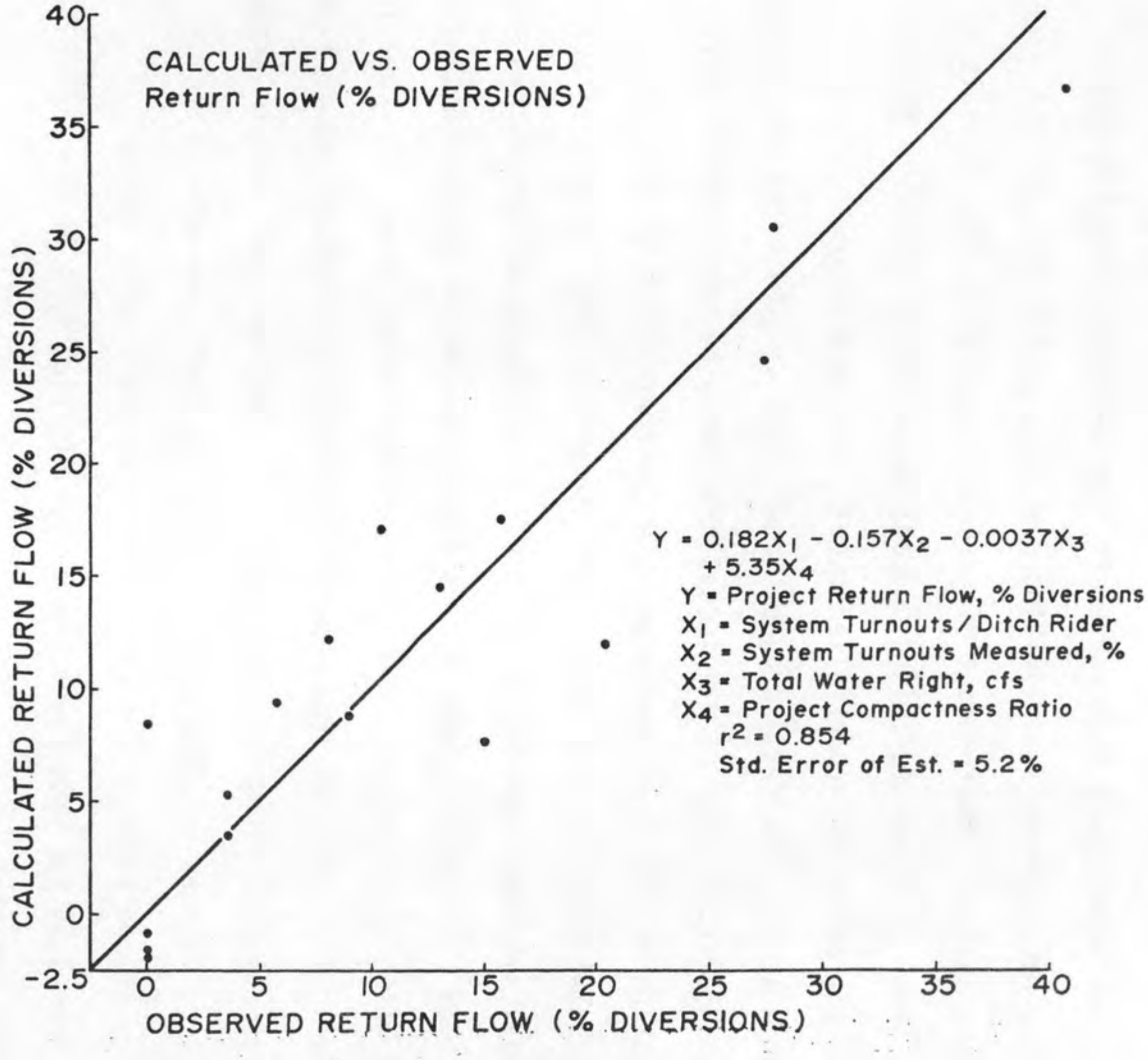


Figure 12. Comparison of observed project return flow percentages and project return flow percentages calculated using a four-variable regression model for seventeen Idaho irrigation projects.

Discussion of Regression Results

Equations presented in this chapter were developed using a maximum r-square stepwise regression technique. This process entered into each regression model those variables which contributed most to reducing error or differences between calculated and observed data points. Those equations presented are not designed to estimate improvements in costs or operating efficiencies of specific project systems due to changes in a specific parameter or system component, such as decreasing the number of turnouts served by each ditchrider. Rather, these equations were developed to identify relationships between various system parameters and to be used for estimation of O & M costs of individual projects relative to other Idaho projects, based on the variables included in each regression equation.

Equations 21, 22 and 23 present relationships between system efficiencies and system parameters determined through regression analyses. These equations should be used with caution for prediction of project efficiencies due to large variabilities in numerous parameters which affect system water use efficiencies, but are not included in these regression models. Efficiencies, in most cases, are better estimated using actual water diversions, evapotranspiration, rainfall, system losses, soil types, crop types, application system types, land slopes, conveyance materials, and degree of system and farm management. A methodology for obtaining accurate estimates of these efficiencies is presented in Chapter III of this report.

No regression equation presented in this chapter will accurately estimate O & M costs or water use efficiencies of irrigation projects not included in this particular study. Irrigation projects throughout the state of Idaho, and the western United States as a whole, comprise a wide spectrum of various project, system and management characteristics, thereby presenting much difficulty in development of models or equations which can estimate past or future O & M costs or water use efficiencies. However, projects included in this research study are quite diverse in physical characteristics and management procedures, and regression coefficients were sufficiently high, so that equations presented are felt to be of value for potential use in estimating general O & M costs for projects in Idaho and possibly the Pacific Northwest.

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Wright, [illegible] and [illegible] [illegible] Development and Evaluation [illegible] [illegible] [illegible] [illegible] [illegible] Engineers. [illegible]

APPENDIX A

LOCATION MAPS OF COOPERATING IRRIGATION PROJECTS

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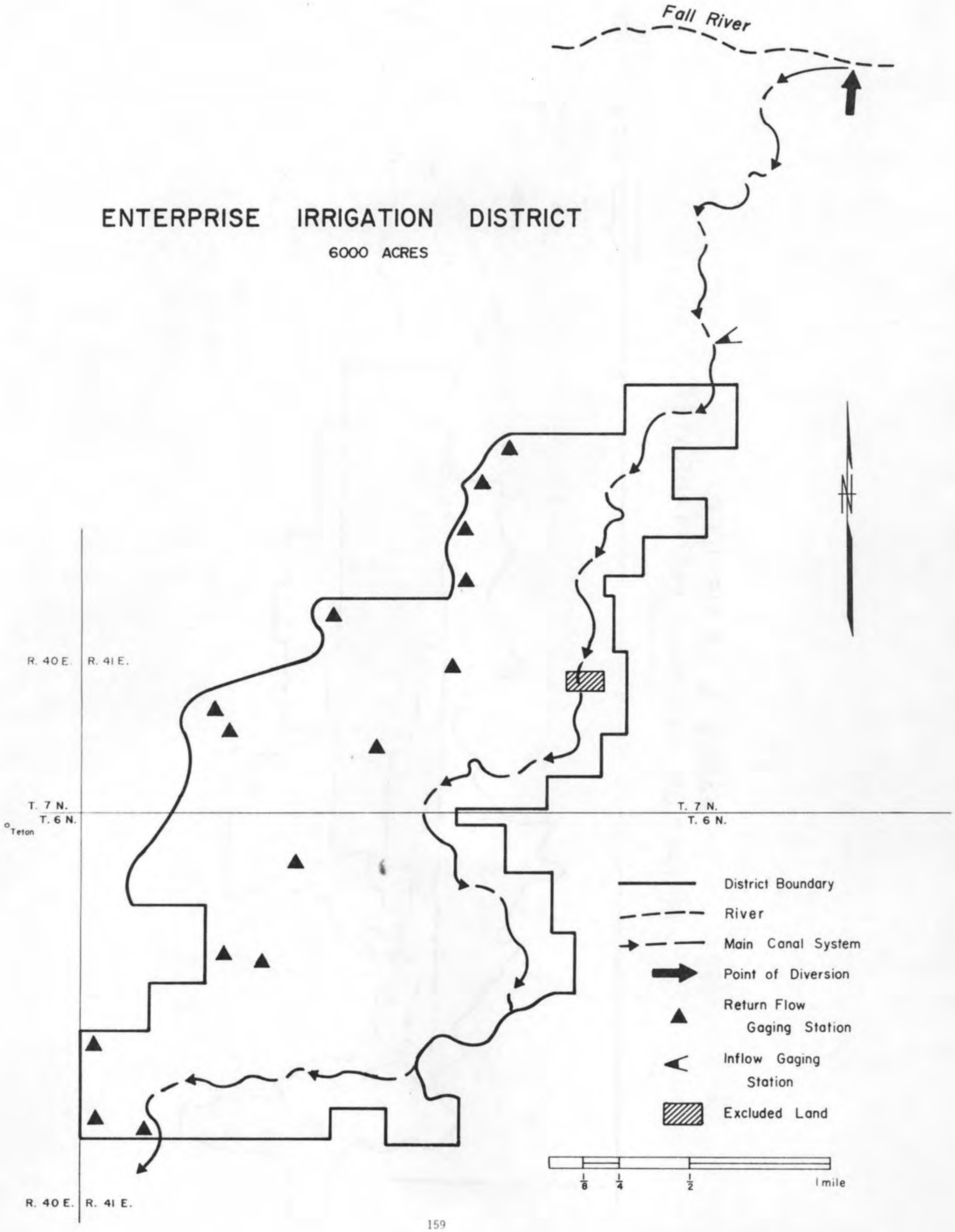
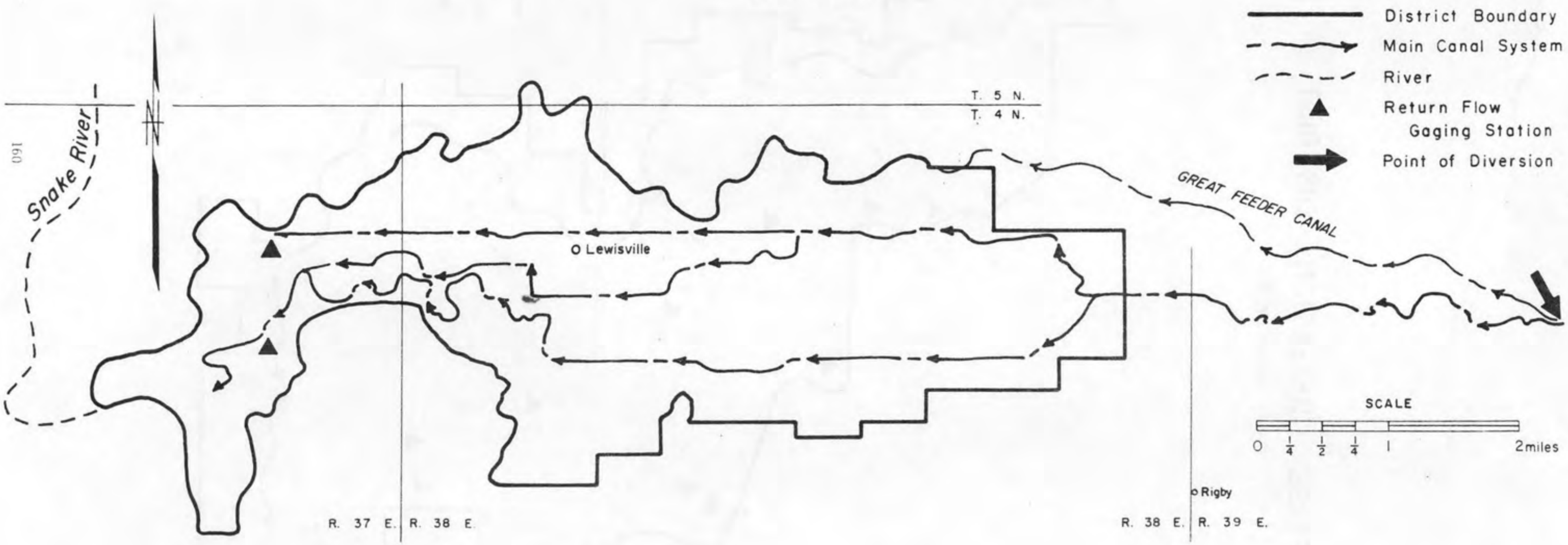
IDAHO
Paddock Valley Res.
LITTLE WILLOW I. D.
Payette River
Boise River
WILDER
BOISE
SETTLERS I. D.
Arrowrock Res.
Lucky Peak Res.
Anderson Ranch Reservoir
SOUTH BOARD OF CONTROL I.D.
HAILEY
WOOD RIVER VALLEY I.D.
Magic Res.
Big Wood
KING HILL I. D.
NORTH SIDE CANAL CO.
BELL RAPIDS M. I. C.
A & B I. D.
A
B
RUPERT
BURLEY I. D.
Salmon Falls Creek
TWIN FALLS
KIMBERLY
MILNER LOWLIFT I. D.
CEDAR MESA RES. CANAL CO.
Cedar Creek Res.
SALMON RIVER CANAL CO.
Salmon Creek Res.
Henry's Fork
Falls River
Jackson Lake
ENTERPRISE I.D.
REXBURG
PARKS & LEWISVILLE I. C.
OSGOOD CANAL CO.
IDAHO FALLS
IDAHO I. D.
Snake River
Palisades Reservoir
DANSKIN DITCH CO.
American Falls Res.
POCATELLO


ENTERPRISE IRRIGATION DISTRICT
6000 ACRES
Fall River
R. 40 E.
R. 41 E.
T. 7 N.
T. 6 N.
Teton
District Boundary
River
Main Canal System
Point of Diversion
Return Flow Gaging Station
Inflow Gaging Station
Excluded Land
1/8
1/4
1/2
1 mile

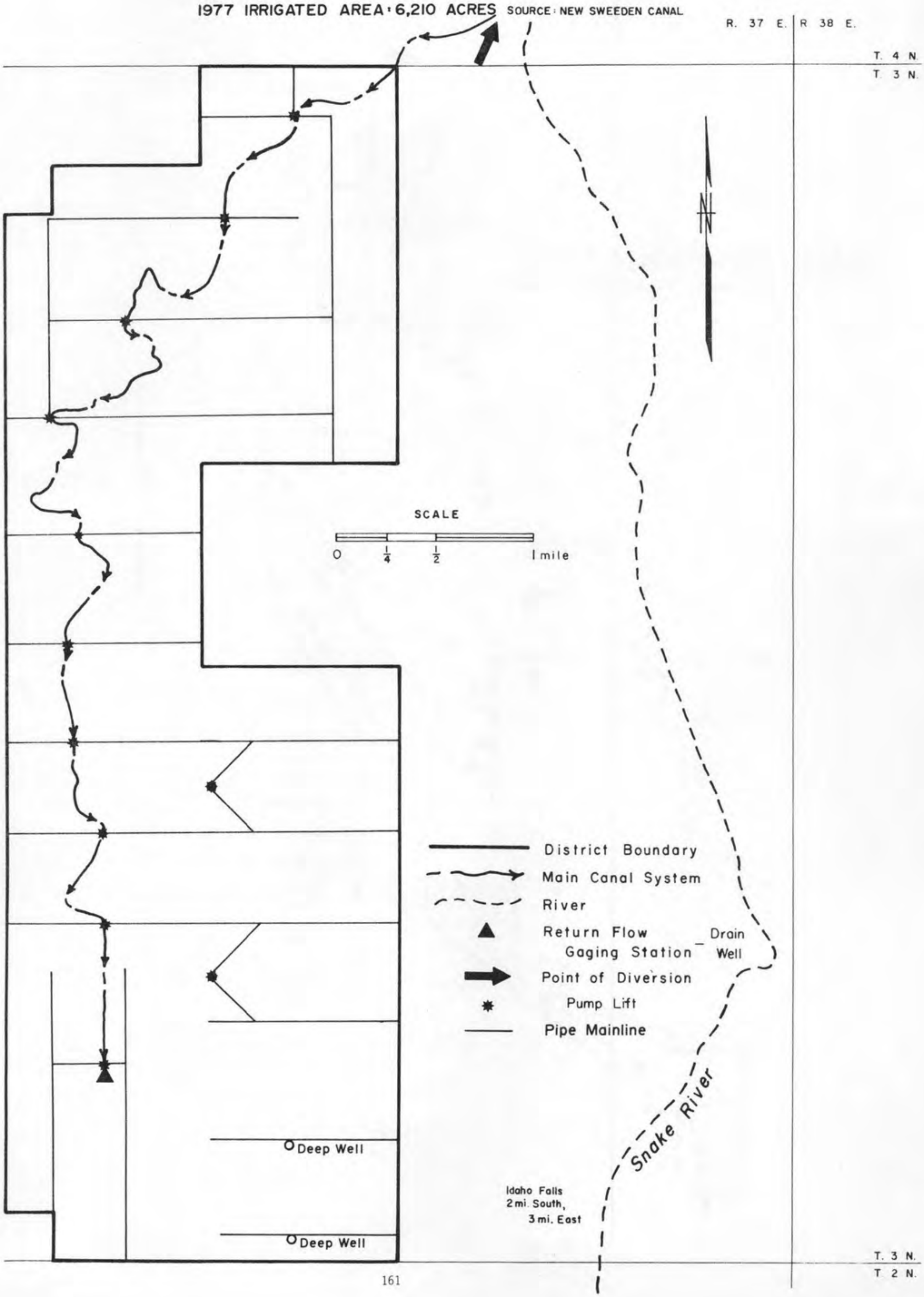
PARKS & LEWISVILLE IRRIGATION COMPANY, INCORPORATED

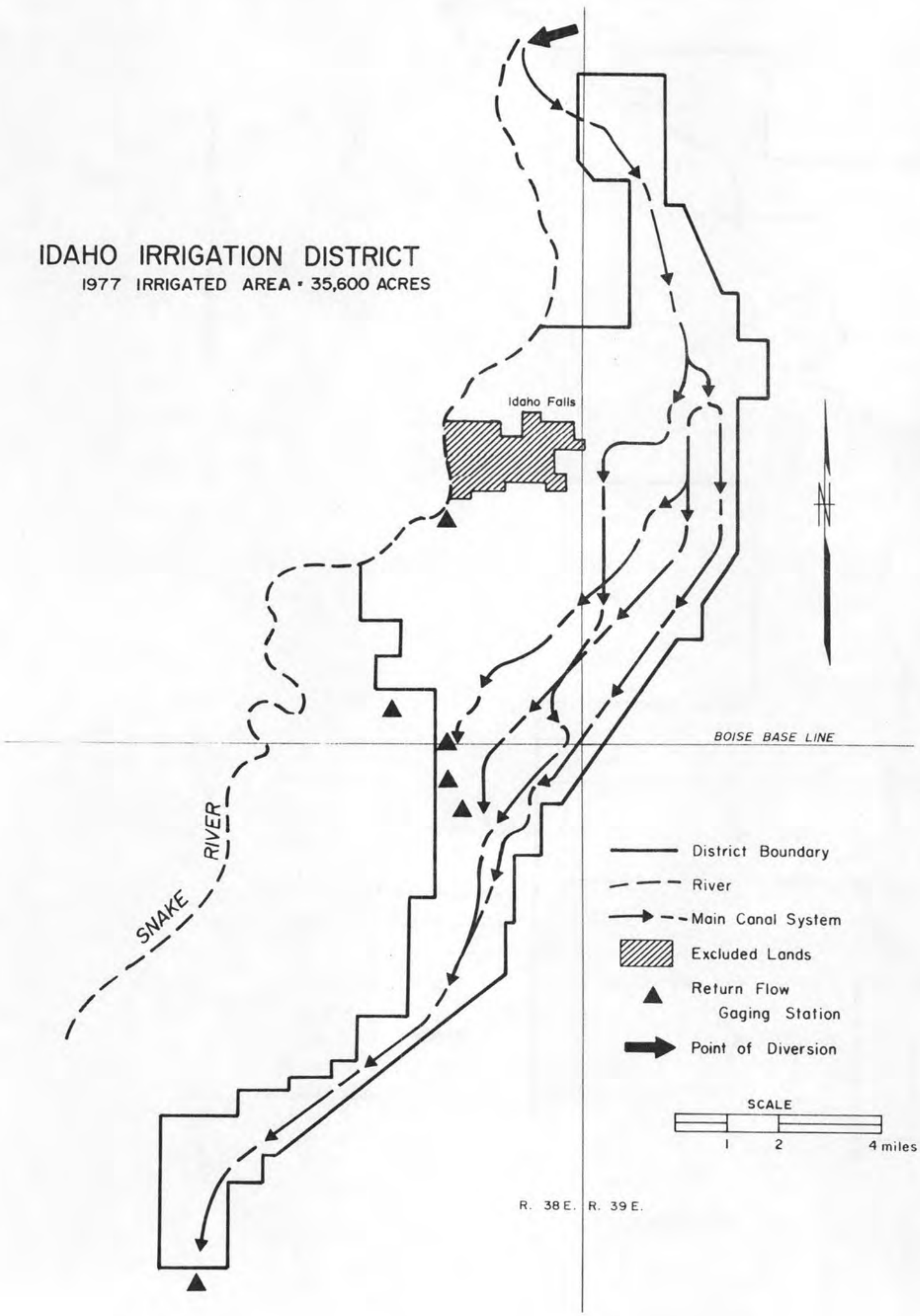
8,500 ACRES



OSGOOD CANAL COMPANY

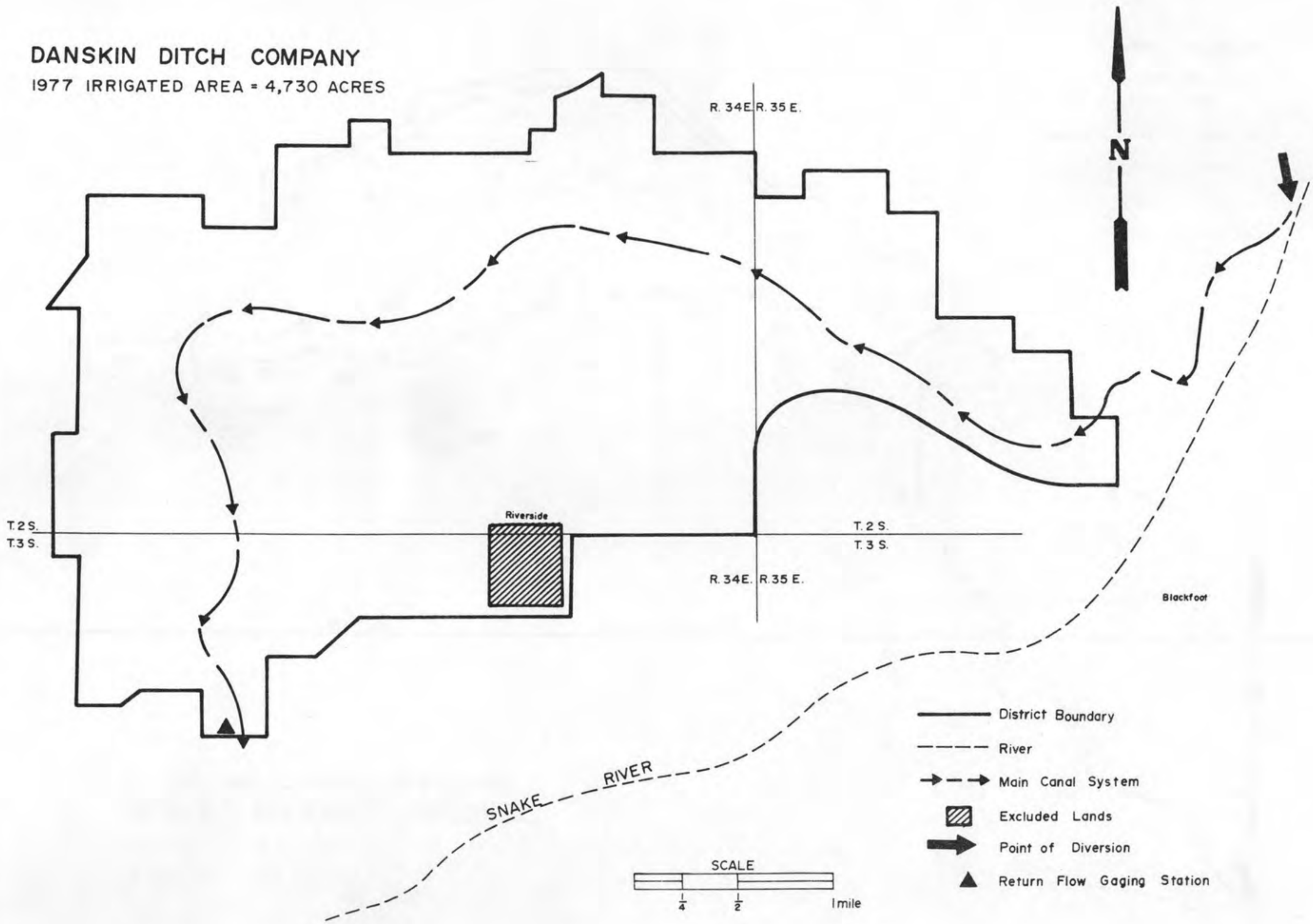
1977 IRRIGATED AREA: 6,210 ACRES SOURCE: NEW SWEEDEN CANAL

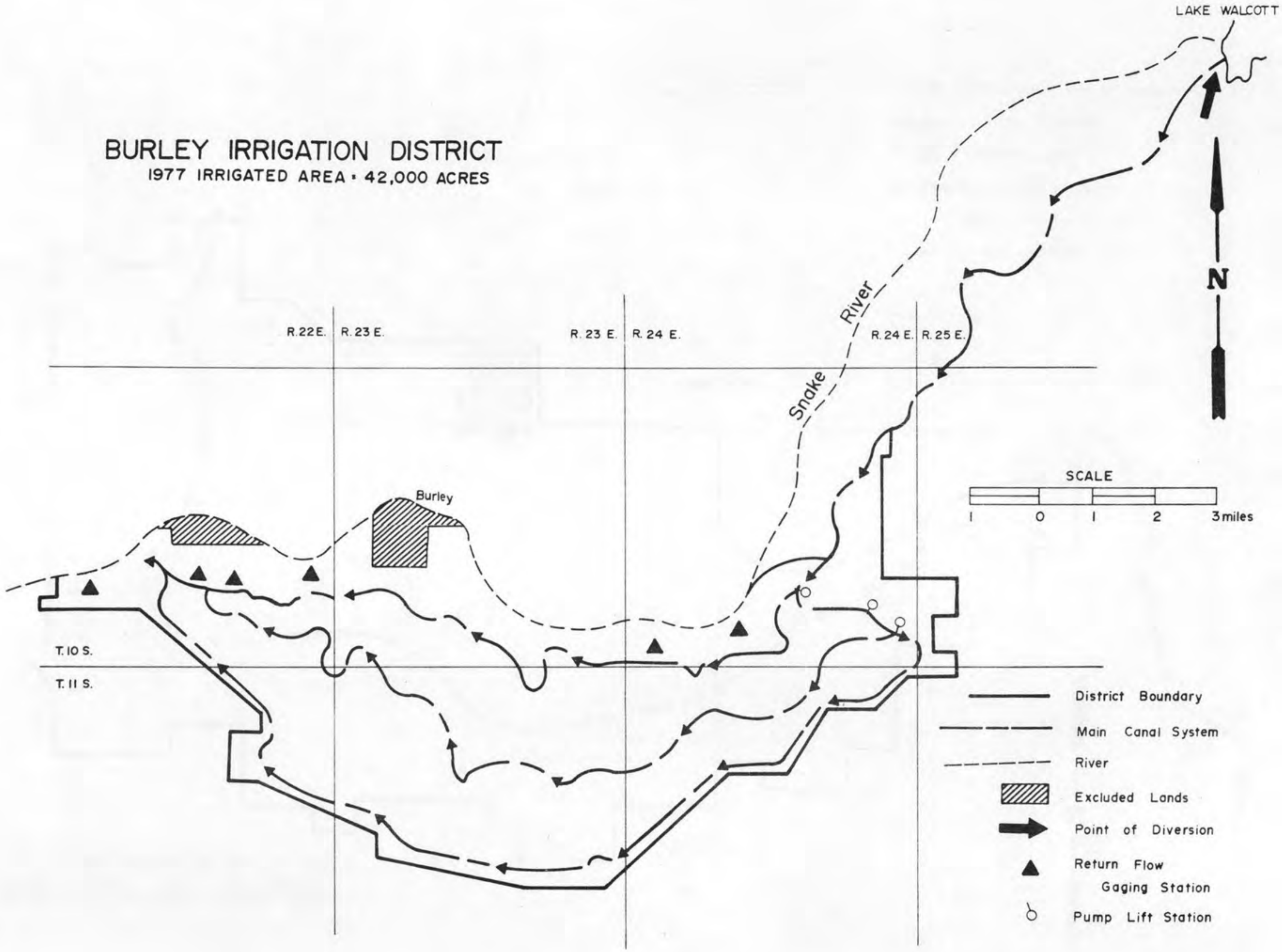


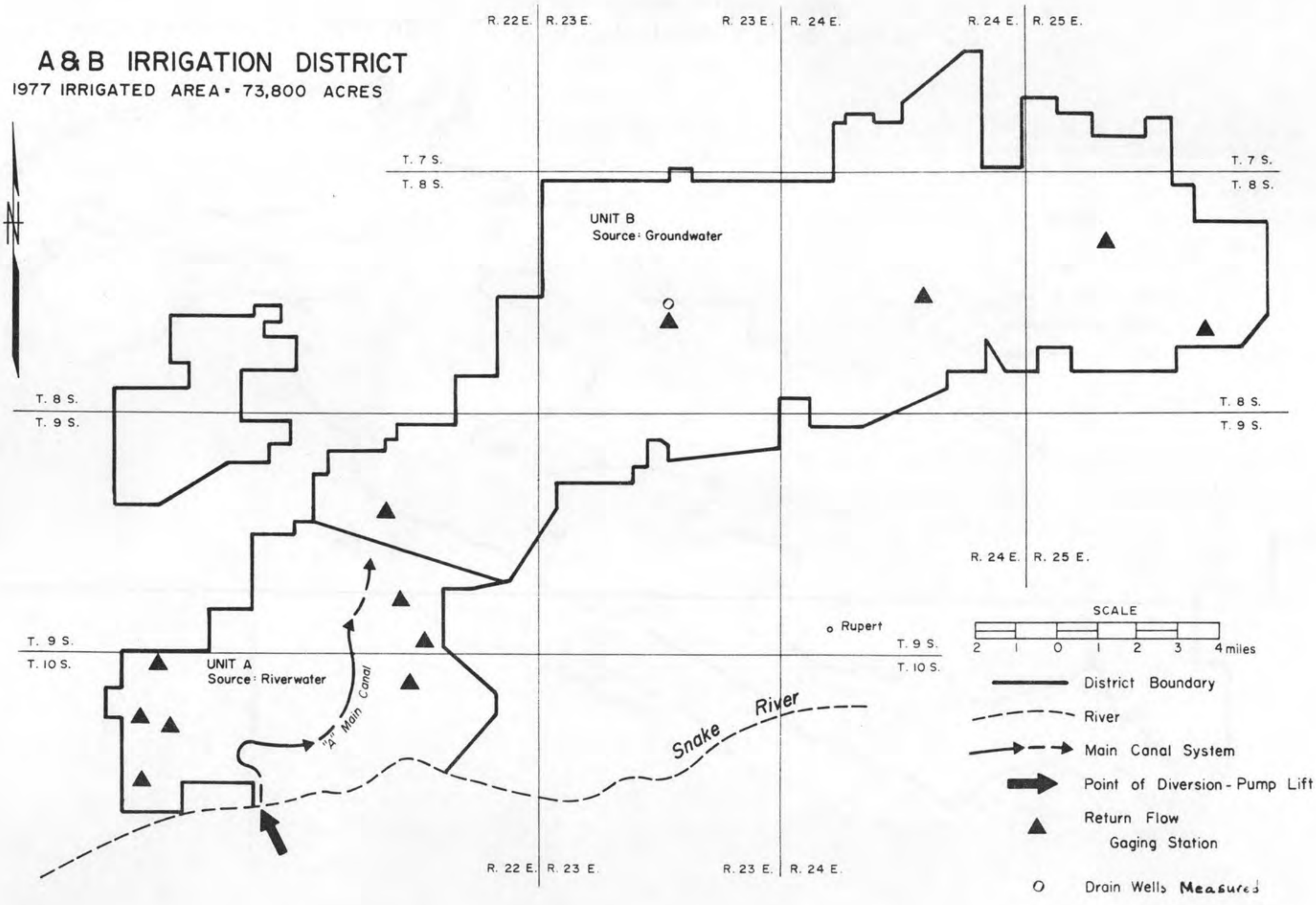

IDAHO IRRIGATION DISTRICT
1977 IRRIGATED AREA • 35,600 ACRES
Idaho Falls
BOISE BASE LINE
SNAKE RIVER
District Boundary
River
Main Canal System
Excluded Lands
Return Flow Gaging Station
Point of Diversion
SCALE
1
2
4 miles
R. 38 E.
R. 39 E.

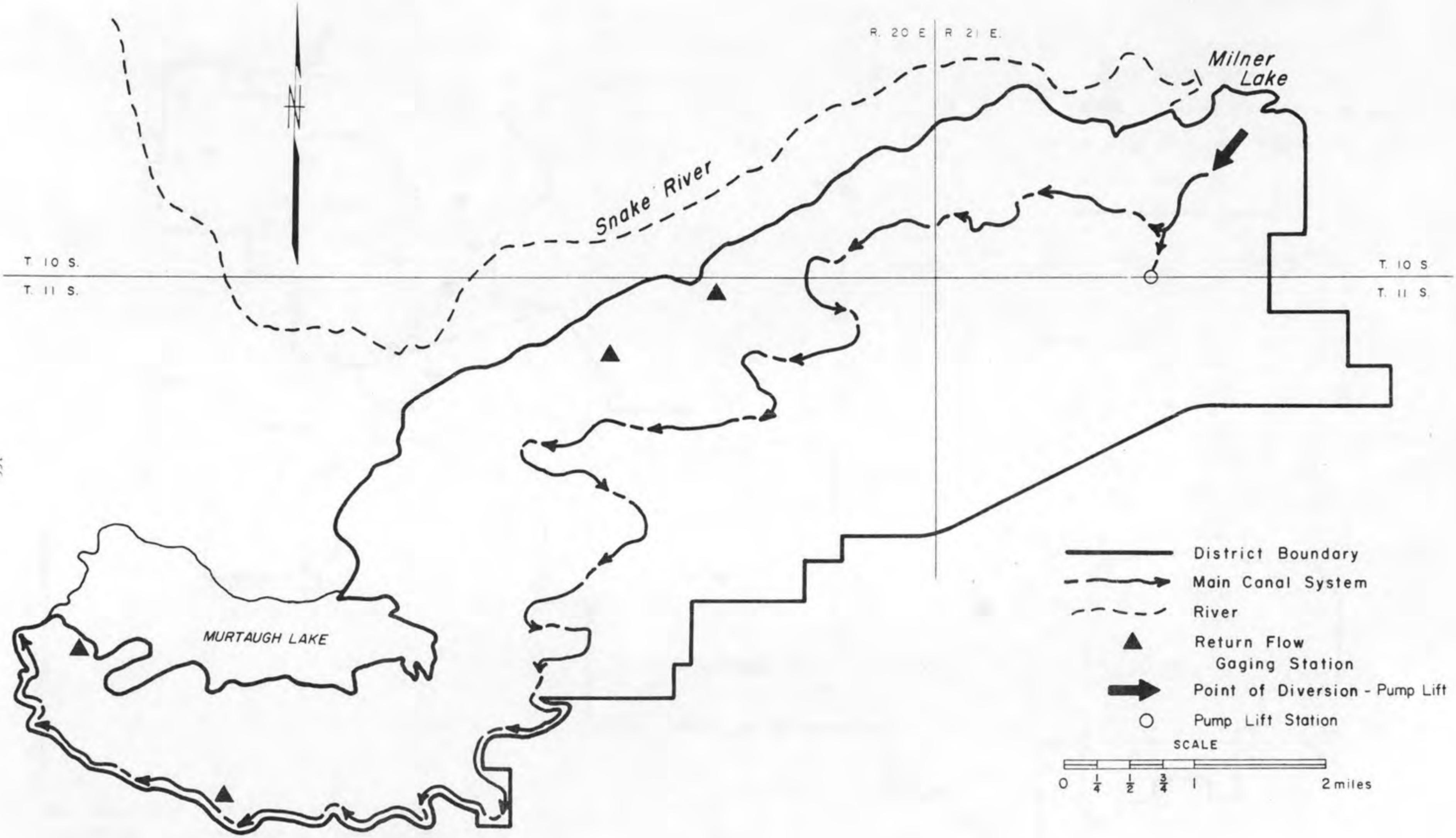
DANSKIN DITCH COMPANY

1977 IRRIGATED AREA = 4,730 ACRES



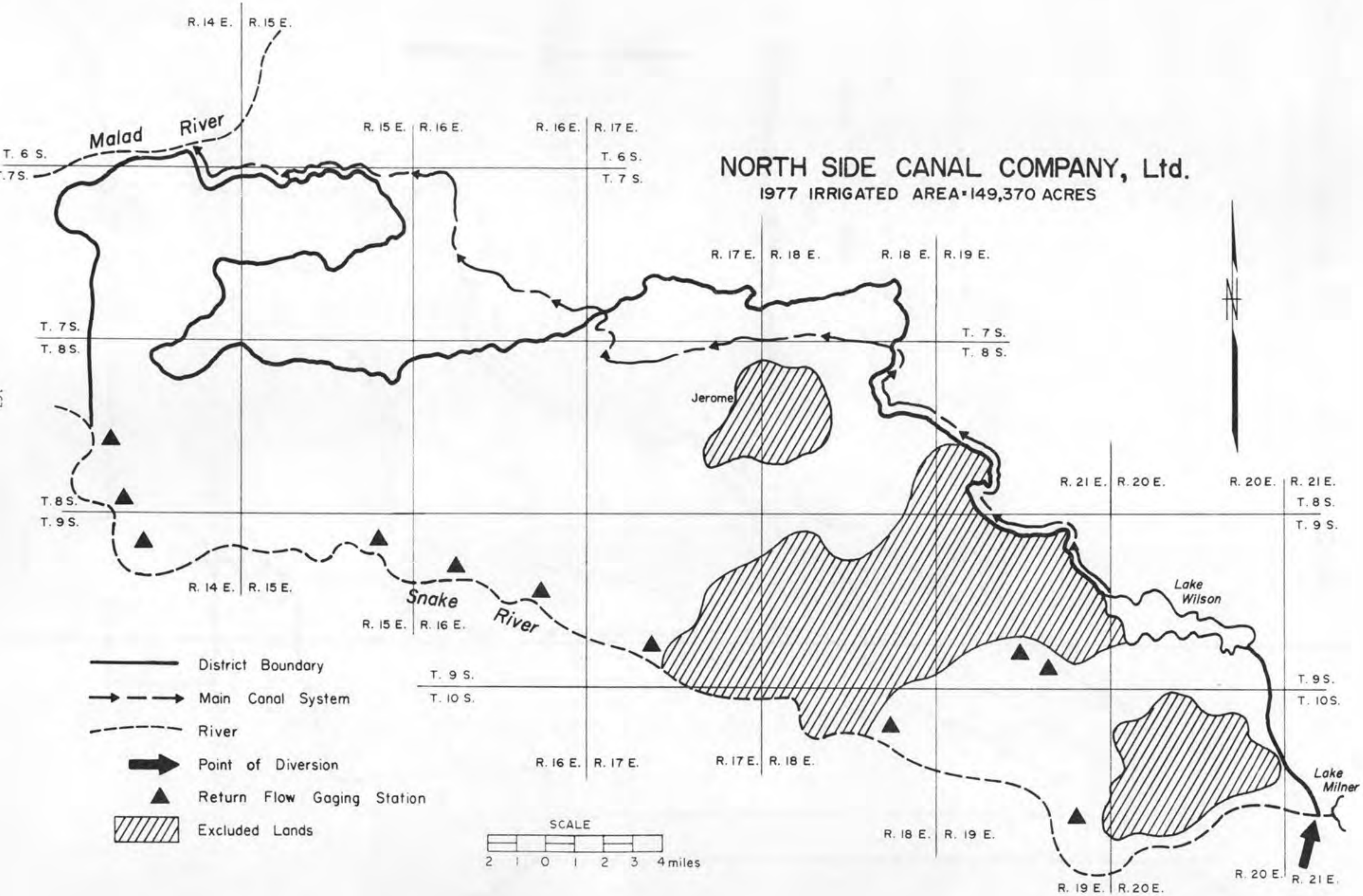

BURLEY IRRIGATION DISTRICT
1977 IRRIGATED AREA • 42,000 ACRES
LAKE WALCOTT
Snake River
R.22E. R.23E.
R.23E. R.24E.
R.24E. R.25E.
T.10S.
T.11S.
Burley
N
SCALE
1 0 1 2 3 miles
District Boundary
Main Canal System
River
Excluded Lands
Point of Diversion
Return Flow Gaging Station
Pump Lift Station


A & B IRRIGATION DISTRICT
1977 IRRIGATED AREA = 73,800 ACRES
N
R. 22 E.
R. 23 E.
R. 23 E.
R. 24 E.
R. 24 E.
R. 25 E.
T. 7 S.
T. 8 S.
T. 9 S.
T. 10 S.
UNIT B
Source: Groundwater
UNIT A
Source: Riverwater
"A" Main Canal
Snake River
Rupert
SCALE
2 1 0 1 2 3 4 miles
District Boundary
River
Main Canal System
Point of Diversion - Pump Lift
Return Flow
Gaging Station
Drain Wells Measured

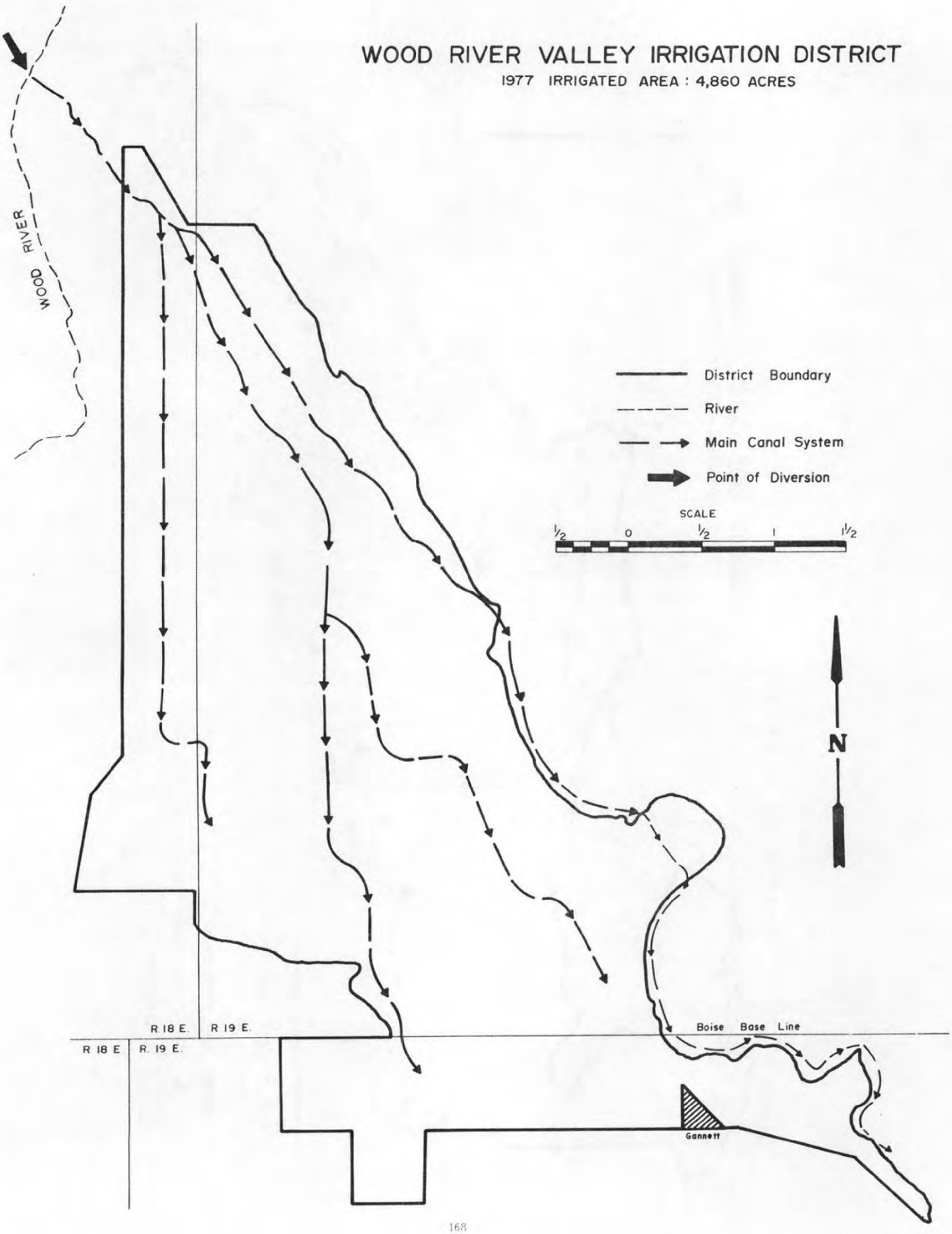


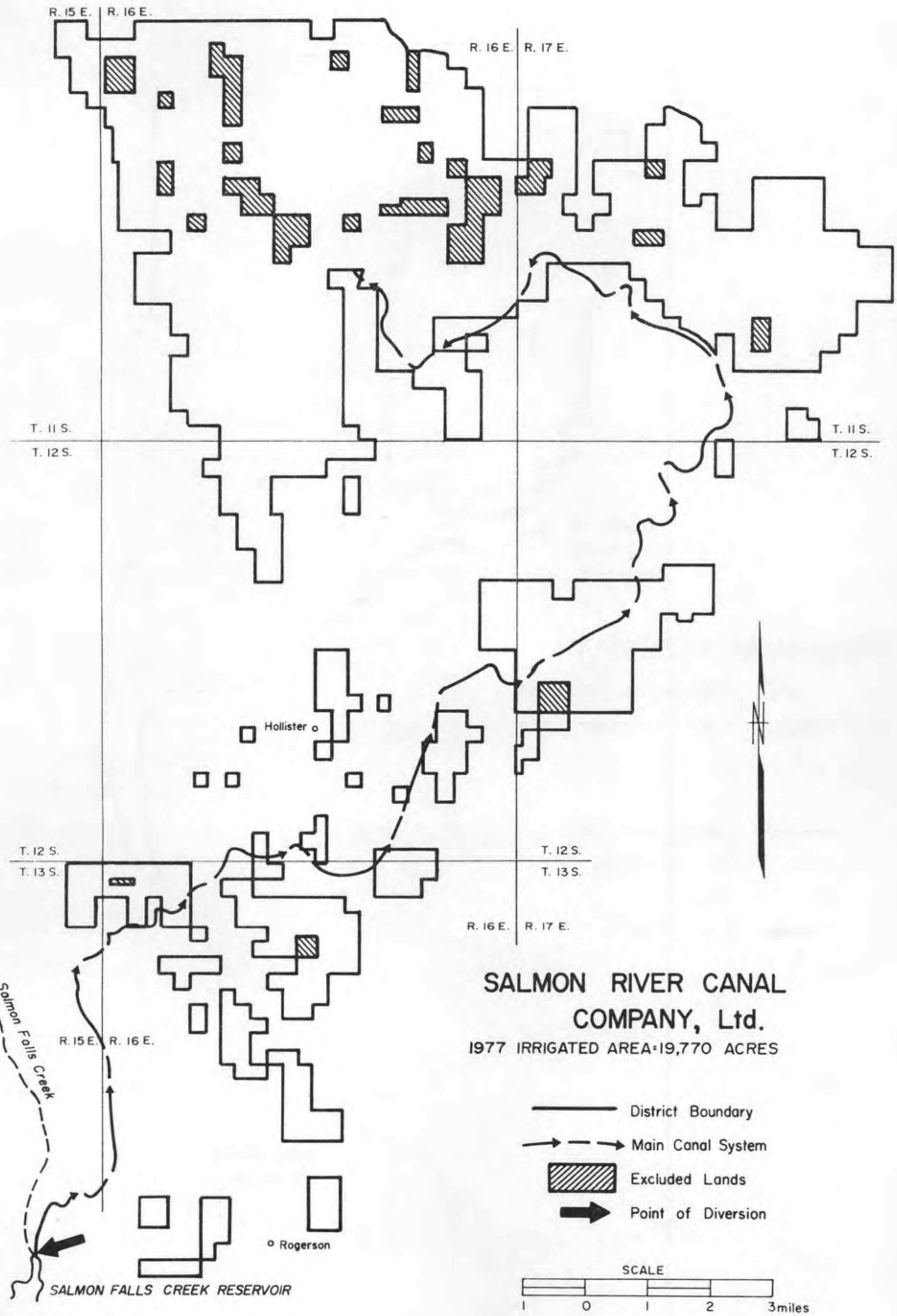
MILNER LOW LIFT IRRIGATION DISTRICT

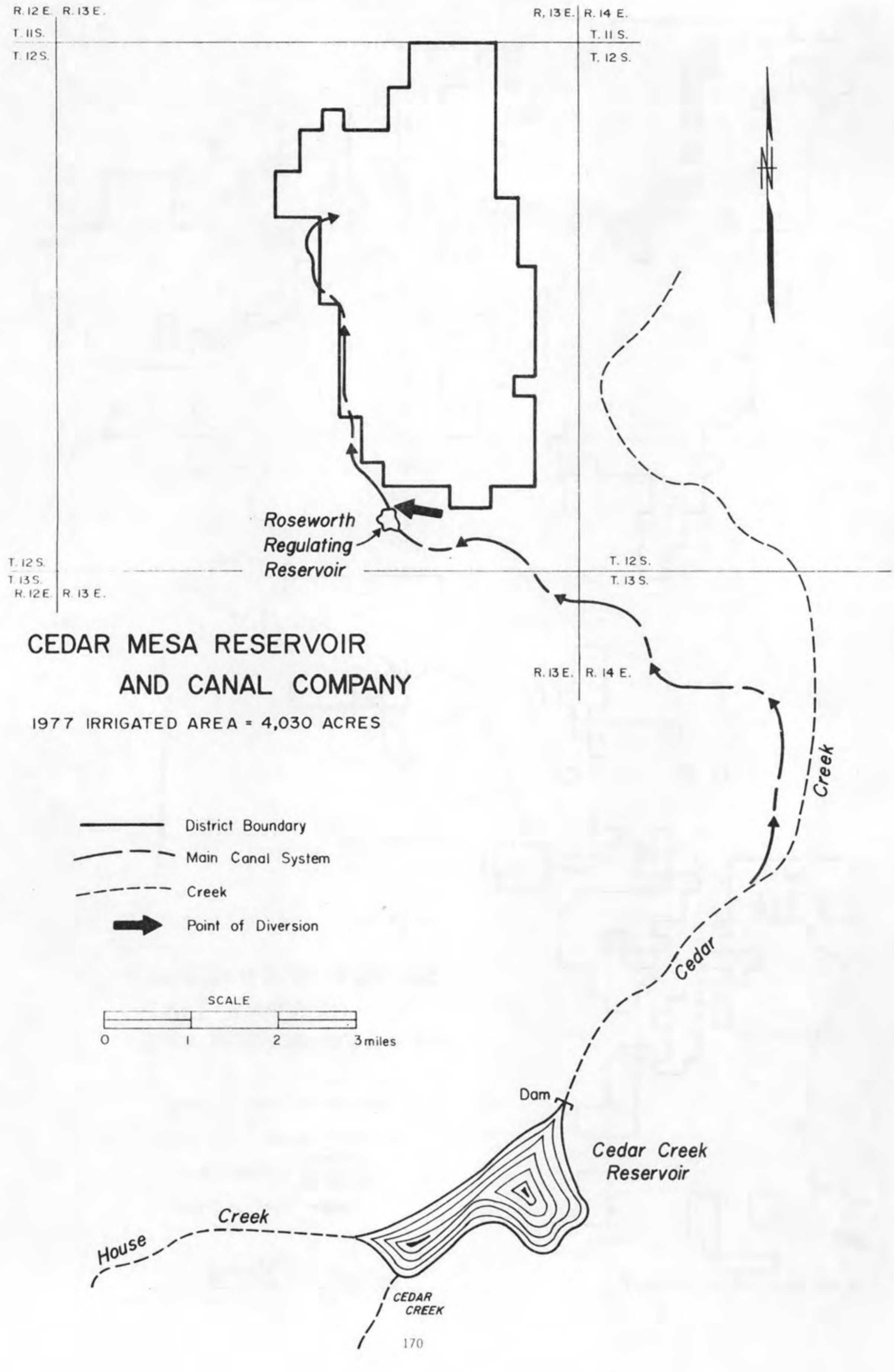
1977 IRRIGATED AREA • 13,480 ACRES

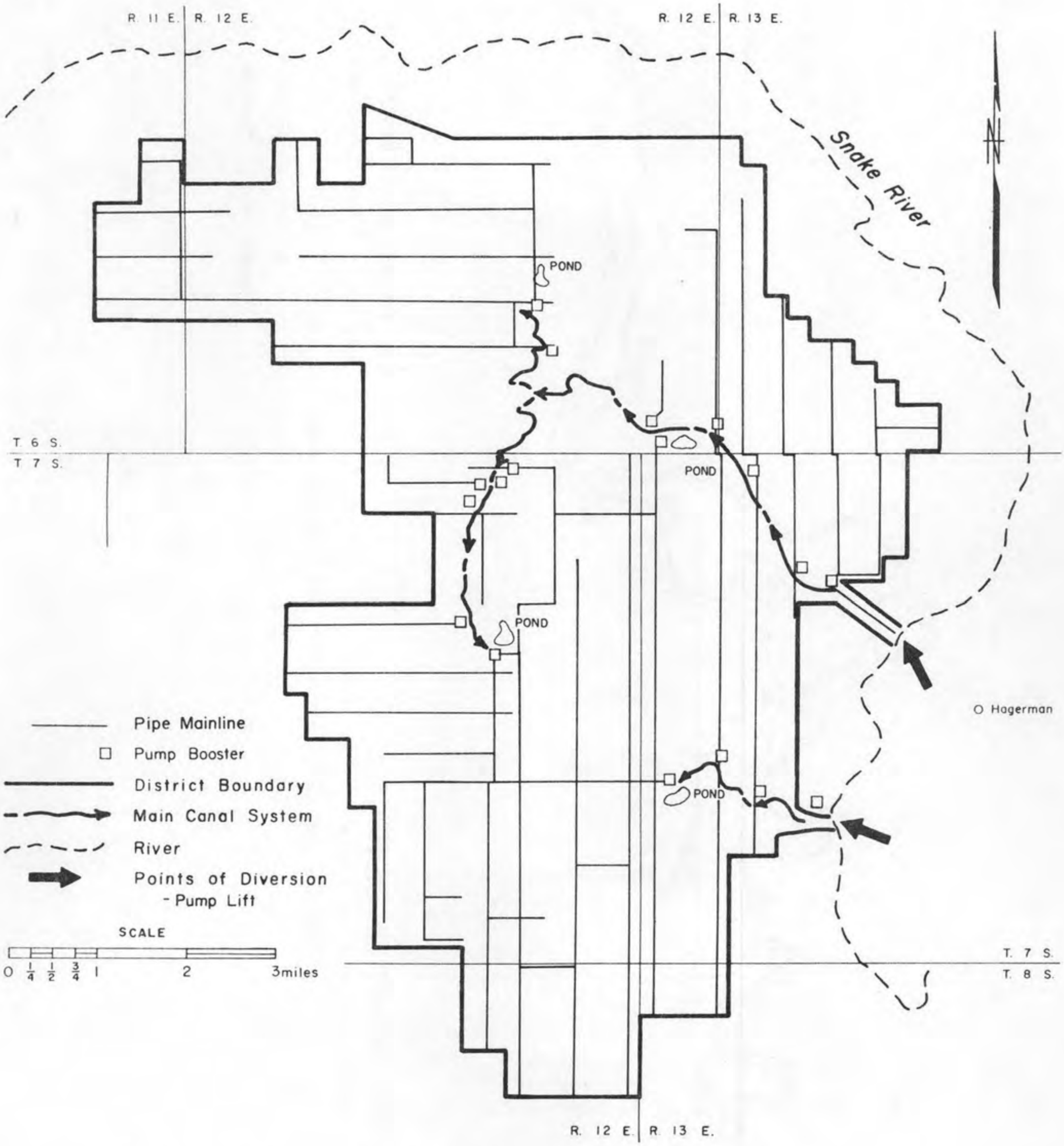


NORTH SIDE CANAL COMPANY, Ltd.
1977 IRRIGATED AREA=149,370 ACRES
Malad River
Snake River
Jerome
Lake Wilson
Lake Milner
N
R. 14 E.
R. 15 E.
R. 16 E.
R. 17 E.
R. 18 E.
R. 19 E.
R. 20 E.
R. 21 E.
T. 6 S.
T. 7 S.
T. 8 S.
T. 9 S.
T. 10 S.
District Boundary
Main Canal System
River
Point of Diversion
Return Flow Gaging Station
Excluded Lands
SCALE
2 1 0 1 2 3 4 miles


WOOD RIVER VALLEY IRRIGATION DISTRICT
1977 IRRIGATED AREA : 4,860 ACRES
WOOD RIVER
District Boundary
River
Main Canal System
Point of Diversion
SCALE
½ 0 ½ 1 1½
N
R 18 E. R 19 E.
R 18 E. R. 19 E.
Boise Base Line
Gannett

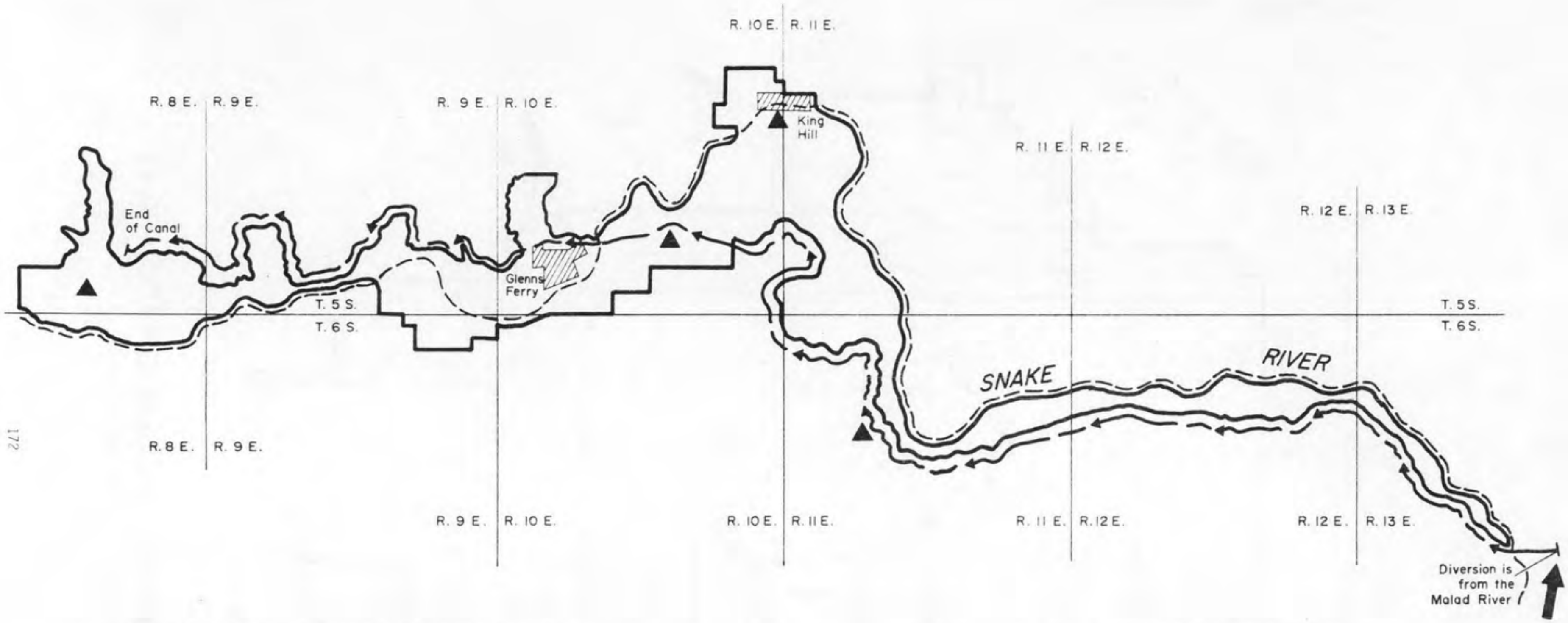

R. 15 E.
R. 16 E.
R. 16 E.
R. 17 E.
T. 11 S.
T. 12 S.
T. 11 S.
T. 12 S.
Hollister
T. 12 S.
T. 13 S.
T. 12 S.
T. 13 S.
R. 16 E.
R. 17 E.
Salmon Falls Creek
R. 15 E.
R. 16 E.
Rogerson
SALMON FALLS CREEK RESERVOIR
SALMON RIVER CANAL
COMPANY, Ltd.
1977 IRRIGATED AREA=19,770 ACRES
District Boundary
Main Canal System
Excluded Lands
Point of Diversion
SCALE
1 0 1 2 3miles


R. 12 E.
R. 13 E.
T. 11 S.
T. 12 S.
R. 13 E.
R. 14 E.
T. 11 S.
T. 12 S.
Roseworth
Regulating
Reservoir
T. 12 S.
T. 13 S.
R. 12 E.
R. 13 E.
T. 12 S.
T. 13 S.
R. 13 E.
R. 14 E.
CEDAR MESA RESERVOIR
AND CANAL COMPANY
1977 IRRIGATED AREA = 4,030 ACRES
District Boundary
Main Canal System
Creek
Point of Diversion
SCALE
0
1
2
3 miles
Creek
Cedar
Dam
Cedar Creek
Reservoir
House
Creek
CEDAR
CREEK



BELL RAPIDS MUTUAL IRRIGATION COMPANY

1977 IRRIGATED AREA • 25,530 ACRES



KING HILL IRRIGATION DISTRICT

1977 IRRIGATED AREA = 11,000 ACRES

MOST OF DISTRICT IS BOUNDED BY THE MAIN CANAL OR LATERALS AND THE SNAKE RIVER

District Boundary

Main Canal System

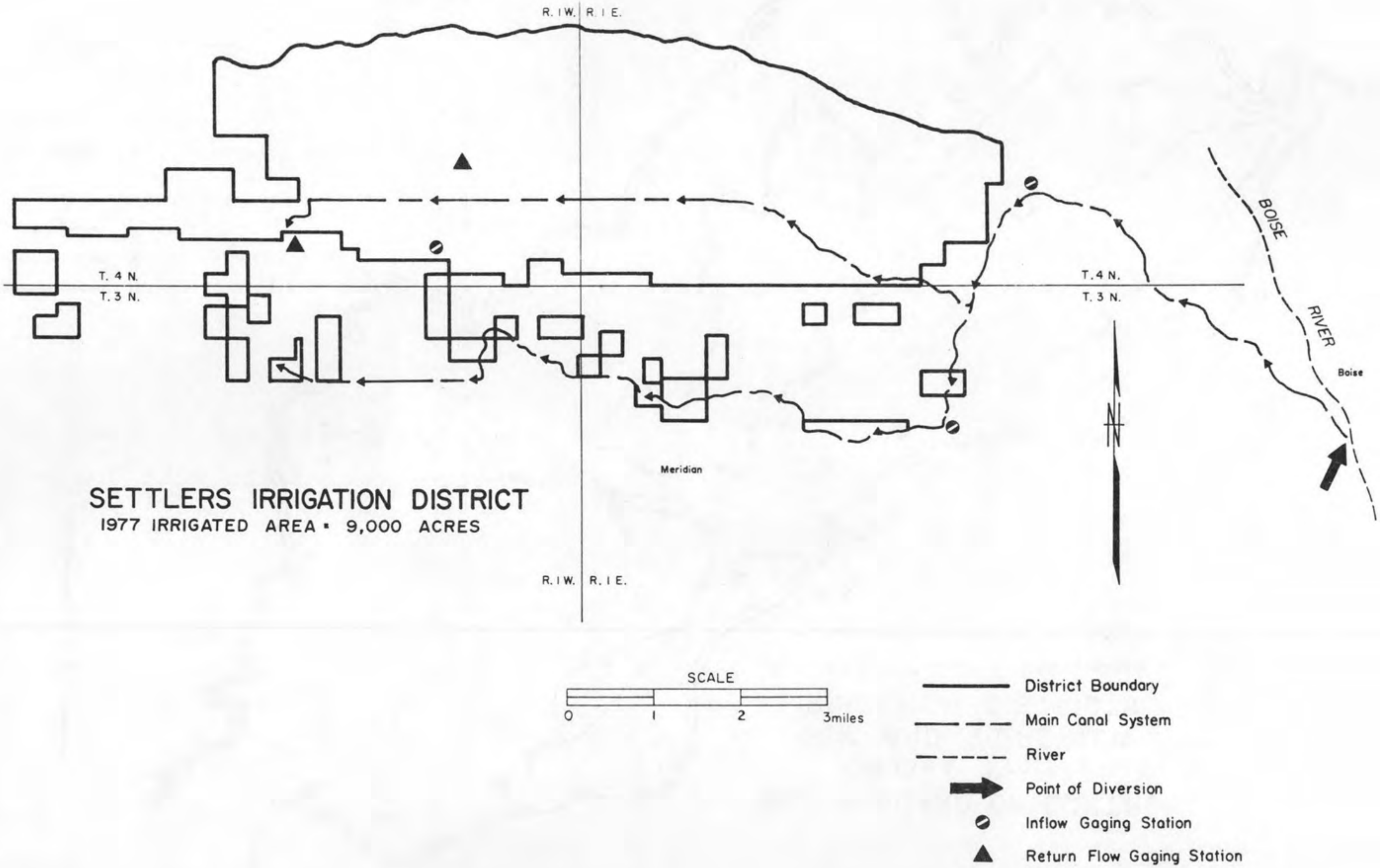
River

▲ Major Return Flow Points

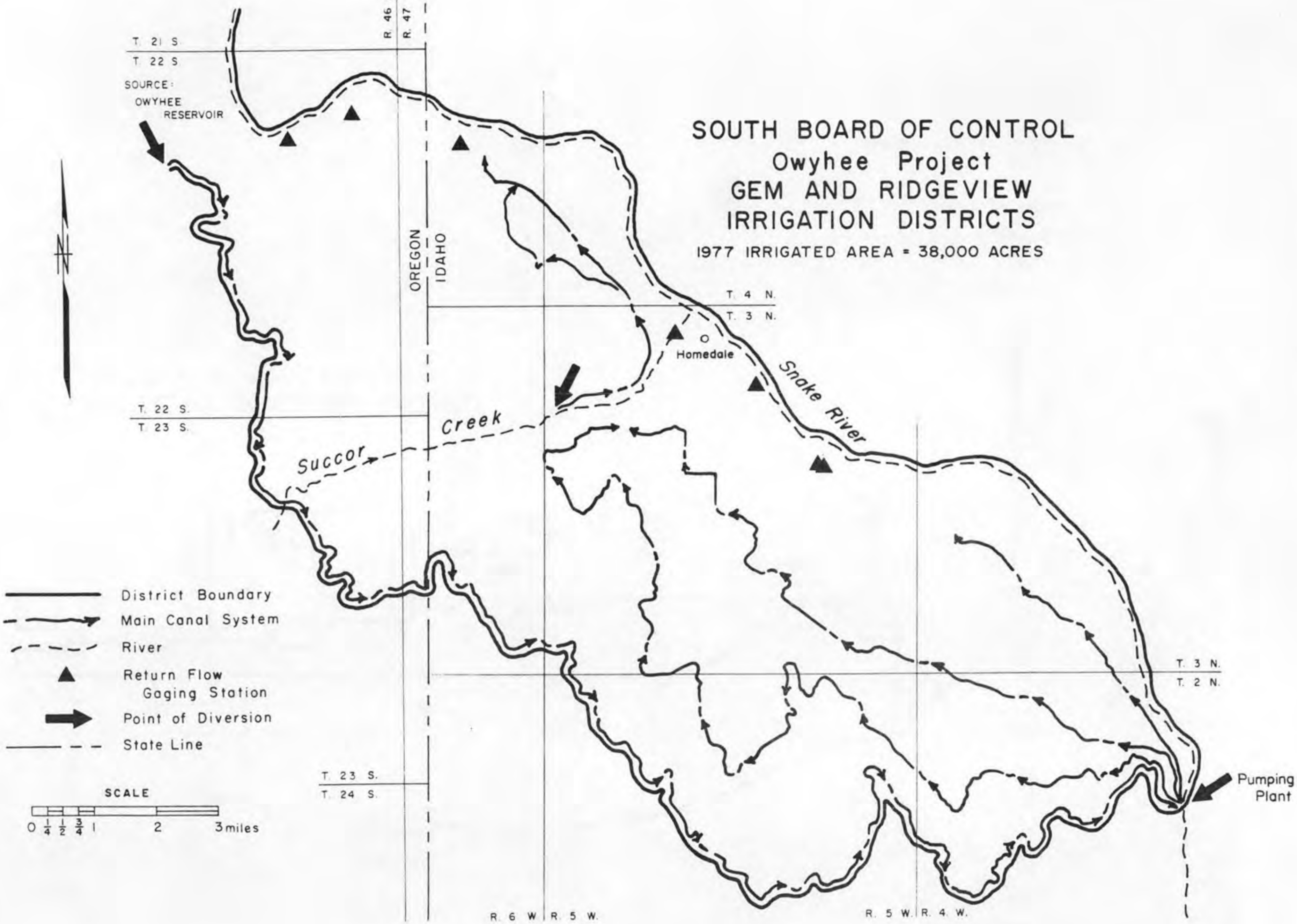
Point of Diversion

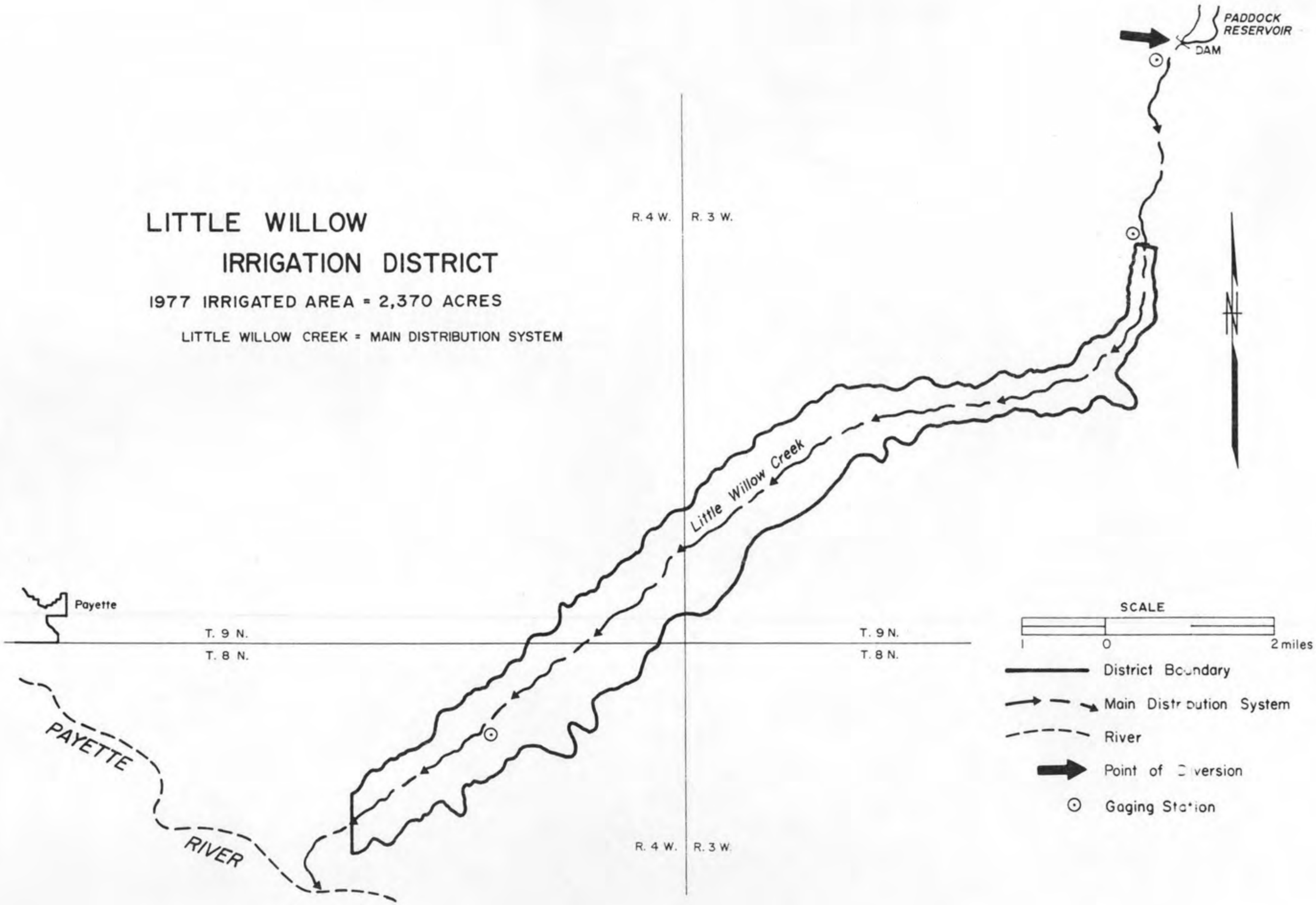
SCALE

2 1 0 1 2 3 4 miles



SETTLERS IRRIGATION DISTRICT
1977 IRRIGATED AREA - 9,000 ACRES


SOUTH BOARD OF CONTROL
Owyhee Project
GEM AND RIDGEVIEW
IRRIGATION DISTRICTS
1977 IRRIGATED AREA = 38,000 ACRES
SOURCE: OWYHEE RESERVOIR
T. 21 S.
T. 22 S.
T. 23 S.
T. 24 S.
T. 4 N.
T. 3 N.
T. 2 N.
R. 46 N.
R. 47 N.
R. 6 W.
R. 5 W.
R. 4 W.
OREGON
IDAHO
Homedale
Snake River
Succor Creek
Pumping Plant
District Boundary
Main Canal System
River
Return Flow Gaging Station
Point of Diversion
State Line
SCALE
0 1/4 1/2 3/4 1 2 3 miles


LITTLE WILLOW
IRRIGATION DISTRICT
1977 IRRIGATED AREA = 2,370 ACRES
LITTLE WILLOW CREEK = MAIN DISTRIBUTION SYSTEM
PADDOCK RESERVOIR
DAM
R. 4 W.
R. 3 W.
Little Willow Creek
Payette
T. 9 N.
T. 8 N.
T. 9 N.
T. 8 N.
PAYETTE
RIVER
R. 4 W.
R. 3 W.
SCALE
1
0
2 miles
District Bo ndary
Main Distr bution System
River
Point of version
Gaging Sta ion

APPENDIX B

O & M COSTS AND PHYSICAL CHARACTERISTICS OF COOPERATING IRRIGATION PROJECTS

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Enterprise	177
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Salmon River	197
Cedar Mesa	199
Bell Rapids	201
King Hill	203
Settlers	205
S. Board of Control	207
Little Willow	209

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*******************************************************************
*                                                                 *
*                 ENTERPRISE IRRIGATION DISTRICT                  *
*                                                                 *
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1977 Irrigated Acres	5970	Nonfederal Origin	
1977 Assessed Acres	5980	Earliest Flow Right	6-12-1903
Total System Length (miles)	15.0	Average Flow Right	7-15-1910
Project Perimeter (miles)	22	Total Water Flow Right	199 cfs
Project Compactness Ratio	1.96	Water Right Duty	30 a/cfs
Irrigated Acres / System Mile	398	Usable Reservoir Storage	16071 af
Water Users > 20 acres	63	Usable Reservoir Storage	2.69 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	20101	3.37	100
Seepage Losses	2675	0.45	13
Operational Losses	1372	0.23	7
Farm Deliveries	16053	2.69	80
Effective Precipitation	3030	0.51	15
Farm Runoff in Return Flow	2734	0.46	14
Deep Percolation	4538	0.76	23
Evapotranspiration	11474	1.92	57
Irrigation Requirement	8782	1.47	44
Project Return Flow	4106	0.69	20
1977 Reservoir Storage	11702	1.96	58

1977 Project Conveyance Efficiency 80 %
1977 Project Application Efficiency 55 %
1977 Project Irrigation Efficiency 44 %

TOPOGRAPHY

Highest Irrigable Elevation	5085 ft
Lowest Irrigable Elevation	5050 ft
Elevation Difference	35 ft
Elevation Diff. / System Mile	2.33 ft/mi
Elevation Difference / Acre	0.006 ft/a
Average Land Slope	0% (0-3%) 100% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	95 acres
Soil---Silt Loam	
Average Soil Depth	48 inches
Ave Soil Moist Holding Cap	2.4 in/ft
Gravity Irrigated Land	5 %
Sprinkler Irrigated Land	95 %
Assessed Land Irrigated (1977)	100 %

CONVEYANCE SYSTEM

Total System Length	15.0 miles
open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	24 acres
Canal Area / Irrig Area	0.40 %
Maximum Seepage Rate	0.97 ft/day
Maximum Diversion Capacity	154 cfs
Irrigated Area at Max Cap.	38.8 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	12
Turnouts / Mile of System	0.8
Irrigated Acres / Turnout	498
Measured Turnouts	0

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	1
Irrigated Area / Ditchrider	5970
Number of Water Users / D.R.	63
System Length / D.R.	15 miles
Turnouts per Ditchrider	12
Turnouts Measured by D.R.	0 %
Turnouts Checked Daily	0 %
Average Mileage / D.R.	50 mi/day
D.R. Mileage / System Mile	3.33 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 95 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

ENTERPRISE IRRIGATION DISTRICT

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	11940	2.00	796	190	0.594		
(1) Administrative Costs	1183	0.20	79	19	0.059	5	5
(2) Water Control Costs	4470	0.75	298	71	0.222	19	19
(3) Maintenance Costs	17283	2.89	1152	274	0.860	75	73
(4) Annual Power Costs	0	0.00	0	0	0.000		0
(5) Reservoir O&M Costs	805	0.13	54	13	0.040		3
Total O&M Costs (1+2+3)	22936	3.84	1529	364	1.141	100	97
Total Project Costs (1+2+3+4)	22936	3.84	1529	364	1.141		97
Total System Costs (1+2+3+4+5)	23741	3.98	1583	377	1.181		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	576	0.096	38	7
Water Control Personnel Costs	3358	0.562	224	39
Maintenance Personnel Costs	4734	0.793	316	55
Total Personnel Costs	8668	1.452	578	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.15	0.000025	0.010000	18
Water Control Labor	0.42	0.000070	0.028000	49
Maintenance Labor	0.28	0.000047	0.018667	33
Total Project Labor	0.85	0.000142	0.056667	100

Average Personnel Cost (total $/total my) $ 10198 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	3647	0.61	243.13	16
Project Vehicle & Equip Deprec.	0	0.00	0.00	0
Hired Vehicle & Equip Deprec.	3339	0.56	222.60	15
Total Vehicle & Equip Deprec.	3339	0.56	222.60	15

1977 Power Consumption	0 kwh	0 kwh/a	0 kwh/mi
1977 Project Power Costs	$ 0	0.0000 $/kwh	
1977 Crop Value	$ 1646000	276 $/a	
1977 Crop Value	82 $/af	143 $/af of ET	

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*********************************************************************
*                                                                   *
*               PARIS & LEWISVILLE IRRIGATION CO. INC.              *
*                                                                   *
*********************************************************************
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1977 Irrigated Acres	8500	Nonfederal Origin	
1977 Assessed Acres	8700	Earliest Flow Right	6 -1-1883
Total System Length (miles)	35.0	Average Flow Right	6-10-1890
Project Perimeter (miles)	25	Total Water Flow Right	433 cfs
Project Compactness Ratio	1.93	Water Right Duty	20 a/cfs
Irrigated Acres / System Mile	243	Usable Reservoir Storage	15250 af
Water Users > 20 acres	150	Usable Reservoir Storage	1.79 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	105947	12.46	100
Seepage Losses	9759	1.15	9
Operational Losses	43257	5.09	41
Farm Deliveries	52930	6.23	50
Effective Precipitation	3650	0.43	3
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	39747	4.68	38
Evapotranspiration	17378	2.04	16
Irrigation Requirement	13183	1.55	12
Project Return Flow	43257	5.09	41
1977 Reservoir Storage	5500	0.65	5

1977 Project Conveyance Efficiency	50 %
1977 Project Application Efficiency	25 %
1977 Project Irrigation Efficiency	12 %

TOPOGRAPHY

Highest Irrigable Elevation	4837 ft
Lowest Irrigable Elevation	4765 ft
Elevation Difference	72 ft
Elevation Diff. / System Mile	2.06 ft/mi
Elevation Difference / Acre	0.008 ft/a
Average Land Slope 100% (0-3%)	0% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	57 acres
Soil---Sandy Loam	
Average Soil Depth	36 inches
Ave Soil Moist Holding Cap	1.7 in/ft
Gravity Irrigated Land	100 %
Sprinkler Irrigated Land	0 %
Assessed Land Irrigated (1977)	98 %

CONVEYANCE SYSTEM

Total System Length	35.0 miles
open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	70 acres
Canal Area / Irrig Area	0.82 %
Maximum Seepage Rate	0.95 ft/day
Maximum Diversion Capacity	512 cfs
Irrigated Area at Max Cap.	16.6 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	153
Turnouts / Mile of System	4.4
Irrigated Acres / Turnout	56
Measured Turnouts	0

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	1
Irrigated Area / Ditchrider	8500
Number of Water Users / D.R.	150
System Length / D.R.	35 miles
Turnouts per Ditchrider	153
Turnouts Measured by D.R.	0 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	50 mi/day
D.R. Mileage / System Mile	1.43 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps	0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps	0 % total
Water Delivered at High Pressure by Project	0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %	

PARKS & LEWISVILLE IRRIGATION CO. INC.

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	14432	1.70	412	96	0.136		
(1) Administrative Costs	2462	0.29	70	16	0.023	16	16
(2) Water Control Costs	3871	0.46	111	26	0.037	25	25
(3) Maintenance Costs	9119	1.07	261	61	0.086	59	58
(4) Annual Power Costs	0	0.00	0	0	0.000		0
(5) Reservoir O&M Costs	232	0.03	7	2	0.002		1
Total O&M Costs (1+2+3)	15452	1.82	441	103	0.146	100	99
Total Project Costs (1+2+3+4)	15452	1.82	441	103	0.146		99
Total System Costs (1+2+3+4+5)	15684	1.85	448	105	0.148		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	594	0.070	17	9
Water Control Personnel Costs	2727	0.321	78	42
Maintenance Personnel Costs	3247	0.382	93	49
Total Personnel Costs	6568	0.773	188	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.08	0.000009	0.002286	9
Water Control Labor	0.35	0.000041	0.010000	41
Maintenance Labor	0.42	0.000049	0.012000	49
Total Project Labor	0.85	0.000100	0.024286	100

Average Personnel Cost (total $/total my) $ 7727 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	2385	0.28	68.14	15
Project Vehicle & Equip Deprec.	0	0.00	0.00	0
Hired Vehicle & Equip Deprec.	4043	0.48	115.51	26
Total Vehicle & Equip Deprec.	4043	0.48	115.51	26

1977 Power Consumption 0 kwh 0 kwh/a 0 kwh/mi
1977 Project Power Costs $ 0 0.0000 $/kwh
1977 Crop Value $ 3098000 364 $/a
1977 Crop Value 29 $/af 178 $/af of ET

OSGOOD CANAL CO. (U&I SUGAR CO.)

1977 Irrigated Acres	6220	Nonfederal Origin	
1977 Assessed Acres	6220	Earliest Flow Right	6 -1-1885
Total System Length (miles)	30.0	Average Flow Right	8-10-1893
Project Perimeter (miles)	18	Total Water Flow Right	232 cfs
Project Compactness Ratio	1.57	Water Right Duty	27 a/cfs
Irrigated Acres / System Mile	207	Usable Reservoir Storage	21230 af
Water Users > 20 acres	17	Usable Reservoir Storage	3.41 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	16946	2.72	100
Seepage Losses	1984	0.32	12
Operational Losses	1503	0.24	9
Farm Deliveries	13458	2.16	79
Effective Precipitation	2522	0.41	15
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	4487	0.72	26
Evapotranspiration	11207	1.80	66
Irrigation Requirement	8971	1.44	53
Project Return Flow	1503	0.24	9
1977 Reservoir Storage	31807	5.11	188

1977 Project Conveyance Efficiency	79 %
1977 Project Application Efficiency	67 %
1977 Project Irrigation Efficiency	53 %

TOPOGRAPHY

Highest Irrigable Elevation	4820 ft
Lowest Irrigable Elevation	4740 ft
Elevation Difference	80 ft
Elevation Diff. / System Mile	2.67 ft/mi
Elevation Difference / Acre	0.013 ft/a
Average Land Slope	100% (0-3%) 0% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	360 acres
Soil---Silt Loam	
Average Soil Depth	48 inches
Ave Soil Moist Holding Cap	2.7 in/ft
Gravity Irrigated Land	0 %
Sprinkler Irrigated Land	100 %
Assessed Land Irrigated (1977)	100 %

CONVEYANCE SYSTEM

Total System Length	30.0 miles
open channel	24.0 %
lined channel	0.0 %
pipe	76.0 %
lined channel + pipe	76.0 %
Canal Wetted Area	20 acres
Canal Area / Irrig Area	0.32 %
Maximum Seepage Rate	0.95 ft/day
Maximum Diversion Capacity	105 cfs
Irrigated Area at Max Cap.	59.2 a/cfs
Project Irrigation Wells	2
Project Total Pumps	30
Maximum Pump Demand	3625 hp
Number of System Turnouts	13
Turnouts / Mile of System	0.4
Irrigated Acres / Turnout	478
Measured Turnouts	0

WATER SOURCE

River or Canal	91.3 %
Groundwater	8.7 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	2
Irrigated Area / Ditchrider	3110
Number of Water Users / D.R.	9
System Length / D.R.	15 miles
Turnouts per Ditchrider	7
Turnouts Measured by D.R.	0 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	25 mi/day
D.R. Mileage / System Mile	1.67 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 100 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 0 % total
Water Delivered at High Pressure by Project 100 % total
Sprinkler Systems Pressurized by Project 100 % by Farms 0 %

OSGOOD CANAL CO. (U&I SUGAR CO.)

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	0	0.00	0	0	0.000		
(1) Administrative Costs	10169	1.63	339	598	0.600	16	6
(2) Water Control Costs	16935	2.72	565	996	0.999	27	10
(3) Maintenance Costs	36372	5.85	1212	2140	2.146	57	21
(4) Annual Power Costs	107795	17.33	3593	6341	6.361		63
(5) Reservoir O&M Costs	1064	0.17	35	63	0.063		1
Total O&M Costs (1+2+3)	63476	10.21	2116	3734	3.746	100	37
Total Project Costs (1+2+3+4)	171271	27.54	5709	10075	10.107		99
Total System Costs (1+2+3+4+5)	172335	27.71	5745	10137	10.170		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	8045	1.293	268	25
Water Control Personnel Costs	10877	1.749	363	34
Maintenance Personnel Costs	13508	2.172	450	42
Total Personnel Costs	32430	5.214	1081	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.33	0.000053	0.011000	16
Water Control Labor	0.64	0.000103	0.021333	32
Maintenance Labor	1.06	0.000170	0.035333	52
Total Project Labor	2.03	0.000326	0.067667	100

Average Personnel Cost (total $/total my) $ 15975 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	19806	3.18	660.20	31
Project Vehicle & Equip Deprec.	1525	0.25	50.83	2
Hired Vehicle & Equip Deprec.	3200	0.51	106.67	5
Total Vehicle & Equip Deprec.	4725	0.76	157.50	7

1977 Power Consumption 4207100 kwh 676 kwh/a 140236 kwh/mi
1977 Project Power Costs $ 107795 0.0256 $/kwh
1977 Crop Value $ 2116000 340 $/a
1977 Crop Value 125 $/af 189 $/af of ET

IDAHO IRRIGATION DISTRICT

1977 Irrigated Acres	35600	Nonfederal Origin	
1977 Assessed Acres	35600	Earliest Flow Right	8-13-1888
Total System Length (miles)	150.0	Average Flow Right	2-15-1889
Project Perimeter (miles)	73	Total Water Flow Right	1000 cfs
Project Compactness Ratio	2.51	Water Right Duty	36 a/cfs
Irrigated Acres / System Mile	237	Usable Reservoir Storage	94941 af
Water Users > 20 acres	540	Usable Reservoir Storage	2.67 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	314297	8.83	100
Seepage Losses	60876	1.71	19
Operational Losses	83231	2.34	26
Farm Deliveries	170190	4.78	54
Effective Precipitation	13871	0.39	4
Farm Runoff in Return Flow	4603	0.13	1
Deep Percolation	111586	3.13	36
Evapotranspiration	68830	1.93	22
Irrigation Requirement	54001	1.52	17
Project Return Flow	87833	2.47	28
1977 Reservoir Storage	85113	2.39	27

1977 Project Conveyance Efficiency 54 %
1977 Project Application Efficiency 32 %
1977 Project Irrigation Efficiency 17 %

TOPOGRAPHY

Highest Irrigable Elevation	4780 ft
Lowest Irrigable Elevation	4585 ft
Elevation Difference	195 ft
Elevation Diff. / System Mile	1.30 ft/mi
Elevation Difference / Acre	0.005 ft/a
Average Land Slope 100% (0-3%)	0% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	80 acres
Soil---Sandy Loam	
Average Soil Depth	36 inches
Ave Soil Moist Holding Cap	1.8 in/ft
Gravity Irrigated Land	65 %
Sprinkler Irrigated Land	35 %
Assessed Land Irrigated (1977)	100 %

CONVEYANCE SYSTEM

Total System Length	150.0 miles
Open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	423 acres
Canal Area / Irrig Area	1.19 %
Maximum Seepage Rate	1.07 ft/day
Maximum Diversion Capacity	1540 cfs
Irrigated Area at Max Cap.	23.1 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	800
Turnouts / Mile of System	5.3
Irrigated Acres / Turnout	45
Measured Turnouts	800

WATER SOURCE

River or Canal	92.6 %
Groundwater	0.0 %
Other	7.4 %

WATER CONTROL

Number of Ditchriders	4
Irrigated Area / Ditchrider	8900
Number of Water Users / D.R.	135
System Length / D.R.	38 miles
Turnouts per Ditchrider	200
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	60 mi/day
D.R. Mileage / System Mile	1.60 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 11 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

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*   IDAHO IRRIGATION DISTRICT   *
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OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	142400	4.00	949	264	0.453		
(1) Administrative Costs	29353	0.82	196	54	0.093	23	22
(2) Water Control Costs	27022	0.76	180	50	0.086	21	20
(3) Maintenance Costs	73486	2.06	490	136	0.234	57	55
(4) Annual Power Costs	0	0.00	0	0	0.000		0
(5) Reservoir O&M Costs	4296	0.12	29	8	0.014		3
Total O&M Costs (1+2+3)	129861	3.65	866	240	0.413	100	97
Total Project Costs (1+2+3+4)	129861	3.65	866	240	0.413		97
Total System Costs (1+2+3+4+5)	134157	3.77	894	248	0.427		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	12625	0.355	84	16
Water Control Personnel Costs	24367	0.684	162	32
Maintenance Personnel Costs	39811	1.118	265	52
Total Personnel Costs	76803	2.157	512	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	1.20	0.000034	0.008000	15
Water Control Labor	2.40	0.000067	0.016000	30
Maintenance Labor	4.50	0.000126	0.030000	56
Total Project Labor	8.10	0.000228	0.054000	100

Average Personnel Cost (total $/total my) $ 9482 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	15842	0.45	105.60	12
Project Vehicle & Equip Deprec.	8088	0.23	53.92	6
Hired Vehicle & Equip Deprec.	885	0.02	5.90	1
Total Vehicle & Equip Deprec.	8973	0.25	59.82	7

1977 Power Consumption	0 kwh	0 kwh/a	0 kwh/mi
1977 Project Power Costs	$ 0	0.0000 $/kwh	
1977 Crop Value	$ 10751000	302 $/a	
1977 Crop Value	34 $/af	156 $/af of ET	

DANSKIN DITCH COMPANY

1977 Irrigated Acres	4730	Nonfederal Origin	
1977 Assessed Acres	6060	Earliest Flow Right	6 -1-1886
Total System Length (miles)	20.0	Average Flow Right	6-10-1904
Project Perimeter (miles)	19	Total Water Flow Right	276 cfs
Project Compactness Ratio	1.87	Water Right Duty	17 a/cfs
Irrigated Acres / System Mile	237	Usable Reservoir Storage	2350 af
Water Users > 20 acres	80	Usable Reservoir Storage	0.50 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	59342	12.55	100
Seepage Losses	7363	1.56	12
Operational Losses	3273	0.69	6
Farm Deliveries	48706	10.30	82
Effective Precipitation	2952	0.62	5
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	37627	7.95	63
Evapotranspiration	13815	2.92	23
Irrigation Requirement	11079	2.34	19
Project Return Flow	3273	0.69	6
1977 Reservoir Storage	2350	0.50	4

1977 Project Conveyance Efficiency 82 %
1977 Project Application Efficiency 23 %
1977 Project Irrigation Efficiency 19 %

TOPOGRAPHY

Highest Irrigable Elevation	4480 ft
Lowest Irrigable Elevation	4448 ft
Elevation Difference	32 ft
Elevation Diff. / System Mile	1.60 ft/mi
Elevation Difference / Acre	0.007 ft/a
Average Land Slope 100% (0-3%)	0% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	75 acres
Soil---Loam	
Average Soil Depth	60 inches
Ave Soil Moist Holding Cap	2.1 in/ft
Gravity Irrigated Land	90 %
Sprinkler Irrigated Land	10 %
Assessed Land Irrigated (1977)	78 %

CONVEYANCE SYSTEM

Total System Length	20.0 miles
open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	47 acres
Canal Area / Irrig Area	0.99 %
Maximum Seepage Rate	1.04 ft/day
Maximum Diversion Capacity	302 cfs
Irrigated Area at Max Cap.	15.7 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	22
Turnouts / Mile of System	1.1
Irrigated Acres / Turnout	215
Measured Turnouts	5

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	1
Irrigated Area / Ditchrider	4730
Number of Water Users / D.R.	80
System Length / D.R.	20 miles
Turnouts per Ditchrider	22
Turnouts Measured by D.R.	23 %
Turnouts Checked Daily	50 %
Average Mileage / D.R.	30 mi/day
D.R. Mileage / System Mile	1.50 mpd/mi
Water Delivery Type -- Rotation	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-Farm Pumps 3 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

DANSKIN DITCH COMPANY

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	22287	4.71	1114	279	0.376		
(1) Administrative Costs	1548	0.33	77	19	0.026	14	14
(2) Water Control Costs	2061	0.44	103	26	0.035	19	19
(3) Maintenance Costs	7156	1.51	358	89	0.121	66	66
(4) Annual Power Costs	0	0.00	0	0	0.000		0
(5) Reservoir O&M Costs	99	0.02	5	1	0.002		1
Total O&M Costs (1+2+3)	10765	2.28	538	135	0.181	100	99
Total Project Costs (1+2+3+4)	10765	2.28	538	135	0.181		99
Total System Costs (1+2+3+4+5)	10864	2.30	543	136	0.183		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	881	0.186	44	12
Water Control Personnel Costs	5032	1.064	252	70
Maintenance Personnel Costs	1255	0.265	63	18
Total Personnel Costs	7168	1.515	358	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.10	0.000021	0.005000	16
Water Control Labor	0.20	0.000042	0.010000	32
Maintenance Labor	0.32	0.000068	0.016000	52
Total Project Labor	0.62	0.000131	0.031000	100

Average Personnel Cost (total $/total my) $ 11561 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	852	0.18	42.60	8
Project Vehicle & Equip Deprec.	0	0.00	0.00	0
Hired Vehicle & Equip Deprec.	1000	0.21	50.00	9
Total Vehicle & Equip Deprec.	1000	0.21	50.00	9

1977 Power Consumption	0 kwh	0 kwh/a	0 kwh/mi
1977 Project Power Costs	$ 0	0.0000 $/kwh	
1977 Crop Value	$ 893000	189 $/a	
1977 Crop Value	15 $/af	65 $/af of ET	

BURLEY IRRIGATION DISTRICT

1977 Irrigated Acres	41440	Federal Origin	
1977 Assessed Acres	47204	Earliest Flow Right	3-26-1903
Total System Length (miles)	267.0	Average Flow Right	12-12-1909
Project Perimeter (miles)	51	Total Water Flow Right	1197 cfs
Project Compactness Ratio	1.62	Water Right Duty	35 a/cfs
Irrigated Acres / System Mile	155	Usable Reservoir Storage	197142 af
Water Users > 20 acres	570	Usable Reservoir Storage	4.76 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	235763	5.69	100
Seepage Losses	46377	1.12	20
Operational Losses	14366	0.35	6
Farm Deliveries	175020	4.22	74
Effective Precipitation	15742	0.38	7
Farm Runoff in Return Flow	4789	0.12	2
Deep Percolation	99830	2.41	42
Evapotranspiration	86544	2.09	37
Irrigation Requirement	70401	1.70	30
Project Return Flow	19154	0.46	8
1977 Reservoir Storage	143700	3.47	61

1977 Project Conveyance Efficiency 74 %
1977 Project Application Efficiency 40 %
1977 Project Irrigation Efficiency 30 %

TOPOGRAPHY

Highest Irrigable Elevation	4180 ft
Lowest Irrigable Elevation	4140 ft
Elevation Difference	40 ft
Elevation Diff. / System Mile	0.15 ft/mi
Elevation Difference / Acre	0.001 ft/a
Average Land Slope	50% (0-3%) 50% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	75 acres
Soil---Loam	
Average Soil Depth	48 inches
Ave Soil Moist Holding Cap	2.2 in/ft
Gravity Irrigated Land	99 %
Sprinkler Irrigated Land	1 %
Assessed Land Irrigated (1977)	88 %

CONVEYANCE SYSTEM

Total System Length	267.0 miles
open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	421 acres
Canal Area / Irrig Area	1.02 %
Maximum Seepage Rate	0.96 ft/day
Maximum Diversion Capacity	1325 cfs
Irrigated Area at Max Cap.	31.3 a/cfs
Project Irrigation Wells	0
Project Total Pumps	15
Maximum Pump Demand	13010 hp
Number of System Turnouts	850
Turnouts / Mile of System	3.2
Irrigated Acres / Turnout	49
Measured Turnouts	408

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	10
Irrigated Area / Ditchrider	4144
Number of Water Users / D.R.	57
System Length / D.R.	27 miles
Turnouts per Ditchrider	85
Turnouts Measured by D.R.	48 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	70 mi/day
D.R. Mileage / System Mile	2.62 mpd/mi

Water Delivery Type -- Continuous

Water Diverted, Lifted, or Pressurized with Project Pumps 100 % total
Water Diverted, Lifted, or Pressurized with On-Farm Pumps 1 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

BURLEY IRRIGATION DISTRICT

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	589746	14.23	2209	1035	2.501		
(1) Administrative Costs	58369	1.41	219	102	0.248	13	10
(2) Water Control Costs	116252	2.81	435	204	0.493	25	20
(3) Maintenance Costs	283199	6.83	1061	497	1.201	62	50
(4) Annual Power Costs	87630	2.11	328	154	0.372		15
(5) Reservoir O&M Costs	22472	0.54	84	39	0.095		4
Total O&M Costs (1+2+3)	457820	11.05	1715	803	1.942	100	81
Total Project Costs (1+2+3+4)	545450	13.16	2043	957	2.314		96
Total System Costs (1+2+3+4+5)	567922	13.70	2127	996	2.409		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	38116	0.920	143	13
Water Control Personnel Costs	101498	2.449	380	35
Maintenance Personnel Costs	149050	3.597	558	52
Total Personnel Costs	288664	6.966	1081	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	3.00	0.000072	0.011236	11
Water Control Labor	11.00	0.000265	0.041199	42
Maintenance Labor	12.30	0.000297	0.046067	47
Total Project Labor	26.30	0.000635	0.098502	100

Average Personnel Cost (total $/total my) $ 10976 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	100081	2.42	374.84	22
Project Vehicle & Equip Deprec.	11538	0.28	43.21	3
Hired Vehicle & Equip Deprec.	4217	0.10	15.79	1
Total Vehicle & Equip Deprec.	15755	0.38	59.01	3

1977 Power Consumption	27470400 kwh	663 kwh/a	102885 kwh/mi
1977 Project Power Costs	$ 87630	0.0032 $/kwh	
1977 Crop Value	$ 8621000	208 $/a	
1977 Crop Value	37 $/af	100 $/af of ET	

A & B IRRIGATION DISTRICT

1977 Irrigated Acres	73850
1977 Assessed Acres	76796
Total System Length (miles)	166.0
Project Perimeter (miles)	110
Project Compactness Ratio	2.40
Irrigated Acres / System Mile	445
Water Users > 20 acres	516

Federal Origin		
Earliest Flow Right	4 -1-1939	
Average Flow Right	4 -1-1939	
Total Water Flow Right		267 cfs
Water Right Duty		277 a/cfs
Usable Reservoir Storage		138393 af
Usable Reservoir Storage		1.87 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	282956	3.83	100
Seepage Losses	23885	0.32	8
Operational Losses	4977	0.07	2
Farm Deliveries	254094	3.44	90
Effective Precipitation	26566	0.36	9
Farm Runoff in Return Flow	37701	0.51	13
Deep Percolation	100825	1.37	36
Evapotranspiration	145499	1.97	51
Irrigation Requirement	115567	1.56	41
Project Return Flow	42678	0.58	15
1977 Reservoir Storage	122289	1.66	43

1977 Project Conveyance Efficiency 90 %
1977 Project Application Efficiency 45 %
1977 Project Irrigation Efficiency 41 %

TOPOGRAPHY

Highest Irrigable Elevation	4350 ft
Lowest Irrigable Elevation	4150 ft
Elevation Difference	200 ft
Elevation Diff. / System Mile	1.20 ft/mi
Elevation Difference / Acre	0.003 ft/a
Average Land Slope	0% (0-3%) 100% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	149 acres
Soil---Loam	
Average Soil Depth	60 inches
Ave Soil Moist Holding Cap	2.2 in/ft
Gravity Irrigated Land	90 %
Sprinkler Irrigated Land	10 %
Assessed Land Irrigated (1977)	95 %

CONVEYANCE SYSTEM

Total System Length	166.0 miles
open channel	99.0 %
lined channel	0.0 %
pipe	1.0 %
lined channel + pipe	1.0 %
Canal Wetted Area	266 acres
Canal Area / Irrig Area	0.36 %
Maximum Seepage Rate	0.67 ft/day
Maximum Diversion Capacity	1320 cfs
Irrigated Area at Max Cap.	55.9 a/cfs
Project Irrigation Wells	177
Project Total Pumps	191
Maximum Pump Demand	34488 hp
Number of System Turnouts	700
Turnouts / Mile of System	4.2
Irrigated Acres / Turnout	106
Measured Turnouts	700

WATER SOURCE

River or Canal	19.2 %
Groundwater	80.8 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	11
Irrigated Area / Ditchrider	6714
Number of Water Users / D.R.	47
System Length / D.R.	15 miles
Turnouts per Ditchrider	64
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	60 mi/day
D.R. Mileage / System Mile	3.98 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 100 % total
Water Diverted, Lifted, or Pressurized with On-Farm Pumps 10 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

A & B IRRIGATION DISTRICT

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	1070820	14.50	6451	2075	3.784		
(1) Administrative Costs	116410	1.58	701	226	0.411	15	10
(2) Water Control Costs	167271	2.27	1008	324	0.591	22	14
(3) Maintenance Costs	493840	6.69	2975	957	1.745	64	41
(4) Annual Power Costs	422731	5.72	2547	819	1.494		35
(5) Reservoir O&M Costs	5650	0.08	34	11	0.020		0
Total O&M Costs (1+2+3)	777521	10.53	4684	1507	2.748	100	64
Total Project Costs (1+2+3+4)	1200250	16.25	7230	2326	4.242		100
Total System Costs (1+2+3+4+5)	1205900	16.33	7264	2337	4.262		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	79754	1.080	480	17
Water Control Personnel Costs	130502	1.767	785	28
Maintenance Personnel Costs	261004	3.534	1572	55
Total Personnel Costs	471260	6.381	2839	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	6.00	0.000081	0.036145	14
Water Control Labor	8.20	0.000111	0.049398	19
Maintenance Labor	29.80	0.000404	0.179519	68
Total Project Labor	44.00	0.000595	0.265060	100

Average Personnel Salary (total $/total my) $ 10710 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	124081	1.68	747.48	16
Project Vehicle & Equip Deprec.	51085	0.69	307.74	7
Hired Vehicle & Equip Deprec.	4100	0.06	24.70	1
Total Vehicle & Equip Deprec.	55185	0.75	332.44	7

1977 Power Consumption	86011800 kwh	1165 kwh/a	518143 kwh/mi
1977 Project Power Costs	$ 422731	0.0049 $/kwh	
1977 Crop Value	$ 19106000	259 $/a	
1977 Crop Value	68 $/af	131 $/af of CU	

MILNER LOW LIFT IRRIGATION DISTRICT

1977 Irrigated Acres	13480	Nonfederal Origin	
1977 Assessed Acres	13524	Earliest Flow Right	11-14-1916
Total System Length (miles)	50.0	Average Flow Right	9-15-1930
Project Perimeter (miles)	30	Total Water Flow Right	307 cfs
Project Compactness Ratio	1.84	Water Right Duty	44 a/cfs
Irrigated Acres / System Mile	270	Usable Reservoir Storage	90187 af
Water Users > 20 acres	85	Usable Reservoir Storage	6.69 af/a

1977 PROJECT WATER USE	AF	AF/A	% INFLOW
Water Diverted to Project	56573	4.20	100
Seepage Losses	8543	0.63	15
Operational Losses	1532	0.11	3
Farm Deliveries	46498	3.45	82
Effective Precipitation	4010	0.30	7
Farm Runoff in Return Flow	4379	0.32	8
Deep Percolation	24218	1.80	43
Evapotranspiration	21665	1.61	38
Irrigation Requirement	17901	1.33	32
Project Return Flow	5911	0.44	10
1977 Reservoir Storage	74728	5.54	132

1977 Project Conveyance Efficiency 82 %
1977 Project Application Efficiency 38 %
1977 Project Irrigation Efficiency 32 %

TOPOGRAPHY

Highest Irrigable Elevation	4350 ft
Lowest Irrigable Elevation	4128 ft
Elevation Difference	222 ft
Elevation Diff. / System Mile	4.44 ft/mi
Elevation Difference / Acre	0.016 ft/a
Average Land Slope	0% (0-3%) 100% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	163 acres
Soil---Silt Loam	
Average Soil Depth	48 inches
Ave Soil Moist Holding Cap	2.4 in/ft
Gravity Irrigated Land	99 %
Sprinkler Irrigated Land	1 %
Assessed Land Irrigated (1977)	100 %

CONVEYANCE SYSTEM

Total System Length	50.0 miles
Open channel	92.0 %
Lined channel	0.0 %
Pipe	8.0 %
Lined channel + pipe	8.0 %
Canal Wetted Area	73 acres
Canal Area / Irrig Area	0.54 %
Maximum Seepage Rate	0.95 ft/day
Maximum Diversion Capacity	296 cfs
Irrigated Area at Max Cap.	45.5 a/cfs
Project Irrigation Wells	1
Project Total Pumps	50
Maximum Pump Demand	5510 hp
Number of System Turnouts	260
Turnouts / Mile of System	5.2
Irrigated Acres / Turnout	52
Measured Turnouts	255

WATER SOURCE

River or Canal	99.8 %
Groundwater	0.2 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	2
Irrigated Area / Ditchrider	6740
Number of Water Users / D.R.	43
System Length / D.R.	25 miles
Turnouts per Ditchrider	130
Turnouts Measured by D.R.	98 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	45 mi/day
D.R. Mileage / System Mile	1.80 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 100 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 1 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

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*            MILNER LOW LIFT IRRIGATION DISTRICT                      *
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OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	160959	11.94	3219	1894	2.845		
(1) Administrative Costs	18294	1.36	366	215	0.323	14	9
(2) Water Control Costs	20508	1.52	410	241	0.363	16	11
(3) Maintenance Costs	93074	6.90	1861	1095	1.645	71	48
(4) Annual Power Costs	58858	4.37	1177	692	1.040		30
(5) Reservoir O&M Costs	3331	0.25	67	39	0.059		2
Total O&M Costs (1+2+3)	131876	9.78	2638	1551	2.331	100	68
Total Project Costs (1+2+3+4)	190734	14.15	3815	2244	3.371		98
Total System Costs (1+2+3+4+5)	194065	14.40	3881	2283	3.430		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	7019	0.521	140	11
Water Control Personnel Costs	17942	1.331	359	27
Maintenance Personnel Costs	41246	3.060	825	62
Total Personnel Costs	66207	4.911	1324	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.40	0.000030	0.008000	9
Water Control Labor	1.30	0.000096	0.026000	29
Maintenance Labor	2.80	0.000208	0.056000	62
Total Project Labor	4.50	0.000334	0.090000	100

Average Personnel Cost (total $/total my) $ 14713 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	20856	1.55	417.12	16
Project Vehicle & Equip Deprec.	18476	1.37	369.52	14
Hired Vehicle & Equip Deprec.	0	0.00	0.00	0
Total Vehicle & Equip Deprec.	18476	1.37	369.52	14

1977 Power Consumption	10682200 kwh	792 kwh/a	213644 kwh/mi
1977 Project Power Costs	$ 58858	0.0055 $/kwh	
1977 Crop Value	$ 3282000	243 $/a	
1977 Crop Value	58 $/af	151 $/af of ET	

NORTHSIDE CANAL COMPANY

1977 Irrigated Acres	149340	Nonfederal Origin	
1977 Assessed Acres	149340	Earliest Flow Right	10-11-1900
Total System Length (miles)	755.0	Average Flow Right	4-15-1910
Project Perimeter (miles)	140	Total Water Flow Right	4560 cfs
Project Compactness Ratio	2.15	Water Right Duty	33 a/cfs
Irrigated Acres / System Mile	198	Usable Reservoir Storage	546987 af
Water Users > 20 acres	1100	Usable Reservoir Storage	3.66 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	794930	5.32	100
Seepage Losses	286012	1.92	36
Operational Losses	2307	0.02	0
Farm Deliveries	506111	3.39	64
Effective Precipitation	26181	0.18	3
Farm Runoff in Return Flow	25262	0.17	3
Deep Percolation	180414	1.21	23
Evapotranspiration	335056	2.25	42
Irrigation Requirement	300435	2.01	38
Project Return Flow	28059	0.19	4
1977 Reservoir Storage	572336	3.83	72

1977 Project Conveyance Efficiency 64 %
1977 Project Application Efficiency 59 %
1977 Project Irrigation Efficiency 38 %

TOPOGRAPHY

Highest Irrigable Elevation	4134 ft
Lowest Irrigable Elevation	3120 ft
Elevation Difference	1014 ft
Elevation Diff. / System Mile	1.34 ft/mi
Elevation Difference / Acre	0.007 ft/a
Average Land Slope	20% (0-3%) 80% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	136 acres
Soil---Loam	
Average Soil Depth	48 inches
Ave Soil Moist Holding Cap	2.0 in/ft
Gravity Irrigated Land	70 %
Sprinkler Irrigated Land	30 %
Assessed Land Irrigated (1977)	100 %

CONVEYANCE SYSTEM

Total System Length	755.0 miles
Open channel	99.4 %
lined channel	0.2 %
pipe	0.6 %
lined channel + pipe	0.8 %
Canal Wetted Area	2645 acres
Canal Area / Irrig Area	1.77 %
Maximum Seepage Rate	0.83 ft/day
Maximum Diversion Capacity	4050 cfs
Irrigated Area at Max Cap.	36.9 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	2970
Turnouts / Mile of System	3.9
Irrigated Acres / Turnout	50
Measured Turnouts	2970

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	22
Irrigated Area / Ditchrider	6788
Number of Water Users / D.R.	50
System Length / D.R.	34 miles
Turnouts per Ditchrider	135
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	45 mi/day
D.R. Mileage / System Mile	1.31 mod/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 21 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

NORTHSIDE CANAL COMPANY

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	896008	6.00	1187	815	1.127		
(1) Administrative Costs	91686	0.61	121	83	0.115	11	10
(2) Water Control Costs	176297	1.18	234	160	0.222	20	20
(3) Maintenance Costs	592020	3.96	784	538	0.745	69	66
(4) Annual Power Costs	0	0.00	0	0	0.000		0
(5) Reservoir O&M Costs	34749	0.23	46	32	0.044		4
Total O&M Costs (1+2+3)	860005	5.76	1139	782	1.082	100	96
Total Project Costs (1+2+3+4)	860005	5.76	1139	782	1.082		96
Total System Costs (1+2+3+4+5)	894754	5.99	1185	813	1.126		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	38832	0.260	51	8
Water Control Personnel Costs	130083	0.871	172	26
Maintenance Personnel Costs	337361	2.259	447	67
Total Personnel Costs	506276	3.390	671	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	3.50	0.000023	0.004636	6
Water Control Labor	19.70	0.000132	0.026093	36
Maintenance Labor	30.90	0.000207	0.040927	57
Total Project Labor	54.10	0.000362	0.071656	100

Average Personnel Cost (total $/total my) $ 9358 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	90101	0.60	119.34	10
Project Vehicle & Equip Deprec.	49762	0.33	65.91	6
Hired Vehicle & Equip Deprec.	8910	0.06	11.80	1
Total Vehicle & Equip Deprec.	58672	0.39	77.71	7

1977 Power Consumption 0 kwh 0 kwh/a 0 kwh/mi
1977 Project Power Costs $ 0 0.0000 $/kwh
1977 Crop Value $ 41039000 275 $/a
1977 Crop Value 52 $/af 122 $/af of ET

WOOD RIVER VALLEY IRRIGATION DISTRICT

1977 Irrigated Acres	4850	Nonfederal Origin	
1977 Assessed Acres	8010	Earliest Flow Right	6-10-1880
Total System Length (miles)	22.0	Average Flow Right	1-10-1909
Project Perimeter (miles)	18	Total Water Flow Right	623 cfs
Project Compactness Ratio	1.54	Water Right Duty	8 a/cfs
Irrigated Acres / System Mile	220	Usable Reservoir Storage	0 af
Water Users > 20 acres	34	Usable Reservoir Storage	0.00 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	46549	9.60	100
Seepage Losses	11060	2.28	24
Operational Losses	0	0.00	0
Farm Deliveries	35489	7.32	76
Effective Precipitation	2357	0.49	5
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	25307	5.32	55
Evapotranspiration	11802	2.43	25
Irrigation Requirement	9682	2.00	21
Project Return Flow	0	0.00	0
1977 Reservoir Storage	0	0.00	0

1977 Project Conveyance Efficiency 76 %
1977 Project Application Efficiency 27 %
1977 Project Irrigation Efficiency 21 %

TOPOGRAPHY

Highest Irrigable Elevation	5095 ft
Lowest Irrigable Elevation	5020 ft
Elevation Difference	75 ft
Elevation Diff. / System Mile	3.41 ft/mi
Elevation Difference / Acre	0.015 ft/a
Average Land Slope 100% (0-3%)	0% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	204 acres
Soil---Silt Loam	
Average Soil Depth	30 inches
Ave Soil Moist Holding Cap	2.4 in/ft
Gravity Irrigated Land	58 %
Sprinkler Irrigated Land	42 %
Assessed Land Irrigated (1977)	61 %

CONVEYANCE SYSTEM

Total System Length	22.0 miles
open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	40 acres
Canal Area / Irrig Area	0.82 %
Maximum Seepage Rate	3.10 ft/day
Maximum Diversion Capacity	615 cfs
Irrigated Area at Max Cap.	7.9 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	42
Turnouts / Mile of System	1.9
Irrigated Acres / Turnout	115
Measured Turnouts	42

WATER SOURCE

River or Canal	56.7 %
Groundwater	43.3 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	1
Irrigated Area / Ditchrider	4850
Number of Water Users / D.R.	34
System Length / D.R.	22 miles
Turnouts per Ditchrider	42
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	60 mi/day
D.R. Mileage / System Mile	2.73 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 43 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 43 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

WOOD RIVER VALLEY IRRIGATION DISTRICT

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	9128	1.88	415	268	0.196		
(1) Administrative Costs	1028	0.21	47	30	0.022	7	7
(2) Water Control Costs	4761	0.98	216	140	0.102	34	34
(3) Maintenance Costs	8319	1.72	373	245	0.179	59	59
(4) Annual Power Costs	0	0.00	0	0	0.000		0
(5) Reservoir O&M Costs	0	0.00	0	0	0.000		0
Total O&M Costs (1+2+3)	14108	2.91	641	415	0.303	100	100
Total Project Costs (1+2+3+4)	14108	2.91	641	415	0.303		100
Total System Costs (1+2+3+4+5)	14108	2.91	641	415	0.303		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	355	0.073	16	5
Water Control Personnel Costs	4164	0.859	189	54
Maintenance Personnel Costs	3202	0.660	146	41
Total Personnel Costs	7721	1.592	351	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.05	0.000010	0.002273	6
Water Control Labor	0.50	0.000103	0.022727	62
Maintenance Labor	0.26	0.000054	0.011818	32
Total Project Labor	0.81	0.000167	0.036318	100

Average Personnel Cost (total $/total my) $ 9532 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	551	0.11	25.05	4
Project Vehicle & Equip Deprec.	0	0.00	0.00	0
Hired Vehicle & Equip Deprec.	1650	0.34	75.00	12
Total Vehicle & Equip Deprec.	1650	0.34	75.00	12

1977 Power Consumption	0 kwh	0 kwh/a	0 kwh/mi
1977 Project Power Costs	$ 0	0.0000 $/kwh	
1977 Crop Value	$ 808000	167 $/a	
1977 Crop Value	17 $/af	68 $/af of ET	

SALMON RIVER CANAL CO. LTD.

1977 Irrigated Acres	19770	Federal Origin	
1977 Assessed Acres	33400	Earliest Flow Right	12-29-1906
Total System Length (miles)	109.0	Average Flow Right	2-15-1908
Project Perimeter (miles)	54	Total Water Flow Right	2850 cfs
Project Compactness Ratio	2.02	Water Right Duty	7 a/cfs
Irrigated Acres / System Mile	181	Usable Reservoir Storage	180000 af
Water Users > 20 acres	174	Usable Reservoir Storage	9.10 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	75950	3.84	100
Seepage Losses	27958	1.41	37
Operational Losses	0	0.00	0
Farm Deliveries	47998	2.43	63
Effective Precipitation	6485	0.33	9
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	20989	1.06	28
Evapotranspiration	31826	1.61	42
Irrigation Requirement	27009	1.37	36
Project Return Flow	0	0.00	0
1977 Reservoir Storage	80000	4.05	105

1977 Project Conveyance Efficiency 63 %
1977 Project Application Efficiency 56 %
1977 Project Irrigation Efficiency 36 %

TOPOGRAPHY

Highest Irrigable Elevation	4990 ft
Lowest Irrigable Elevation	4005 ft
Elevation Difference	985 ft
Elevation Diff. / System Mile	9.04 ft/mi
Elevation Difference / Acre	0.050 ft/a
Average Land Slope	50% (0-3%) 50% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	170 acres
Soil---Silt Loam	
Average Soil Depth	35 inches
Ave Soil Moist Holding Cap	2.5 in/ft
Gravity Irrigated Land	91 %
Sprinkler Irrigated Land	9 %
Assessed Land Irrigated (1977)	59 %

CONVEYANCE SYSTEM

Total System Length	109.0 miles
open channel	91.0 %
lined channel	1.0 %
pipe	9.0 %
lined channel + pipe	10.0 %
Canal Wetted Area	293 acres
Canal Area / Irrig Area	1.48 %
Maximum Seepage Rate	0.98 ft/day
Maximum Diversion Capacity	705 cfs
Irrigated Area at Max Cap.	28.0 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	520
Turnouts / Mile of System	4.8
Irrigated Acres / Turnout	38
Measured Turnouts	520

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	7
Irrigated Area / Ditchrider	2824
Number of Water Users / D.R.	25
System Length / D.R.	16 miles
Turnouts per Ditchrider	74
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	43 mi/day
D.R. Mileage / System Mile	2.76 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-Farm Pumps 6 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

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*   SALMON RIVER CANAL CO. LTD.   *
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OPERATION AND MAINTENANCE COSTS

	Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
	1977 O&M Assessment	193844	9.80	1778	1114	2.552		
(1)	Administrative Costs	54165	2.74	497	311	0.713	29	28
(2)	Water Control Costs	33451	1.69	307	192	0.440	18	17
(3)	Maintenance Costs	99316	5.02	911	571	1.308	53	51
(4)	Annual Power Costs	0	0.00	0	0	0.000		0
(5)	Reservoir O&M Costs	6700	0.34	61	39	0.088		3
	Total O&M Costs (1+2+3)	186932	9.46	1715	1074	2.461	100	97
	Total Project Costs (1+2+3+4)	186932	9.46	1715	1074	2.461		97
	Total System Costs (1+2+3+4+5)	193632	9.79	1776	1113	2.549		100

PERSONNEL INFORMATION

Adjusted 1977 Costs		$	$/acre	$/mile	%total
Administrative	Personnel Costs	23563	1.192	216	24
Water Control	Personnel Costs	24141	1.221	221	24
Maintenance	Personnel Costs	50848	2.572	466	52
Total	Personnel Costs	98552	4.985	904	0

Personnel Labor Requirements		manyears	my/a	my/mi	%total
Administrative	Labor	2.00	0.000101	0.018349	19
Water Control	Labor	3.63	0.000184	0.033303	35
Maintenance	Labor	4.87	0.000246	0.044679	46
Total Project	Labor	10.50	0.000531	0.096330	100

Average Personnel Cost (total $/total my) $ 9386 / year

MISCELLANEOUS

Adjusted 1977 Costs		$	$/acre	$/mi	%O&M
Maintenance	Materials Purchased	25375	1.28	232.80	14
Project	Vehicle & Equip Deprec.	17557	0.89	161.07	9
Hired	Vehicle & Equip Deprec.	2465	0.12	22.61	1
Total	Vehicle & Equip Deprec.	20022	1.01	183.69	11

1977 Power Consumption	0 kwh	0 kwh/a	0 kwh/mi
1977 Project Power Costs	$ 0	0.0000 $/kwh	
1977 Crop Value	$ 3853000	195 $/a	
1977 Crop Value	51 $/af	121 $/af of ET	

CEDAR MESA RESERVOIR & CANAL CO.

1977 Irrigated Acres	4030	Nonfederal Origin	
1977 Assessed Acres	5000	Earliest Flow Right	5 -1-1894
Total System Length (miles)	11.0	Average Flow Right	5 -1-1894
Project Perimeter (miles)	18	Total Water Flow Right	9 cfs
Project Compactness Ratio	1.76	Water Right Duty	468 a/cfs
Irrigated Acres / System Mile	366	Usable Reservoir Storage	30000 af
Water Users > 20 acres	10	Usable Reservoir Storage	7.44 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	17049	4.23	100
Seepage Losses	5271	1.31	31
Operational Losses	0	0.00	0
Farm Deliveries	11778	2.92	69
Effective Precipitation	1689	0.42	10
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	4886	1.21	29
Evapotranspiration	8663	2.15	51
Irrigation Requirement	6891	1.71	40
Project Return Flow	0	0.00	0
1977 Reservoir Storage	17050	4.23	100

1977 Project Conveyance Efficiency 69 %
1977 Project Application Efficiency 59 %
1977 Project Irrigation Efficiency 40 %

TOPOGRAPHY

Highest Irrigable Elevation	4680 ft
Lowest Irrigable Elevation	4355 ft
Elevation Difference	325 ft
Elevation Diff. / System Mile	29.55 ft/mi
Elevation Difference / Acre	0.081 ft/a
Average Land Slope 100% (0-3%)	0% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	500 acres
Soil---Silt Loam	
Average Soil Depth	35 inches
Ave Soil Moist Holding Cap	2.5 in/ft
Gravity Irrigated Land	100 %
Sprinkler Irrigated Land	0 %
Assessed Land Irrigated (1977)	81 %

CONVEYANCE SYSTEM

Total System Length	11.0 miles
open channel	87.3 %
lined channel	4.5 %
pipe	12.2 %
lined channel + pipe	16.7 %
Canal Wetted Area	14 acres
Canal Area / Irrig Area	0.34 %
Maximum Seepage Rate	0.60 ft/day
Maximum Diversion Capacity	105 cfs
Irrigated Area at Max Cap.	38.4 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	30
Turnouts / Mile of System	2.7
Irrigated Acres / Turnout	134
Measured Turnouts	30

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	1
Irrigated Area / Ditchrider	4030
Number of Water Users / D.R.	10
System Length / D.R.	11 miles
Turnouts per Ditchrider	30
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	100 mi/day
D.R. Mileage / System Mile	9.09 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 0 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

CEDAR MESA RESERVOIR & CANAL CO.

OPERATION AND MAINTENANCE COSTS

	Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
	1977 O&M Assessment	30000	7.44	2727	3000	1.760		
(1)	Administrative Costs	4502	1.12	409	450	0.264	23	23
(2)	Water Control Costs	9191	2.28	835	919	0.539	47	46
(3)	Maintenance Costs	5724	1.42	520	572	0.336	29	29
(4)	Annual Power Costs	0	0.00	0	0	0.000		0
(5)	Reservoir O&M Costs	400	0.10	36	40	0.023		2
	Total O&M Costs (1+2+3)	19417	4.82	1765	1942	1.139	100	98
	Total Project Costs (1+2+3+4)	19417	4.82	1765	1942	1.139		98
	Total System Costs (1+2+3+4+5)	19817	4.92	1802	1982	1.162		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	2056	0.511	187	21
Water Control Personnel Costs	6024	1.495	548	62
Maintenance Personnel Costs	1632	0.405	148	17
Total Personnel Costs	9714	2.410	883	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.25	0.000062	0.022727	28
Water Control Labor	0.50	0.000124	0.045455	56
Maintenance Labor	0.15	0.000037	0.013636	17
Total Project Labor	0.90	0.000223	0.081818	100

Average Personnel Cost (total $/total my) $ 10793 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	1385	0.34	126.00	7
Project Vehicle & Equip Deprec.	0	0.00	0.00	0
Hired Vehicle & Equip Deprec.	1446	0.36	131.45	7
Total Vehicle & Equip Deprec.	1446	0.36	131.45	7

1977 Power Consumption	0 kwh	0 kwh/a	0 kwh/mi
1977 Project Power Costs	$ 0	0.0000 $/kwh	
1977 Crop Value	$ 932000	231 $/a	
1977 Crop Value	55 $/af	108 $/af of CT	

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*   BELL RAPIDS MUTUAL IRRIGATION CO.   *
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1977 Irrigated Acres	25520	Nonfederal Origin	
1977 Assessed Acres	25827	Earliest Flow Right	2 -3-1964
Total System Length (miles)	119.0	Average Flow Right	2 -3-1964
Project Perimeter (miles)	47	Total Water Flow Right	573 cfs
Project Compactness Ratio	1.75	Water Right Duty	45 a/cfs
Irrigated Acres / System Mile	214	Usable Reservoir Storage	0 af
Water Users > 20 acres	15	Usable Reservoir Storage	0.00 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	66911	2.62	100
Seepage Losses	5439	0.21	8
Operational Losses	0	0.00	0
Farm Deliveries	61472	2.41	92
Effective Precipitation	5072	0.20	8
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	24635	0.97	37
Evapotranspiration	41214	1.61	62
Irrigation Requirement	36338	1.44	55
Project Return Flow	0	0.00	0
1977 Reservoir Storage	0	0.00	0

1977 Project Conveyance Efficiency 92 %
1977 Project Application Efficiency 60 %
1977 Project Irrigation Efficiency 55 %

TOPOGRAPHY	
Highest Irrigable Elevation	3500 ft
Lowest Irrigable Elevation	3030 ft
Elevation Difference	470 ft
Elevation Diff. / System Mile	3.95 ft/mi
Elevation Difference / Acre	0.018 ft/a
Average Land Slope	0% (0-3%) 100% (3-10%)

PROJECT SERVICE AREA	
Average Farm Size	1700 acres
Soil---Silt Loam	
Average Soil Depth	35 inches
Ave Soil Moist Holding Cap	2.5 in/ft
Gravity Irrigated Land	0 %
Sprinkler Irrigated Land	100 %
Assessed Land Irrigated (1977)	99 %

CONVEYANCE SYSTEM	
Total System Length	119.0 miles
open channel	9.3 %
lined channel	0.1 %
pipe	90.7 %
lined channel + pipe	90.8 %
Canal Wetted Area	67 acres
Canal Area / Irrig Area	0.26 %
Maximum Seepage Rate	0.60 ft/day
Maximum Diversion Capacity	432 cfs
Irrigated Area at Max Cap.	59.1 a/cfs
Project Irrigation Wells	0
Project Total Pumps	90
Maximum Pump Demand	50835 hp
Number of System Turnouts	41
Turnouts / Mile of System	0.3
Irrigated Acres / Turnout	622
Measured Turnouts	0

WATER SOURCE	
River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL	
Number of Ditchriders	6
Irrigated Area / Ditchrider	4253
Number of Water Users / D.R.	3
System Length / D.R.	20 miles
Turnouts per Ditchrider	7
Turnouts Measured by D.R.	0 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	115 mi/day
D.R. Mileage / System Mile	11.34 mod/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 100 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 0 % total
Water Delivered at High Pressure by Project 100 % total
Sprinkler Systems Pressurized by Project 100 % by Farms 0 %

BELL RAPIDS MUTUAL IRRIGATION CO.

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	1678750	65.78	14107	111917	25.085		
(1) Administrative Costs	60015	2.35	504	4001	0.897	19	4
(2) Water Control Costs	68612	2.69	577	4574	1.025	22	4
(3) Maintenance Costs	181687	7.12	1527	12112	2.715	59	12
(4) Annual Power Costs	1256140	49.22	10555	83743	13.773		80
(5) Reservoir O&M Costs	0	0.00	0	0	0.000		0
Total O&M Costs (1+2+3)	310314	12.16	2608	20688	4.638	100	20
Total Project Costs (1+2+3+4)	1566450	61.38	13163	104430	23.411		100
Total System Costs (1+2+3+4+5)	1566450	61.38	13163	104430	23.411		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	11783	0.462	99	10
Water Control Personnel Costs	58579	2.295	492	47
Maintenance Personnel Costs	53168	2.083	447	43
Total Personnel Costs	123530	4.841	1038	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.60	0.000024	0.005042	6
Water Control Labor	4.10	0.000161	0.034454	41
Maintenance Labor	5.25	0.000206	0.044118	53
Total Project Labor	9.95	0.000390	0.083613	100

Average Personnel Cost (total $/total my) $ 12415 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	97391	3.82	818.41	31
Project Vehicle & Equip Deprec.	11649	0.46	97.89	4
Hired Vehicle & Equip Deprec.	0	0.00	0.00	0
Total Vehicle & Equip Deprec.	11649	0.46	97.89	4

1977 Power Consumption	80285600 kwh	3146 kwh/a	674668 Kwh/mi
1977 Project Power Costs	$ 1256140	0.0156 $/kwh	
1977 Crop Value	$ 15062000	590 $/a	
1977 Crop Value	225 $/af	365 $/af of ET	

KING HILL IRRIGATION DISTRICT

1977 Irrigated Acres	11000	Federal Origin	
1977 Assessed Acres	10321	Earliest Flow Right	6 -1-1908
Total System Length (Miles)	83.0	Average Flow Right	7-10-1908
Project Perimeter (miles)	30	Total Water Flow Right	300 cfs
Project Compactness Ratio	4.17	Water Right Duty	37 a/cfs
Irrigated Acres / System Mile	133	Usable Reservoir Storage	0 af
Water Users > 20 acres	65	Usable Reservoir Storage	0.00 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	111925	10.18	100
Seepage Losses	30119	2.74	27
Operational Losses	17690	1.61	16
Farm Deliveries	64116	5.83	57
Effective Precipitation	2037	0.19	2
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	36749	3.34	33
Evapotranspiration	29407	2.67	26
Irrigation Requirement	27363	2.49	24
Project Return Flow	17690	1.61	16
1977 Reservoir Storage	0	0.00	0

1977 Project Conveyance Efficiency 57 %
1977 Project Application Efficiency 43 %
1977 Project Irrigation Efficiency 24 %

TOPOGRAPHY

Highest Irrigable Elevation	2870 ft
Lowest Irrigable Elevation	2475 ft
Elevation Difference	395 ft
Elevation Diff. / System Mile	4.76 ft/mi
Elevation Difference / Acre	0.036 ft/a
Average Land Slope	33% (0-3%) 67% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	150 acres
Soil---Sandy loam	
Average Soil Depth	50 inches
Ave Soil Moist Holding Cap	1.7 in/ft
Gravity Irrigated Land	20 %
Sprinkler Irrigated Land	80 %
Assessed Land Irrigated (1977)	107 %

CONVEYANCE SYSTEM

Total System Length	83.0 miles
Open channel	73.0 %
Lined channel	19.0 %
Pipe	8.0 %
Lined channel + pipe	27.0 %
Canal Wetted Area	201 acres
Canal Area / Irrig Area	1.83 %
Maximum Seepage Rate	0.99 ft/day
Maximum Diversion Capacity	350 cfs
Irrigated Area at Max Cap.	31.4 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	128
Turnouts / Mile of System	1.5
Irrigated Acres / Turnout	86
Measured Turnouts	93

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	3
Irrigated Area / Ditchrider	3667
Number of Water Users / D.R.	22
System Length / D.R.	28 miles
Turnouts per Ditchrider	43
Turnouts Measured by D.R.	73 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	65 mi/day
D.R. Mileage / System Mile	2.35 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 38 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

KING HILL IRRIGATION DISTRICT

OPERATION AND MAINTENANCE COSTS

	Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
	1977 O&M Assessment	141676	12.88	1707	2130	1.266		
(1)	Administrative Costs	21155	1.92	255	325	0.189	15	15
(2)	Water Control Costs	22207	2.02	257	342	0.198	16	16
(3)	Maintenance Costs	97046	8.82	1169	1493	0.867	69	69
(4)	Annual Power Costs	0	0.00	0	0	0.000		0
(5)	Reservoir O&M Costs	0	0.00	0	0	0.000		0
	Total O&M Costs (1+2+3)	140408	12.76	1692	2160	1.254	100	100
	Total Project Costs (1+2+3+4)	140408	12.76	1692	2160	1.254		100
	Total System Costs (1+2+3+4+5)	140408	12.76	1692	2160	1.254		100

PERSONNEL INFORMATION

Adjusted 1977 Costs		$	$/acre	$/mile	%total
Administrative	Personnel Costs	14808	1.346	178	19
Water Control	Personnel Costs	15473	1.407	186	20
Maintenance	Personnel Costs	47911	4.356	577	61
Total	Personnel Costs	78192	7.108	942	0

Personnel Labor Requirements		manyears	my/a	my/mi	%total
Administrative	Labor	1.20	0.000109	0.014458	19
Water Control	Labor	1.60	0.000145	0.019277	25
Maintenance	Labor	3.67	0.000334	0.044217	57
Total Project	Labor	6.47	0.000538	0.077952	100

Average Personnel Cost (total $/total my) $ 12085 / year

MISCELLANEOUS

Adjusted 1977 Costs		$	$/acre	$/mi	%O&M
Maintenance	Materials Purchased	16115	1.47	194.16	11
Project	Vehicle & Equip Deprec.	11058	1.01	133.23	8
Hired	Vehicle & Equip Deprec.	309	0.03	3.72	0
Total	Vehicle & Equip Deprec.	11367	1.03	136.95	8

1977 Power Consumption	0 kwh	0 kwh/a	0 kwh/mi
1977 Project Power Costs	$ 0	0.0000 $/kwh	
1977 Crop Value	$ 2688000	244 $/a	
1977 Crop Value	24 $/af	91 $/af of ET	

SETTLERS IRRIGATION DISTRICT

1977 Irrigated Acres	9440	Nonfederal Origin	
1977 Assessed Acres	9440	Earliest Flow Right	6-1-1864
Total System Length (miles)	55.0	Average Flow Right	5-15-1886
Project Perimeter (miles)	27	Total Water Flow Right	187 cfs
Project Compactness Ratio	1.80	Water Right Duty	50 a/cfs
Irrigated Acres / System Mile	172	Usable Reservoir Storage	2398 af
Water Users > 2.0 acres	170	Usable Reservoir Storage	0.25 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	47058	4.98	100
Seepage Losses	9626	1.02	20
Operational Losses	1688	0.18	4
Farm Deliveries	35743	3.79	76
Effective Precipitation	3855	0.41	8
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	13702	1.45	29
Evapotranspiration	24663	2.61	52
Irrigation Requirement	22041	2.33	47
Project Return Flow	1683	0.18	4
1977 Reservoir Storage	18758	1.99	40

1977 Project Conveyance Efficiency 76 %
1977 Project Application Efficiency 62 %
1977 Project Irrigation Efficiency 47 %

TOPOGRAPHY

Highest Irrigable Elevation	2655 ft
Lowest Irrigable Elevation	2505 ft
Elevation Difference	150 ft
Elevation Diff. / System Mile	2.73 ft/mi
Elevation Difference / Acre	0.016 ft/a
Average Land Slope 100% (0-3%)	0% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	56 acres
Soil---Silt Loam	
Average Soil Depth	48 inches
Ave Soil Moist Holding Cap	2.3 in/ft
Gravity Irrigated Land	100 %
Sprinkler Irrigated Land	0 %
Assessed Land Irrigated (1977)	100 %

CONVEYANCE SYSTEM

Total System Length	55.0 miles
Open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	81 acres
Canal Area / Irrig Area	0.86 %
Maximum Seepage Rate	0.95 ft/day
Maximum Diversion Capacity	205 cfs
Irrigated Area at Max Cap.	46.0 a/cfs
Project Irrigation Wells	2
Project Total Pumps	2
Maximum Pump Demand	46 hp
Number of System Turnouts	66
Turnouts / Mile of System	1.2
Irrigated Acres / Turnout	143
Measured Turnouts	66

WATER SOURCE

River or Canal	91.7 %
Groundwater	3.6 %
Other	4.7 %

WATER CONTROL

Number of Ditchriders	1
Irrigated Area / Ditchrider	9440
Number of Water Users / D.R.	170
System Length / D.R.	55 miles
Turnouts per Ditchrider	66
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	35 mi/day
D.R. Mileage / System Mile	0.64 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 0 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

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*              SETTLERS IRRIGATION DISTRICT                     *
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OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	50654	5.37	921	298	1.076		
(1) Administrative Costs	14759	1.56	268	87	0.314	22	21
(2) Water Control Costs	9080	0.96	165	53	0.193	13	13
(3) Maintenance Costs	44609	4.73	811	262	0.948	65	63
(4) Annual Power Costs	1398	0.15	25	8	0.030		2
(5) Reservoir O&M Costs	406	0.04	7	2	0.009		1
Total O&M Costs (1+2+3)	68448	7.25	1245	403	1.455	100	97
Total Project Costs (1+2+3+4)	69846	7.40	1270	411	1.484		99
Total System Costs (1+2+3+4+5)	70252	7.44	1277	413	1.493		100

PERSONNEL INFORMATION

Adjusted 1977 Costs		$	$/acre	$/mile	%total
Administrative	Personnel Costs	7422	0.786	135	16
Water Control	Personnel Costs	7683	0.814	140	17
Maintenance	Personnel Costs	30880	3.271	561	67
Total	Personnel Costs	45985	4.871	836	0

Personnel Labor Requirements		manyears	my/a	my/mi	%total
Administrative	Labor	1.00	0.000106	0.018182	19
Water Control	Labor	0.70	0.000074	0.012727	14
Maintenance	Labor	3.45	0.000365	0.062727	67
Total Project	Labor	5.15	0.000546	0.093636	100

Average Personnel Cost (total $/total my) $ 8929 / year

MISCELLANEOUS

Adjusted 1977 Costs		$	$/acre	$/mi	%O&M
Maintenance	Materials Purchased	8871	0.94	161.29	13
Project	Vehicle & Equip Deprec.	1582	0.17	28.76	2
Hired	Vehicle & Equip Deprec.	3896	0.41	70.84	6
Total	Vehicle & Equip Deprec.	5478	0.58	99.60	8

1977 Power Consumption	89077 kwh	9 kwh/a	1620 kwh/mi
1977 Project Power Costs	$ 1398	0.0157 $/kwh	
1977 Crop Value	$ 1743000	185 $/a	
1977 Crop Value	37 $/af	71 $/af of ET	

SOUTH BOARD OF CONTROL, OWYHEE PROJECT

1977 Irrigated Acres	38030	Federal Origin	
1977 Assessed Acres	39841	Earliest Flow Right	4-15-1919
Total System Length (miles)	194.0	Average Flow Right	6-15-1927
Project Perimeter (miles)	55	Total Water Flow Right	324 cfs
Project Compactness Ratio	1.55	Water Right Duty	117 a/cfs
Irrigated Acres / System Mile	196	Usable Reservoir Storage	208500 af
Water Users > 20 acres	496	Usable Reservoir Storage	5.48 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	244155	6.42	100
Seepage Losses	47947	1.26	20
Operational Losses	31426	0.83	13
Farm Deliveries	164781	4.33	67
Effective Precipitation	11797	0.31	5
Farm Runoff in Return Flow	35915	0.94	15
Deep Percolation	50645	1.33	21
Evapotranspiration	90736	2.39	37
Irrigation Requirement	78221	2.06	32
Project Return Flow	67341	1.77	28
1977 Reservoir Storage	209224	5.50	86

1977 Project Conveyance Efficiency 67 %
1977 Project Application Efficiency 47 %
1977 Project Irrigation Efficiency 32 %

TOPOGRAPHY

Highest Irrigable Elevation	2580 ft
Lowest Irrigable Elevation	2230 ft
Elevation Difference	350 ft
Elevation Diff. / System Mile	1.80 ft/mi
Elevation Difference / Acre	0.009 ft/a
Average Land Slope	50% (0-3%) 50% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	77 acres
Soil---Loam	
Average Soil Depth	48 inches
Ave Soil Moist Holding Cap	2.2 in/ft
Gravity Irrigated Land	90 %
Sprinkler Irrigated Land	10 %
Assessed Land Irrigated (1977)	95 %

CONVEYANCE SYSTEM

Total System Length	194.0 miles
open channel	94.0 %
lined channel	5.0 %
pipe	6.0 %
lined channel + pipe	11.0 %
Canal Wetted Area	336 acres
Canal Area / Irrig Area	0.89 %
Maximum Seepage Rate	0.97 ft/day
Maximum Diversion Capacity	825 cfs
Irrigated Area at Max Cap.	46.1 a/cfs
Project Irrigation Wells	0
Project Total Pumps	13
Maximum Pump Demand	6630 hp
Number of System Turnouts	959
Turnouts / Mile of System	4.9
Irrigated Acres / Turnout	40
Measured Turnouts	710

WATER SOURCE

River or Canal	100.0 %
Groundwater	0.0 %
Other	0.0 %

WATER CONTROL

Number of Ditchriders	6
Irrigated Area / Ditchrider	6338
Number of Water Users / D.R.	83
System Length / D.R.	32 miles
Turnouts per Ditchrider	160
Turnouts Measured by D.R.	74 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	55 mi/day
D.R. Mileage / System Mile	1.70 mpd/mi
Water Delivery Type -- Continuous	

Water Diverted, Lifted, or Pressurized with Project Pumps 44 % total
Water Diverted, Lifted, or Pressurized with On-Farm Pumps 8 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

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*           SOUTH BOARD OF CONTROL, OWYHEE PROJECT                  *
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OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	460820	12.12	2375	929	1.887		
(1) Administrative Costs	72309	1.90	373	146	0.296	18	15
(2) Water Control Costs	76030	2.00	392	153	0.311	18	16
(3) Maintenance Costs	263815	6.94	1360	532	1.081	64	56
(4) Annual Power Costs	39208	1.03	202	79	0.161		8
(5) Reservoir O&M Costs	22071	0.58	114	44	0.090		5
Total O&M Costs (1+2+3)	412154	10.84	2125	831	1.688	100	87
Total Project Costs (1+2+3+4)	451362	11.87	2327	910	1.849		95
Total System Costs (1+2+3+4+5)	473433	12.45	2440	955	1.939		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	54905	1.444	283	20
Water Control Personnel Costs	60535	1.592	312	23
Maintenance Personnel Costs	152401	4.007	786	57
Total Personnel Costs	267841	7.043	1381	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	3.80	0.000100	0.019588	16
Water Control Labor	5.50	0.000145	0.028351	24
Maintenance Labor	14.10	0.000371	0.072680	60
Total Project Labor	23.40	0.000615	0.120618	100

Average Personnel Cost (total $/total my) $ 11446 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	55921	1.47	288.25	14
Project Vehicle & Equip Deprec.	23407	0.62	120.65	6
Hired Vehicle & Equip Deprec.	4488	0.12	23.13	1
Total Vehicle & Equip Deprec.	27895	0.73	143.79	7

1977 Power Consumption	11260000 kwh	296 kwh/a	58041 kwh/mi
1977 Project Power Costs	$ 39209	0.0035 $/kwh	
1977 Crop Value	$ 8597000	226 $/a	
1977 Crop Value	35 $/af	95 $/af of ET	

LITTLE WILLOW IRRIGATION DISTRICT

1977 Irrigated Acres	2370
1977 Assessed Acres	2865
Total System Length (miles)	51.0
Project Perimeter (miles)	21
Project Compactness Ratio	2.31
Irrigated Acres / System Mile	46
Water Users > 20 acres	25

Nonfederal Origin

Earliest Flow Right	12-29-1913
Average Flow Right	12-29-1913
Total Water Flow Right	50 cfs
Water Right Duty	47 a/cfs
Usable Reservoir Storage	29000 af
Usable Reservoir Storage	12.24 af/a

1977 PROJECT WATER USE	AF	AF/A	%INFLOW
Water Diverted to Project	8956	3.78	100
Seepage Losses	0	0.00	0
Operational Losses	1174	0.50	13
Farm Deliveries	7782	3.28	87
Effective Precipitation	641	0.27	7
Farm Runoff in Return Flow	0	0.00	0
Deep Percolation	2502	1.06	28
Evapotranspiration	6007	2.53	67
Irrigation Requirement	5281	2.23	59
Project Return Flow	1174	0.50	13
1977 Reservoir Storage	19365	8.17	216

1977 Project Conveyance Efficiency	87 %
1977 Project Application Efficiency	68 %
1977 Project Irrigation Efficiency	59 %

TOPOGRAPHY

Highest Irrigable Elevation	2540 ft
Lowest Irrigable Elevation	2370 ft
Elevation Difference	170 ft
Elevation Diff. / System Mile	3.33 ft/mi
Elevation Difference / Acre	0.072 ft/a
Average Land Slope	20% (0-3%) 80% (3-10%)

PROJECT SERVICE AREA

Average Farm Size	170 acres
Soil---Loam	
Average Soil Depth	40 inches
Ave Soil Moist Holding Cap	2.1 in/ft
Gravity Irrigated Land	60 %
Sprinkler Irrigated Land	40 %
Assessed Land Irrigated (1977)	83 %

CONVEYANCE SYSTEM

Total System Length	51.0 miles
open channel	100.0 %
lined channel	0.0 %
pipe	0.0 %
lined channel + pipe	0.0 %
Canal Wetted Area	37 acres
Canal Area / Irrig Area	1.56 %
Maximum Seepage Rate	0.54 ft/day
Maximum Diversion Capacity	60 cfs
Irrigated Area at Max Cap.	39.5 a/cfs
Project Irrigation Wells	0
Project Total Pumps	0
Maximum Pump Demand	0 hp
Number of System Turnouts	100
Turnouts / Mile of System	2.0
Irrigated Acres / Turnout	24
Measured Turnouts	100

WATER SOURCE

River or Canal	96.0 %
Groundwater	0.0 %
Other	4.0 %

WATER CONTROL

Number of Ditchriders	1
Irrigated Area / Ditchrider	2370
Number of Water Users / D.R.	25
System Length / D.R.	51 miles
Turnouts per Ditchrider	100
Turnouts Measured by D.R.	100 %
Turnouts Checked Daily	100 %
Average Mileage / D.R.	47 mi/day
D.R. Mileage / System Mile	0.92 mpd/mi

Water Delivery Type -- Continuous

Water Diverted, Lifted, or Pressurized with Project Pumps 0 % total
Water Diverted, Lifted, or Pressurized with On-farm Pumps 40 % total
Water Delivered at High Pressure by Project 0 % total
Sprinkler Systems Pressurized by Project 0 % by Farms 100 %

LITTLE WILLOW IRRIGATION DISTRICT

OPERATION AND MAINTENANCE COSTS

Adjusted 1977 Costs	$	$/acre	$/mile	$/user	$/af	%O&M	%system
1977 O&M Assessment	23718	10.01	465	949	2.648		
(1) Administrative Costs	2477	1.05	49	99	0.277	9	9
(2) Water Control Costs	5567	2.35	109	223	0.622	20	20
(3) Maintenance Costs	19898	8.40	390	796	2.222	71	71
(4) Annual Power Costs	0	0.00	0	0	0.000		0
(5) Reservoir O&M Costs	228	0.10	4	9	0.025		1
Total O&M Costs (1+2+3)	27942	11.79	548	1118	3.120	100	99
Total Project Costs (1+2+3+4)	27942	11.79	548	1118	3.120		99
Total System Costs (1+2+3+4+5)	28170	11.89	552	1127	3.145		100

PERSONNEL INFORMATION

Adjusted 1977 Costs	$	$/acre	$/mile	%total
Administrative Personnel Costs	1524	0.643	30	12
Water Control Personnel Costs	3888	1.641	76	32
Maintenance Personnel Costs	6871	2.899	135	56
Total Personnel Costs	12283	5.183	241	0

Personnel Labor Requirements	manyears	my/a	my/mi	%total
Administrative Labor	0.25	0.000105	0.004902	19
Water Control Labor	0.42	0.000177	0.008235	32
Maintenance Labor	0.65	0.000274	0.012745	49
Total Project Labor	1.32	0.000557	0.025882	100

Average Personnel Cost (total $/total my) $ 9305 / year

MISCELLANEOUS

Adjusted 1977 Costs	$	$/acre	$/mi	%O&M
Maintenance Materials Purchased	3784	1.60	74.20	14
Project Vehicle & Equip Deprec.	0	0.00	0.00	0
Hired Vehicle & Equip Deprec.	2087	0.88	40.92	7
Total Vehicle & Equip Deprec.	2087	0.88	40.92	7

1977 Power Consumption 0 kwh 0 kwh/a 0 kwh/mi
1977 Project Power Costs $ 0 0.0000 $/kwh
1977 Crop Value $ 559000 236 $/a
1977 Crop Value 62 $/af 93 $/af of ET

APPENDIX C

1977 EVAPOTRANSPIRATION AND CROP INFORMATION FOR COOPERATING IRRIGATION PROJECTS

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1977 Crop Information

ENTERPRISE IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	5972	1176					91		2352		1130	1223			
Crop Distribution (%)	100	20					2		39		19	20			
Crop Planting Date		3-25					3-25		5-15		4 -5	3-25			
Effective Cover Date		4-25					4-25		7-18		7 -8	7 -1			
Harvest Date		6-25 8-14					10-30		9-20		8-17	8-10			
Monthly Evapotranspiration (inches)															
April	7.612	6.472					5.482		0.000		1.079	2.057			
May	6.786	6.786					5.903		0.374		2.714	3.934			
June	8.488	7.469					7.384		2.545		6.451	6.960			
July	10.044	8.535					8.739		7.835		8.035	7.835			
August	8.800	6.599					7.652		6.070		1.786	0.740			
September	7.327	7.180					6.374		3.812		0.000	0.000			
October	5.285	5.285					4.597		0.597		0.000	0.000			
Total	54.341	48.325					46.130		21.234		20.065	21.527			
Crop Yield (units/A)		3.00					6.00		168.00		61.00	61.00			
1977 Price ($/unit)		49.40					5.40		2.90		2.25	2.25			
1977 Crop Value ($/A)	276	148					32		487		137	137			

1977 Crop Information

PARKS & LEWISVILLE IRRIGATION CO. INC.

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	8500	2000							2250		4250				
Crop Distribution (%)	100	24							26		50				
Crop Planting Date		3-25							5-15		4 -5				
Effective Cover Date		4-25							7-18		7 -8				
Harvest Date		6-25 8-14							9-20		8-17				
Monthly Evapotranspiration (inches)															
April	7.612	6.472							0.000		1.079				
May	6.786	6.786							0.374		2.714				
June	8.488	7.469							2.545		6.451				
July	10.044	8.535							7.835		8.035				
August	8.800	6.599							6.070		1.786				
September	7.327	7.180							3.812		0.000				
October	5.285	5.285							0.597		0.000				
Total	54.341	48.325							21.234		20.065				
Crop Yield (units/A)		4.00							275.00		95.00				
1977 Price ($/unit)		49.40							2.90		2.25				
1977 Crop Value ($/A)	364	198							798		214				

1977 Crop Information

OSGOOD CANAL CO. (U&I SUGAR CO.)

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	6218	74							2137	2072	1935				
Crop Distribution (%)	100	1							34	33	31				
Crop Planting Date		3-25							5-15	5 -1	4 -5				
Effective Cover Date		4-25							7-18	7-24	7 -8				
Harvest Date		6-25 8-14							9-20	10-10	8-17				
Monthly Evapotranspiration (inches)															
April	7.612	6.472							0.000	0.000	1.079				
May	6.786	6.786							0.374	0.883	2.714				
June	8.488	7.469							2.545	3.397	6.451				
July	10.044	8.535							7.835	7.229	8.035				
August	8.800	6.599							6.070	6.863	1.786				
September	7.327	7.160							3.812	5.641	0.000				
October	5.285	5.285							0.597	1.456	0.000				
Total	54.341	43.325							21.234	25.469	20.065				
Crop Yield (units/A)		3.00							205.00	15.30	80.00				
1977 Price ($/unit)		49.40							2.90	15.34	2.25				
1977 Crop Value ($/A)	340	148							595	235	180				

1977 Crop Information

IDAHO IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	35600	5320				400	580	320	11780	430	9230	7540			
Crop Distribution (%)	100	15				1	2	1	33	1	26	21			
Crop Planting Date		3-25				5-20	3-25	5 -1	5-15	5 -1	4 -5	3-25			
Effective Cover Date		4-25				6 -5	4-25	7-15	7-18	7-24	7 -8	7 -1			
Harvest Date		6-25				10-25	10-30	9 -1	9-20	10-10	8-17	8-10			
		8-14													
Monthly Evapotranspiration (inches)															
April	7.612	6.472				0.000	5.482	0.000	0.000	0.000	1.079	2.057			
May	6.786	6.786				0.549	5.903	0.814	0.374	0.883	2.714	3.934			
June	8.488	7.469				2.888	7.384	3.311	2.545	3.397	6.451	6.960			
July	10.044	8.535				7.534	8.739	8.836	7.835	7.229	8.035	7.835			
August	8.800	6.599				8.621	7.652	2.726	6.070	6.863	1.786	0.740			
September	7.327	7.180				5.861	6.374	0.000	3.812	5.641	0.000	0.000			
October	5.285	5.285				1.790	4.597	0.000	0.597	1.456	0.000	0.000			
Total	54.341	48.325				27.242	46.130	15.687	21.234	25.469	20.065	21.527			
Crop Yield (units/A)		4.00				17.00	8.00	19.00	192.00	16.00	76.00	76.00			
1977 Price ($/unit)		49.40				10.25	5.40	12.00	2.90	15.34	2.25	2.25			
1977 Crop Value ($/A)	302	198				174	43	228	557	245	171	171			

1977 Crop Information

DANSKIN DITCH COMPANY

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	4730	940			170		1640		625		950	405			
Crop Distribution (%)	100	20			4		35		13		20	9			
Crop Planting Date		3-25			5-20		3-25		5-15		4 -5	3-25			
Effective Cover Date		4-25			8 -5		4-25		7-18		7 -8	7 -1			
Harvest Date		6-25 8-14			10-25		10-30		9-20		8-17	8-10			
Monthly Evapotranspiration (inches)															
April	7.612	6.472			0.000		5.482		0.000		1.079	2.057			
May	6.786	6.786			0.549		5.903		0.374		2.714	3.934			
June	8.488	7.469			2.888		7.384		2.545		6.451	6.960			
July	10.044	8.535			7.534		8.739		7.835		8.035	7.835			
August	8.800	6.599			8.621		7.652		6.070		1.786	0.740			
September	7.327	7.180			5.861		6.374		3.812		0.000	0.000			
October	5.285	5.285			1.790		4.597		0.597		0.000	0.000			
Total	54.341	48.325			27.242		46.130		21.234		20.065	21.527			
Crop Yield (units/A)		4.00			80.00		8.00		200.00		80.00	80.00			
1977 Price ($/unit)		49.40			2.23		5.40		2.90		2.25	2.25			
1977 Crop Value ($/A)	189	198			178		43		580		180	180			

1977 Crop Information

BURLEY IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	41440	8186	115	8729	190	3775	3289	421	750	4636	6435	4282	27	561	44
Crop Distribution (%)	100	20	0	21	0	9	8	1	2	11	16	10	0	1	0
Crop Planting Date		3-20	3-20	6 -1	5-10	5-10	4 -1	4 -1	5-20	4-15	4 -1	3 -5	4-15	4-26	5 -1
Effective Cover Date		4-20	4-20	7-20	8 -1	8 -1	5 -1	6-15	7-25	7-20	6-15	6 -5	8 -1	7-22	7-10
Harvest Date		6-20 8 -5 9-25	10-30	9-15	10-10	10-10	10-30	8 -1	10-10	10-15	8-10	8 -5	9-20	8-15	8 -1
Monthly Evapotranspiration (inches)															
April	7.897	7.184	7.184	0.000	0.000	0.000	4.977	0.867	0.000	0.367	1.658	3.315	3.002	0.183	0.668
May	5.647	5.647	5.647	0.000	0.923	0.923	4.910	2.315	0.281	1.184	3.332	4.349	4.235	1.469	1.692
June	8.455	6.761	8.455	1.438	3.718	3.718	7.355	7.522	1.776	4.228	7.017	6.594	8.370	4.989	5.242
July	8.515	7.921	8.515	6.814	7.067	7.067	7.408	2.897	5.960	6.387	3.320	1.790	7.323	7.835	6.643
August	7.660	5.594	6.123	5.517	7.506	7.506	6.664	0.000	5.594	5.899	0.281	0.130	3.446	3.779	0.000
September	6.578	5.787	3.947	0.550	4.802	4.802	5.722	0.000	3.751	5.067	0.000	0.000	0.631	0.000	0.000
October	5.114	4.345	2.046	0.000	0.838	0.838	4.447	0.000	0.740	2.022	0.000	0.000	0.000	0.000	0.000
Total	49.865	43.238	41.916	14.318	24.854	24.854	41.483	13.601	18.102	25.152	15.607	16.178	27.006	18.256	14.245
Crop Yield (units/A)		4.50	4.00	16.50	85.00	17.00	10.00	22.00	325.00	17.00	84.00	84.00	300.00	5.00	15.00
1977 Price ($/unit)		49.40	105.00	11.40	2.23	10.25	5.40	12.00	2.90	15.34	2.25	2.25	2.60	53.00	16.00
1977 Crop Value ($/A)	208	222	420	188	190	174	54	264	943	261	189	189	780	265	240

1977 Crop Information

A & B IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	73854	14924	91	5604		1400	991	785	6043	11404	27586	4870	7	136	7
Crop Distribution (%)	100	20	0	8		2	1	1	8	15	37	7	0	0	0
Crop Planting Date		3-20	3-20	6 -1		5-10	4 -1	4 -1	5-20	4-15	4 -1	3 -5	4-15	4-26	5 -1
Effective Cover Date		4-20	4-20	7-20		8 -1	5 -1	6-15	7-25	7-20	6-15	6 -5	8 -1	7-22	7-10
Harvest Date		6-20	10-30	9-15		10-10	10-30	8 -1	10-10	10-15	8-10	8 -5	9-20	8-15	8 -1
		8 -5													
		9-25													
Montly Evapotranspiration (inches)															
April	7.897	7.184	7.184	0.000		0.000	4.977	0.867	0.000	0.367	1.658	3.315	3.002	0.183	0.668
May	5.647	5.647	5.647	0.000		0.923	4.910	2.315	0.281	1.184	3.332	4.349	4.235	1.469	1.692
June	8.455	6.761	8.455	1.438		3.718	7.355	7.522	1.776	4.228	7.017	6.594	8.370	4.989	5.242
July	8.515	7.921	8.515	6.814		7.067	7.408	2.897	5.960	6.387	3.320	1.790	7.323	7.835	6.643
August	7.660	5.594	6.123	5.517		7.506	6.664	0.000	5.594	5.899	0.281	0.130	3.446	3.779	0.000
September	6.578	5.787	3.947	0.550		4.802	5.722	0.000	3.751	5.067	0.000	0.000	0.631	0.000	0.000
October	5.114	4.345	2.046	0.000		0.838	4.447	0.000	0.740	2.022	0.000	0.000	0.000	0.000	0.000
Total	49.865	43.238	41.916	14.318		24.854	41.483	13.601	18.102	25.152	15.607	16.173	27.006	18.256	14.245
Crop Yield (units/A)		5.00	3.00	18.40		17.50	12.30	24.10	238.00	17.70	87.00	87.00	0.00	6.30	12.00
1977 Price ($/unit)		49.40	105.00	11.40		10.25	5.40	12.00	2.90	15.34	2.25	2.25	2.60	53.00	16.00
1977 Crop Value ($/A)	259	247	315	210		179	66	289	690	272	196	196	0	334	192

1977 Crop Information

MILNER LOW LIFT IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	13480	1420		6100	130	30	200	940	690	220	2070	1580		100	
Crop Distribution (%)	100	11		45	1	0	1	7	5	2	15	12		1	
Crop Planting Date		3-20		5-20	5-10	5-10	4 -1	4 -1	5-20	4-15	4 -1	3 -5		4-26	
Effective Cover Date		4-20		7-10	8 -1	8 -1	5 -1	6-15	7-25	7-20	6-15	6 -5		7-22	
Harvest Date		6-20 8 -5 9-25		9 -5	10-10	10-10	10-30	8 -1	10-10	10-15	8-10	8 -5		8-15	
Monthly Evapotranspiration (inches)															
April	7.791	7.091		0.000	0.000	0.000	4.908	0.855	0.000	0.648	1.637	3.274		0.228	
May	5.683	5.683		0.232	0.887	0.687	4.943	2.331	0.285	1.420	3.352	4.377		1.477	
June	8.720	6.977		2.965	3.837	3.837	7.586	7.759	1.833	4.533	7.237	6.802		5.144	
July	9.426	8.767		8.767	7.823	7.823	8.202	3.206	6.599	7.071	3.678	1.981		8.673	
August	8.018	5.854		3.767	7.860	7.860	6.977	0.000	5.654	6.176	0.932	0.138		4.063	
September	6.569	5.779		0.126	4.794	4.794	5.714	0.000	3.743	5.058	0.000	0.000		0.000	
October	5.110	4.345		0.000	0.830	0.830	4.447	0.000	0.740	0.224	0.000	0.000		0.000	
Total	51.318	44.496		15.857	26.030	26.030	42.777	14.151	19.054	25.128	16.836	16.573		19.525	
Crop Yield (units/A)		5.00		18.60	90.00	17.00	10.00	22.00	300.00	17.30	80.00	80.00		6.00	
1977 Price ($/unit)		49.40		11.40	2.23	10.25	5.40	12.00	2.90	15.34	2.25	2.25		53.00	
1977 Crop Value ($/A)	243	247		212	201	174	54	264	870	265	180	180		318	

1977 Crop Information

NORTHSIDE CANAL COMPANY

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	149340	33600	1670	20730	5970	3080	16160	3080	15370	3340	23240	18710		4390	
Crop Distribution (%)	100	22	1	14	4	2	11	2	10	2	16	13		3	
Crop Planting Date		3-20	3-20	5-20	5-10	5-10	4 -1	4 -1	5-20	4-15	4 -1	3 -5		4-26	
Effective Cover Date		4-20	4-20	7-10	8 -1	8 -1	5 -1	6-15	7-25	7-20	6-15	6 -5		7-22	
Harvest Date		6-20 8 -5 9-25	10-30	9 -5	10-10	10-10	10-30	8 -1	10-10	10-15	8-10	8 -5		9-15	
Monthly Evapotranspiration (inches)															
April	7.791	7.091	7.091	0.000	0.000	0.000	4.908	0.855	0.000	0.648	1.637	3.274		0.228	
May	5.683	5.683	5.683	0.232	0.887	0.887	4.943	2.331	0.285	1.420	3.352	4.377		1.477	
June	8.720	6.977	6.977	2.965	3.837	3.837	7.588	7.759	1.833	4.533	7.237	6.802		5.144	
July	9.426	8.767	8.710	8.767	7.823	7.823	8.202	3.206	6.599	7.071	3.678	1.981		8.673	
August	8.018	5.854	7.543	3.767	7.860	7.860	6.977	0.000	5.854	6.176	0.932	0.138		4.003	
September	6.569	5.779	3.413	0.126	4.794	4.794	5.714	0.000	3.743	5.058	0.000	0.000		0.000	
October	5.110	4.345	1.875	0.000	0.830	0.830	4.447	0.000	0.740	0.224	0.000	0.000		0.000	
Total	51.318	44.496	41.291	15.857	26.030	26.030	42.777	14.151	19.054	25.128	16.836	16.573		19.525	
Crop Yield (units/A)		5.00	6.00	19.00	95.00	20.00	10.00	20.00	310.00	17.20	78.00	78.00		7.00	
1977 Price ($/unit)		49.40	105.00	11.40	2.23	10.25	5.40	12.00	2.90	15.34	2.25	2.25		53.00	
1977 Crop Value ($/A)	275	247	630	217	212	205	54	240	899	264	176	176		371	

1977 Crop Information

WOOD RIVER VALLEY IRRIGATION DISTRICT

	Total (Ref)	Alfalfa 2cut	Alfalfa 1cut	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	4852	2038	1019				776				1019				
Crop Distribution (%)	100	42	21				16				21				
Crop Planting Date		5 -1	5 -1				5 -1				5 -1				
Effective Cover Date		6 -1	6 -1				6 -1				7 -5				
Harvest Date		7-10 9-10	8-10				10-30				9 -5				
Monthly Evapotranspiration (inches)															
April	7.412	0.741	0.741				0.741				0.000				
May	5.069	3.694	3.694				3.185				1.216				
June	9.209	9.209	9.209				8.011				6.170				
July	8.673	6.334	8.673				7.547				6.765				
August	7.551	7.551	5.512				6.570				1.660				
September	5.869	4.285	5.869				5.107				0.110				
October	4.304	4.304	4.304				3.747				0.000				
Total	48.087	36.117	38.002				34.908				15.922				
Crop Yield (units/A)		4.50	3.00				5.00				80.00				
1977 Price ($/unit)		49.40	49.40				5.40				2.25				
1977 Crop Value ($/A)	167	222	148				27				180				

1977 Crop Information

SALMON RIVER CANAL CO. LTD.

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	19770	4400	750	6870	50	1000	200	1000	650		4850				
Crop Distribution (%)	100	22	4	35	0	5	1	5	3		25				
Crop Planting Date		3-20	3-20	5-20	5-10	5-10	4 -1	4 -1	5-20		4 -1				
Effective Cover Date		4-20	4-20	7-10	8 -1	8 -1	5 -1	6-15	7-25		6-15				
Harvest Date		6-20 8 -5 9-25	10-30	9 -5	10-10	10-10	10-30	8 -1	10-10		8-10				
Monthly Evapotranspiration (inches)															
April	7.791	7.091	7.091	0.000	0.000	0.000	4.908	0.855	0.000		1.637				
May	5.683	5.683	5.683	0.232	0.887	0.887	4.943	2.331	0.285		3.352				
June	8.720	6.977	6.977	2.965	3.837	3.837	7.588	7.759	1.833		7.237				
July	9.426	8.767	8.710	8.767	7.823	7.823	8.202	3.206	6.599		3.678				
August	8.018	5.854	7.543	3.767	7.860	7.860	6.977	0.000	5.854		0.932				
September	6.569	5.779	3.413	0.126	4.794	4.794	5.714	0.000	3.743		0.000				
October	5.110	4.345	1.875	0.000	0.830	0.830	4.447	0.000	0.740		0.000				
Total	51.318	44.496	41.291	15.857	26.030	26.030	42.777	14.151	19.054		16.836				
Crop Yield (units/A)		3.70	3.00	16.00	73.00	16.00	10.00	22.00	208.00		66.00				
1977 Price ($/unit)		49.40	105.00	11.40	2.23	10.25	5.40	12.00	2.90		2.25				
1977 Crop Value ($/A)	195	183	315	182	163	164	54	264	603		14)				

1977 Crop Information

CEDAR MESA RESERVOIR & CANAL CO.

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	4030	1113		502	275	64	313		100		779	536		346	
Crop Distribution (%)	100	28		12	7	2	8		2		19	13		9	
Crop Planting Date		3-20		5-20	5-10	5-10	4 -1		5-20		4 -1	3 -5		4-26	
Effective Cover Date		4-20		7-10	8 -1	8 -1	5 -1		7-25		6-15	5 -5		7-22	
Harvest Date		6-20 8 -5 9-25		9 -5	10-10	10-10	10-30		10-10		8-10	8 -5		8-15	
Monthly Evapotranspiration (inches)															
April	7.791	7.091		0.000	0.000	0.000	4.908		0.000		1.637	3.274		0.228	
May	5.683	5.633		0.232	0.887	0.887	4.943		0.285		3.352	4.377		1.477	
June	8.720	6.977		2.965	3.837	3.837	7.588		1.633		7.237	6.802		5.144	
July	9.426	8.767		8.767	7.823	7.823	8.202		6.599		3.678	1.981		8.673	
August	8.018	5.854		3.767	7.860	7.860	6.977		5.854		0.932	0.138		4.003	
September	6.569	5.779		0.126	4.794	4.794	5.714		3.743		0.000	0.000		0.000	
October	5.110	4.345		0.000	0.830	0.830	4.447		0.740		0.000	0.000		0.000	
Total	51.318	44.496		15.857	26.030	26.030	42.777		19.054		16.836	15.573		19.525	
Crop Yield (units/A)		4.00		19.00	80.00	19.00	9.00		275.00		95.00	95.00		9.00	
1977 Price ($/unit)		49.40		11.40	2.23	10.25	5.40		2.90		2.25	2.25		53.00	
1977 Crop Value ($/A)	231	198		217	178	195	49		798		214	214		477	

1977 Crop Information

BELL RAPIDS MUTUAL IRRIGATION CO.

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	25517	1200		5103					12758	940	3830	1646	40		
Crop Distribution (%)	100	5		20					50	4	15	6	0		
Crop Planting Date		3-20		5-20					5-20	4-15	4 -1	3 -5	4-15		
Effective Cover Date		4-20		7-10					7-25	7-20	6-15	6 -5	8 -1		
Harvest Date		6-20 8 -5 9-25		9 -5					10-10	10-15	8-10	8 -5	9-20		
Monthly Evapotranspiration (inches)															
April	7.791	7.091		0.000					0.000	0.648	1.637	3.274	2.961		
May	5.683	5.683		0.232					0.285	1.420	3.352	4.377	4.264		
June	8.720	6.977		2.965					1.833	4.533	7.237	6.802	8.634		
July	9.426	8.767		8.767					6.599	7.071	3.678	1.981	8.108		
August	8.018	5.854		3.767					5.854	6.176	0.932	0.138	3.609		
September	6.569	5.779		0.126					3.743	5.058	0.000	0.000	0.615		
October	5.110	4.345		0.000					0.740	0.224	0.000	0.000	0.000		
Total	51.318	44.496		15.857					19.054	25.128	16.836	16.573	28.190		
Crop Yield (units/A)		7.00		20.00					330.00	20.40	77.00	77.00	300.00		
1977 Price ($/unit)		49.40		11.40					2.90	15.34	2.25	2.25	2.60		
1977 Crop Value ($/A)	590	346		228					957	313	173	173	780		

1977 Crop Information

KING HILL IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	11000	3810		270		760	1765		545	790	2445			575	40
Crop Distribution (%)	100	35		2		7	16		5	7	22			5	0
Crop Planting Date		3-20		5-20		5-10	4 -1		5-20	4-15	4 -1			4-26	5 -1
Effective Cover Date		4-20		7-10		8 -1	5 -1		7-25	7-20	6-15			7-22	7-10
Harvest Date		6-20 8 -5 9-25		9 -5		10-10	10-30		10-10	10-15	8-10			8-15	8 -1
Monthly Evapotranspiration (inches)															
April	7.791	7.091		0.000		0.000	4.908		0.000	0.648	1.637			0.228	0.000
May	5.683	5.683		0.232		0.887	4.943		0.285	1.420	3.352			1.477	0.000
June	8.720	6.977		2.965		3.837	7.588		1.833	4.533	7.237			5.144	0.000
July	9.426	8.767		8.767		7.823	8.202		6.599	7.071	3.678			8.673	0.000
August	8.018	5.854		3.767		7.860	6.977		5.854	6.176	0.932			4.003	0.000
September	6.569	5.779		0.126		4.794	5.714		3.743	5.058	0.000			0.000	0.000
October	5.110	4.345		0.000		0.830	4.447		0.740	0.224	0.000			0.000	0.000
Total	51.318	44.496		15.857		26.030	42.777		19.054	25.128	16.836			19.525	0.000
Crop Yield (units/A)		5.80		20.00		17.80	8.00		303.00	22.50	80.00			3.80	20.00
1977 Price ($/unit)		49.40		11.40		10.25	5.40		2.90	15.34	2.25			53.00	16.00
1977 Crop Value ($/A)	244	287		228		182	43		879	345	180			201	320

1977 Crop Information

SETTLERS IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	9443	2775		100	950	1840	2268			720	390			200	200
Crop Distribution (%)	100	29		1	10	19	24			8	4			2	2
Crop Planting Date		3-15		5-25	5 -1	5 -1	3-25			3-15	3 -1			5-15	4-25
Effective Cover Date		4-15		7-15	7-17	7-17	4-30			7-15	6 -3			7-20	7 -5
Harvest Date		5-25 7 -5 8-15 10 -1		9 -9	9-30	9-30	10-30			10 -1	8 -1			8 -1	8 -1
Monthly Evapotranspiration (inches)															
April	6.895	5.376		0.000	0.000	0.000	4.688			1.034	3.242			0.000	0.582
May	5.635	4.845		0.134	1.408	1.408	4.902			1.916	4.451			0.688	1.692
June	8.459	7.188		1.947	4.989	4.989	7.359			5.160	6.260			3.889	5.242
July	9.357	6.831		8.234	8.796	8.796	8.141			7.205	1.591			8.141	7.293
August	8.490	6.371		5.350	7.730	7.730	7.388			6.538	0.000			0.000	0.000
September	6.203	6.077		0.273	3.348	3.348	5.396			4.777	0.000			0.000	0.000
October	2.799	2.046		0.000	0.000	0.000	4.447			0.000	0.000			0.000	0.000
Total	47.838	38.734		15.938	26.270	26.270	42.321			26.631	15.543			12.718	14.815
Crop Yield (units/A)		4.80		0.00	76.00	19.30	8.00			21.20	67.00			2.40	45.00
1977 Price ($/unit)		49.40		11.40	2.23	10.25	5.40			15.34	2.25			53.00	16.00
1977 Crop Value ($/A)	185	237		0	169	198	43			325	151			127	720

1977 Crop Information

SOUTH BOARD OF CONTROL, OWYHEE PROJECT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	38025	8816	5158	376	2619	3219	3550	45	2901	1032	7917	2000	392		
Crop Distribution (%)	100	23	14	1	7	8	9	0	8	3	21	5	1		
Crop Planting Date		3 -5	3 -5	5-25	5 -1	5 -1	3-15	3 -1	4-25	3-15	3 -1	3-15	3-15		
Effective Cover Date		4 -5	4 -5	7-15	7-17	7-17	4-22	6 -3	6-30	7-15	6 -3	5-22	7 -1		
Harvest Date		5-25 7 -5 8-15 10 -1	10-15	9 -9	9-30	9-30	10-30	7-25	9-25	10 -1	8 -1	7-25	9-20		
Monthly Evapotranspiration (inches)															
April	6.395	6.895	6.895	0.000	0.000	0.000	5.311	0.753	0.106	1.034	3.242	4.415	2.619		
May	5.635	4.845	5.635	0.134	1.408	1.408	4.902	2.311	1.127	1.916	4.451	4.735	4.227		
June	8.459	7.188	6.765	1.947	4.989	4.989	7.359	7.526	5.498	5.160	6.260	4.484	8.374		
July	9.357	6.831	5.614	8.234	8.796	8.796	8.141	3.181	7.018	7.205	1.591	0.765	8.047		
August	8.490	6.371	3.397	5.350	7.730	7.730	7.338	0.000	5.093	6.538	0.000	0.000	3.820		
September	6.203	6.077	2.480	0.273	3.348	3.348	5.396	0.000	2.000	4.777	0.000	0.000	0.615		
October	2.799	2.046	2.046	0.000	0.000	0.000	4.447	0.000	0.000	0.000	0.000	0.000	0.000		
Total	47.838	40.253	32.832	15.938	26.270	26.270	42.944	13.776	20.842	26.631	15.543	14.399	27.701		
Crop Yield (units/A)		4.90	0.00	15.90	90.00	19.40	9.90	37.50	304.00	23.40	74.00	74.00	432.00		
1977 Price ($/unit)		49.40	105.00	11.40	2.23	10.25	5.40	12.00	2.90	15.34	2.25	2.25	2.60		
1977 Crop Value ($/A)	226	242	0	181	201	199	53	450	882	359	167	167	1123		

1977 Crop Information

LITTLE WILLOW IRRIGATION DISTRICT

	Total (Ref)	Alfalfa Hay	Alfalfa Seed	Dry Beans	Field Corn	Corn Silage	Pasture	Peas	Potatoes	Sugar Beets	Spring Grain	Winter Grain	Onions	Sweet Corn	Other
Crop Acreage (acres)	2371	1076			61	350	259			25	600				
Crop Distribution (%)	100	45			3	15	11			1	25				
Crop Planting Date		4 -5			5 -1	5 -1	3-25			3-15	4 -1				
Effective Cover Date		5 -5			7-17	7-17	4-30			7-15	7 -3				
Harvest Date		6-25 8 -5 9-15			9-30	9-30	10-30			10 -1	9 -1				
Monthly Evapotranspiration (inches)															
April	6.895	4.618			0.000	0.000	5.134			1.034	1.311				
May	5.635	5.635			1.408	1.408	4.902			1.916	2.648				
June	8.459	7.278			4.989	4.989	7.359			5.160	6.687				
July	9.357	7.949			8.796	8.796	8.141			7.205	6.932				
August	8.490	6.196			7.730	7.730	7.388			6.538	1.444				
September	6.203	4.651			3.348	3.348	5.396			4.777	0.000				
October	2.799	2.742			0.000	0.000	4.447			0.000	0.000				
Total	47.838	39.069			26.270	26.270	42.767			26.631	19.023				
Crop Yield (units/A)		6.00			160.00	25.00	8.00			25.00	80.00				
1977 Price ($/unit)		49.40			2.23	10.25	5.40			15.34	2.25				
1977 Crop Value ($/A)	236	296			357	256	43			384	180				

APPENDIX D

MONTHLY WATER USE AND EFFICIENCIES OF COOPERATING IRRIGATION PROJECTS DURING 1977

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1977 Project Water Balance (Acre-Feet)

ENTERPRISE IRRIGATION DISTRICT

1977 Irrigated Area 5970 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	0	2490	5156	5404	5053	2000	0	20101	3.3670
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	0	2490	5156	5404	5053	2000	0	20101	3.3670
Operational Losses	0	174	474	249	323	152	0	1372	0.2299
Seepage Losses	0	557	656	613	539	310	0	2675	0.4480
Farm Deliveries	0	1759	4025	4542	4190	1538	0	16053	2.6890
Soil Moisture Change	0	854	827	-829	-161	-353	0	337	0.0565
Eff. Precipitation	0	1163	788	583	167	328	0	3030	0.5075
Evapotranspiration	0	1444	2609	4001	2142	1278	0	11474	1.9219
Irrigation Requirement*	0	1135	2648	2588	1814	596	0	8782	1.4709
Runoff Losses	0	339	577	681	859	278	0	2734	0.4579
Deep Percolation	0	285	799	1273	1517	664	0	4538	0.7602
Project Return Flow	0	513	1052	929	1182	430	0	4106	0.6878
Project Conv. Eff.(%)**	0	71	78	84	83	77	0	80	80
Project App. Eff.(%)	0	65	66	57	43	39	0	55	55
Project Irrig. Eff.(%)	0	46	51	48	36	30	0	44	44

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

PARKS & LEWISVILLE IRRIGATION CO. INC.

1977 Irrigated Area 8500 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	0	18909	21801	21249	20595	16001	7393	105947	12.4644
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	0	18909	21801	21249	20595	16001	7393	105947	12.4644
Operational Losses	0	4765	7892	6949	10318	8336	4998	43257	5.0891
Seepage Losses	0	2315	1918	1816	1605	1246	858	9759	1.1481
Farm Deliveries	0	11828	11990	12485	8672	6418	1537	52930	6.2271
Soil Moisture Change	0	903	400	-880	-386	-240	-340	-544	-0.0640
Eff. Precipitation	0	956	1489	461	454	268	22	3650	0.4295
Evapotranspiration	0	2165	4013	5745	2875	1699	881	17378	2.0444
Irrigation Requirement*	0	2111	2923	4404	2035	1191	519	13183	1.5509
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	0	9717	9067	8081	6637	5227	1018	39747	4.6762
Project Return Flow	0	4765	7892	6949	10318	8336	4998	43257	5.0891
Project Conv. Eff.(%)**	0	63	55	59	42	40	21	50	50
Project App. Eff.(%)	0	18	24	35	23	19	34	25	25
Project Irrig. Eff.(%)	0	11	13	21	10	7	7	12	12

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

OSGOOD CANAL CO. (U&I SUGAR CO.)

1977 Irrigated Area 6220 Acres

	April	May	June	July	August	September	October	Season Total AF	Season Total AF/Acre
River (Res.) Diversion	0	610	3276	4496	3718	2553	824	15478	2.4884
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	58	311	426	353	242	78	1468	0.2360
Total Project Inflow	0	668	3587	4923	4071	2795	902	16946	2.7244
Operational Losses	0	111	357	369	369	208	89	1503	0.2416
Seepage Losses	0	208	457	499	408	303	111	1984	0.3190
Farm Deliveries	0	349	2773	4055	3294	2285	702	13458	2.1637
Soil Moisture Change	0	313	791	38	-183	-505	-168	286	0.0460
Eff. Precipitation	0	698	628	664	308	208	17	2522	0.4055
Evapotranspiration	0	700	2130	3998	2599	1496	285	11207	1.8018
Irrigation Requirement*	0	315	2293	3372	2108	784	100	8971	1.4423
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	0	34	481	683	1186	1501	602	4487	0.7214
Project Return Flow	0	111	357	369	369	208	89	1503	0.2416
Project Conv. Eff.(%)**	0	52	77	82	81	82	78	79	79
Project App. Eff.(%)	0	90	83	83	64	34	14	67	67
Project Irrig. Eff.(%)	0	47	64	68	52	28	11	53	53

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change

** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100

** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100

** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

IDAHO IRRIGATION DISTRICT

1977 Irrigated Area 35600 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	0	41086	63988	66474	52060	44465	22999	291070	8.1761
Supplementary Inflow	0	5916	5823	2858	3904	3024	1702	23228	0.6525
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	0	47003	69811	69332	55965	47488	24701	314297	8.8286
Operational Losses	0	21151	14407	9157	18052	14193	6271	83231	2.3379
Seepage Losses	0	13355	12664	11841	9408	7856	5753	60876	1.7100
Farm Deliveries	0	12497	42740	48335	28505	25439	12677	170190	4.7806
Soil Moisture Change	0	4483	2390	-4221	-1128	-1346	-1135	-957	-0.0269
Eff. Precipitation	0	3945	3595	3803	1517	896	116	13871	0.3896
Evapotranspiration	0	8304	15831	23780	11714	6521	2681	68830	1.9334
Irrigation Requirement*	0	8842	14626	15756	9070	4278	1429	54001	1.5169
Runoff Losses	0	1335	758	482	950	747	330	4603	0.1293
Deep Percolation	0	2320	27356	32097	18485	20414	10918	111586	3.1344
Project Return Flow	0	22487	15165	9639	19002	14940	6601	87833	2.4672
Project Conv. Eff.(%)**	0	27	61	70	51	54	51	54	54
Project App. Eff.(%)	0	71	34	33	32	17	11	32	32
Project Irrig. Eff.(%)	0	19	21	23	16	9	6	17	17

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

DANSKIN DITCH COMPANY

1977 Irrigated Area 4730 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	3458	10133	10506	10676	10500	8572	5499	59342	12.5459
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	3458	10133	10506	10676	10500	8572	5499	59342	12.5459
Operational Losses	180	263	578	427	535	360	929	3273	0.6919
Seepage Losses	489	1516	1328	1245	1141	922	723	7363	1.5567
Farm Deliveries	2789	8353	8600	9005	8824	7290	3846	48706	10.2973
Soil Moisture Change	0	1427	222	-494	-146	-137	-655	217	0.0458
Eff. Precipitation	49	916	1289	162	211	302	25	2952	0.6242
Evapotranspiration	1411	1714	2516	3282	2168	1656	1067	13815	2.9207
Irrigation Requirement*	1362	2226	1448	2626	1812	1218	387	11079	2.3423
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	1426	6127	7152	6378	7012	6072	3459	37627	7.9550
Project Return Flow	180	263	578	427	535	360	929	3273	0.6919
Project Conv. Eff.(%)**	81	82	82	84	84	85	70	82	82
Project App. Eff.(%)	49	27	17	29	21	17	10	23	23
Project Irrig. Eff.(%)	39	22	14	25	17	14	7	19	19

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

BURLEY IRRIGATION DISTRICT

1977 Irrigated Area 41440 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	34423	15368	48599	62913	47557	23059	3846	235763	5.6893
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	34423	15368	48599	62913	47557	23059	3846	235763	5.6893
Operational Losses	1317	519	2807	3067	3674	2473	510	14366	0.3467
Seepage Losses	9575	4638	8492	9495	7584	4987	1606	46377	1.1191
Farm Deliveries	23532	10211	37300	50351	36299	15598	1730	175020	4.2235
Soil Moisture Change	6841	2514	-1226	-1958	-1669	-1208	-3695	-401	-0.0097
Eff. Precipitation	465	5322	4673	1869	1340	1985	90	15742	0.3799
Evapotranspiration	8617	9558	17418	20630	15257	9758	5308	86544	2.0884
Irrigation Requirement*	14993	6750	11519	16803	12248	6565	1523	70401	1.6989
Runoff Losses	439	173	936	1022	1225	824	170	4789	0.1156
Deep Percolation	8100	3288	24845	32526	22827	8209	38	99830	2.4090
Project Return Flow	1756	692	3742	4089	4898	3297	680	19154	0.4622
Project Conv. Eff.(%)**	68	66	77	80	76	68	45	74	74
Project App. Eff.(%)	64	66	31	33	34	42	88	40	40
Project Irrig. Eff.(%)	44	44	24	27	26	28	40	30	30

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

A & B IRRIGATION DISTRICT

1977 Irrigated Area 73850 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	4459	7219	10813	15350	11714	4251	647	54453	0.7373
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	22029	36472	42607	52367	43068	25415	6550	228504	3.0942
Total Project Inflow	26488	43691	53420	67717	54782	29666	7197	282956	3.8315
Operational Losses	582	967	736	821	1041	672	158	4977	0.0674
Seepage Losses	1985	4021	4449	4701	4573	3156	1000	23885	0.3234
Farm Deliveries	23921	38703	48235	62195	49168	25838	6039	254094	3.4407
Soil Moisture Change	1341	16011	-6174	-6519	-530	-1781	-5714	-3365	-0.0456
Eff. Precipitation	46	11421	5177	4006	2424	3269	224	26566	0.3597
Evapotranspiration	14988	18468	34512	32304	20202	16835	8191	145499	1.9702
Irrigation Requirement*	16283	23058	23161	21779	17249	11784	2254	115567	1.5649
Runoff Losses	3229	6398	8065	8761	6976	3833	440	37701	0.5105
Deep Percolation	4409	9246	17009	31655	24943	10221	3345	100825	1.3653
Project Return Flow	3811	7365	8801	9582	8017	4505	598	42678	0.5779
Project Conv. Eff.(%)**	90	89	90	92	90	87	84	90	90
Project App. Eff.(%)	68	60	48	35	35	46	37	45	45
Project Irrig. Eff.(%)	61	53	43	32	31	40	31	41	41

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

MILNER LOW LIFT IRRIGATION DISTRICT

1977 Irrigated Area 13480 Acres

	April	May	June	July	August	September	October	Season Total AF	Season Total AF/Acre
River (Res.) Diversion	4603	9488	10461	14858	11498	5528	0	56436	4.1867
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	27	48	33	29	0	137	0.0101
Total Project Inflow	4603	9488	10487	14906	11531	5557	0	56573	4.1968
Operational Losses	138	335	323	225	234	278	0	1532	0.1137
Seepage Losses	1365	1716	1487	1714	1372	889	0	8543	0.6337
Farm Deliveries	3100	7437	8678	12967	9925	4391	0	46498	3.4494
Soil Moisture Change	626	2709	-835	-797	-1330	-147	0	226	0.0167
Eff. Precipitation	72	1349	855	1114	389	231	0	4010	0.2975
Evapotranspiration	1717	2279	5502	7473	3496	1218	0	21685	1.6087
Irrigation Requirement*	2271	3639	3812	5562	1777	839	0	17901	1.3280
Runoff Losses	237	769	1153	859	1060	302	0	4379	0.3248
Deep Percolation	592	3030	3713	6546	7088	3249	0	24218	1.7966
Project Return Flow	375	1104	1476	1083	1294	579	0	5911	0.4385
Project Conv. Eff.(%)**	67	78	83	87	86	79	0	82	82
Project App. Eff.(%)	73	49	44	43	18	19	0	38	38
Project Irrig. Eff.(%)	49	38	36	37	15	15	0	32	32

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change

** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100

** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100

** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

NORTHSIDE CANAL COMPANY

1977 Irrigated Area 149340 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	111048	153774	156592	194698	162008	54765	32422	865306	5.7942
Supplementary Inflow	-9032	-12506	-12736	-15835	-13176	-4454	-2637	-70375	-0.4712
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	102016	141267	143856	178863	148831	50311	29785	794930	5.3230
Operational Losses	479	537	489	733	283	262	24	2807	0.0188
Seepage Losses	48767	51587	45868	50514	42828	24394	22059	286012	1.9152
Farm Deliveries	52770	89144	97499	127615	105720	25655	7702	506111	3.3890
Soil Moisture Change	3924	30030	-5245	-9138	-5417	-10478	-13115	-9439	-0.0632
Eff. Precipitation	84	11585	2243	4985	5047	1988	249	26181	0.1753
Evapotranspiration	36261	39702	70941	82592	52047	34434	20080	336056	2.2503
Irrigation Requirement*	40102	58147	63453	68469	41582	21969	6716	300435	2.0118
Runoff Losses	4315	4831	4402	6600	2545	2355	214	25262	0.1692
Deep Percolation	8353	26166	29645	52546	61593	1332	772	180414	1.2081
Project Return Flow	4794	5368	4891	7333	2828	2617	238	28069	0.1880
Project Conv. Eff.(%)**	52	63	68	71	71	51	26	64	64
Project App. Eff.(%)	76	65	65	54	39	86	87	59	59
Project Irrig. Eff.(%)	39	41	44	38	28	44	23	38	38

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

WOOD RIVER VALLEY IRRIGATION DISTRICT

1977 Irrigated Area 4850 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	1470	3632	13188	4618	1658	1809	0	26375	5.4381
Supplementary Inflow	0	1868	5271	5132	5408	2495	0	20174	4.1596
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	1470	5500	18459	9750	7067	4304	0	46549	9.5978
Operational Losses	0	0	0	0	0	0	0	0	0.0000
Seepage Losses	1192	2123	3221	1806	1418	1300	0	11060	2.2805
Farm Deliveries	278	3377	15238	7944	5649	3004	0	35489	7.3173
Soil Moisture Change	0	594	0	-277	-80	0	0	237	0.0488
Eff. Precipitation	13	1172	314	362	271	225	0	2357	0.4859
Evapotranspiration	237	1251	3391	3076	2146	1701	0	11802	2.4333
Irrigation Requirement*	224	674	3077	2436	1795	1476	0	9682	1.9962
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	54	2703	12160	5508	3854	1528	0	25807	5.3211
Project Return Flow	0	0	0	0	0	0	0	0	0.0000
Project Conv. Eff.(%)**	19	61	83	81	80	70	0	76	76
Project App. Eff.(%)	80	20	20	31	32	49	0	27	27
Project Irrig. Eff.(%)	15	12	17	25	25	34	0	21	21

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

SALMON RIVER CANAL CO. LTD.

1977 Irrigated Area 19770 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	2237	12043	17599	24954	19123	0	0	75956	3.8420
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	2237	12043	17599	24954	19123	0	0	75956	3.8420
Operational Losses	0	0	0	0	0	0	0	0	0.0000
Seepage Losses	1190	3921	6922	8843	7082	0	0	27958	1.4142
Farm Deliveries	1047	8122	10677	16111	12041	0	0	47998	2.4278
Soil Moisture Change	0	3907	508	-1058	-1688	0	0	1668	0.0844
Eff. Precipitation	24	1951	1270	2623	618	0	0	6485	0.3280
Evapotranspiration	882	4223	8759	11735	6227	0	0	31826	1.6098
Irrigation Requirement*	859	6179	7997	8054	3921	0	0	27009	1.3662
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	188	1943	2680	8057	8120	0	0	20989	1.0616
Project Return Flow	0	0	0	0	0	0	0	0	0.0000
Project Conv. Eff.(%)**	47	67	61	65	63	0	0	63	63
Project App. Eff.(%)	82	76	75	50	33	0	0	56	56
Project Irrig. Eff.(%)	38	51	45	32	21	0	0	36	36

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change

** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100

** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100

** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

CEDAR MESA RESERVOIR & CANAL CO.

1977 Irrigated Area 4030 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	2259	2979	3195	4659	3497	461	0	17049	4.2305
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	2259	2979	3195	4659	3497	461	0	17049	4.2305
Operational Losses	0	0	0	0	0	0	0	0	0.0000
Seepage Losses	945	1083	966	1171	916	189	0	5271	1.3081
Farm Deliveries	1313	1896	2228	3488	2581	271	0	11778	2.9225
Soil Moisture Change	343	826	-372	-191	-206	-484	0	-83	-0.0207
Eff. Precipitation	142	391	399	388	223	145	0	1689	0.4190
Evapotranspiration	1047	1152	2020	2250	1337	858	0	8663	2.1497
Irrigation Requirement*	1247	1588	1250	1670	908	229	0	6891	1.7100
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	66	308	979	1818	1673	42	0	4886	1.2125
Project Return Flow	0	0	0	0	0	0	0	0	0.0000
Project Conv. Eff.(%)**	58	64	70	75	74	59	0	69	69
Project App. Eff.(%)	95	84	56	48	35	84	0	59	59
Project Irrig. Eff.(%)	55	53	39	36	26	50	0	40	40

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

BELL RAPIDS MUTUAL IRRIGATION CO.

1977 Irrigated Area 25520 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	6627	6936	16478	16702	12726	6216	1227	66911	2.6219
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	6627	6936	16478	16702	12726	6216	1227	66911	2.6219
Operational Losses	0	0	0	0	0	0	0	0	0.0000
Seepage Losses	987	780	1032	989	789	518	344	5439	0.2131
Farm Deliveries	5641	6156	15446	15714	11937	5698	883	61472	2.4088
Soil Moisture Change	2179	2838	538	-1109	-1226	-1482	-1041	696	0.0273
Eff. Precipitation	161	1277	660	1366	841	621	148	5072	0.1988
Evapotranspiration	1744	2769	7541	13667	9237	5016	1241	41214	1.6150
Irrigation Requirement*	3762	4330	7419	11191	7170	2913	52	36838	1.4435
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	1879	1826	8027	4522	4767	2784	830	24635	0.9653
Project Return Flow	0	0	0	0	0	0	0	0	0.0000
Project Conv. Eff.(%)**	85	89	94	94	94	92	72	92	92
Project App. Eff.(%)	67	70	48	71	60	51	6	60	60
Project Irrig. Eff.(%)	57	62	45	67	56	47	4	55	55

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change

** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100

** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100

** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

KING HILL IRRIGATION DISTRICT

1977 Irrigated Area 11000 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	15884	18423	18312	20139	19033	16635	7114	115538	10.5035
Supplementary Inflow	-449	-325	-739	-820	-559	-437	-284	-3613	-0.3285
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	15435	18098	17573	19319	18474	16198	6830	111925	10.1750
Operational Losses	1314	2775	2176	2299	2282	3828	3016	17690	1.6082
Seepage Losses	5821	5389	4621	4725	4296	3660	1609	30119	2.7381
Farm Deliveries	8300	9935	10777	12295	11896	8710	2205	64116	5.8287
Soil Moisture Change	1393	281	0	-485	-134	-180	-877	-3	-0.0003
Eff. Precipitation	39	786	230	447	309	191	35	2037	0.1852
Evapotranspiration	3366	3463	5766	6647	4539	3488	2138	29407	2.6734
Irrigation Requirement*	4721	2958	5536	5715	4095	3117	1226	27368	2.4880
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	3579	6977	5241	6580	7801	5593	979	36748	3.3407
Project Return Flow	1314	2775	2176	2299	2282	3828	3016	17690	1.6082
Project Conv. Eff.(%)**	54	55	61	64	64	54	32	57	57
Project App. Eff.(%)	57	30	51	46	34	36	56	43	43
Project Irrig. Eff.(%)	31	16	32	30	22	19	18	24	24

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

SETTLERS IRRIGATION DISTRICT

1977 Irrigated Area 9440 Acres

	April	May	June	July	August	September	October	Season Total AF	Season Total AF/Acre
River (Res.) Diversion	3577	7814	8743	9999	9173	3831	0	43137	4.5696
Supplementary Inflow	72	263	313	459	415	195	0	1716	0.1818
Groundwater Diversion	159	473	420	500	460	192	0	2205	0.2335
Total Project Inflow	3809	8550	9476	10958	10048	4217	0	47058	4.9849
Operational Losses	103	354	216	318	411	286	0	1688	0.1788
Seepage Losses	1154	2207	1909	1937	1707	712	0	9626	1.0198
Farm Deliveries	2552	5989	7351	8703	7930	3218	0	35743	3.7864
Soil Moisture Change	0	2476	-118	-71	-501	-553	0	1232	0.1306
Eff. Precipitation	115	1362	816	264	363	935	0	3855	0.4083
Evapotranspiration	2330	2699	4927	5991	5174	3542	0	24663	2.6126
Irrigation Requirement*	2215	3813	3993	5656	4311	2053	0	22041	2.3349
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	337	2177	3358	3047	3619	1165	0	13702	1.4515
Project Return Flow	103	354	216	318	411	286	0	1688	0.1788
Project Conv. Eff.(%)**	67	70	78	79	79	76	0	76	76
Project App. Eff.(%)	87	64	54	65	54	64	0	62	62
Project Irrig. Eff.(%)	58	45	42	52	43	49	0	47	47

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

SOUTH BOARD OF CONTROL, OWYHEE PROJECT

1977 Irrigated Area 38030 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	33374	37518	42904	47214	45740	30406	7001	244155	6.4201
Supplementary Inflow	0	0	0	0	0	0	0	0	0.0000
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	33374	37518	42904	47214	45740	30406	7001	244155	6.4201
Operational Losses	5315	5121	4835	4627	5395	4651	1482	31426	0.8263
Seepage Losses	9876	8445	7790	7870	7244	5286	1436	47947	1.2608
Farm Deliveries	18183	23951	30278	34717	33101	20469	4082	164781	4.3329
Soil Moisture Change	39	10069	-2855	-978	-861	-3366	-2766	-718	-0.0189
Eff. Precipitation	459	5001	1534	660	1101	2871	171	11797	0.3102
Evapotranspiration	12695	12448	19835	18170	14193	9692	3704	90736	2.3859
Irrigation Requirement*	12274	17517	15446	16532	12231	3455	767	78221	2.0568
Runoff Losses	6074	5853	5526	5288	6166	5315	1694	35915	0.9444
Deep Percolation	-165	582	9307	12897	14704	11699	1621	50645	1.3317
Project Return Flow	11389	10974	10361	9915	11561	9966	3176	67341	1.7707
Project Conv. Eff.(%)**	54	64	71	74	72	67	58	67	67
Project App. Eff.(%)	68	73	51	48	37	17	19	47	47
Project Irrig. Eff.(%)	37	47	36	35	27	11	11	32	32

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

1977 Project Water Balance (Acre-Feet)

LITTLE WILLOW IRRIGATION DISTRICT

1977 Irrigated Area 2370 Acres

	April	May	June	July	August	September	October	Season AF	Total AF/Acre
River (Res.) Diversion	1413	1270	1976	1601	2226	112	0	8598	3.6278
Supplementary Inflow	20	21	67	119	110	21	0	358	0.1512
Groundwater Diversion	0	0	0	0	0	0	0	0	0.0000
Total Project Inflow	1433	1291	2043	1720	2336	132	0	8956	3.7790
Operational Losses	198	246	238	246	246	0	0	1174	0.4954
Seepage Losses	0	0	0	0	0	0	0	0	0.0000
Farm Deliveries	1235	1045	1805	1475	2090	132	0	7782	3.2836
Soil Moisture Change	111	444	0	-221	0	-420	0	-85	-0.0360
Eff. Precipitation	6	313	21	94	80	127	0	641	0.2704
Evapotranspiration	598	798	1330	1554	1067	659	0	6007	2.5345
Irrigation Requirement*	703	929	1310	1239	988	112	0	5281	2.2281
Runoff Losses	0	0	0	0	0	0	0	0	0.0000
Deep Percolation	532	116	496	235	1102	20	0	2502	1.0555
Project Return Flow	198	246	238	246	246	0	0	1174	0.4954
Project Conv. Eff.(%)**	86	81	88	86	89	100	0	87	87
Project App. Eff.(%)	57	89	73	84	47	85	0	68	68
Project Irrig. Eff.(%)	49	72	64	72	42	85	0	59	59

* Irrigation requirement = evapotranspiration - effective precipitation + soil moisture change
** Project conveyance efficiency = (farm deliveries) / (total inflow) * 100
** Project application efficiency = (irrigation requirement) / (farm deliveries) * 100
** Project irrigation efficiency = (irrigation requirement) / (total inflow) * 100

APPENDIX E

GRAPHS OF SEASONAL WATER USE FOR
COORPERATING IRRIGATION PROJECTS DURING 1977

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King Hill	....	261
Settlers	....	262
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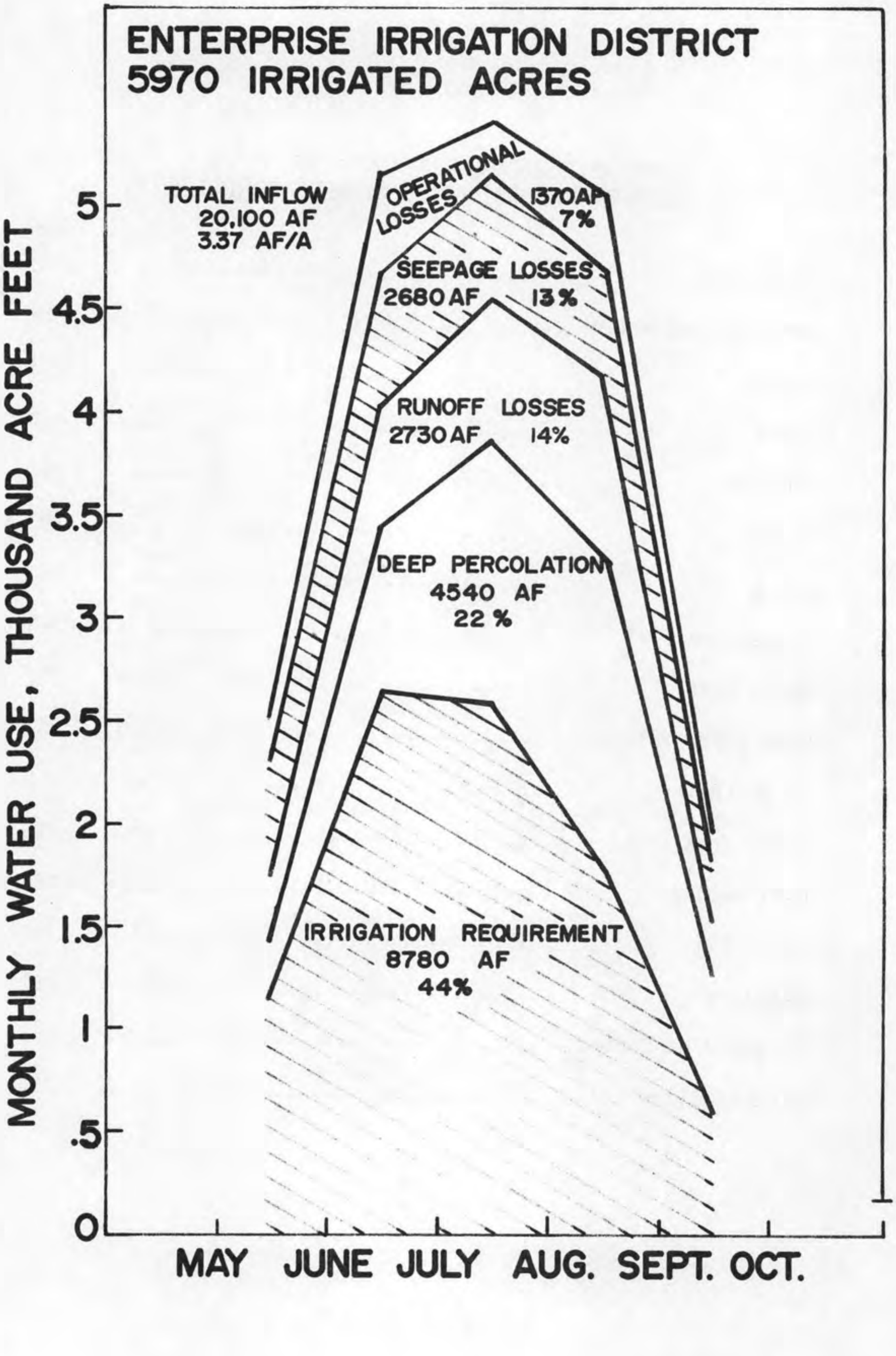
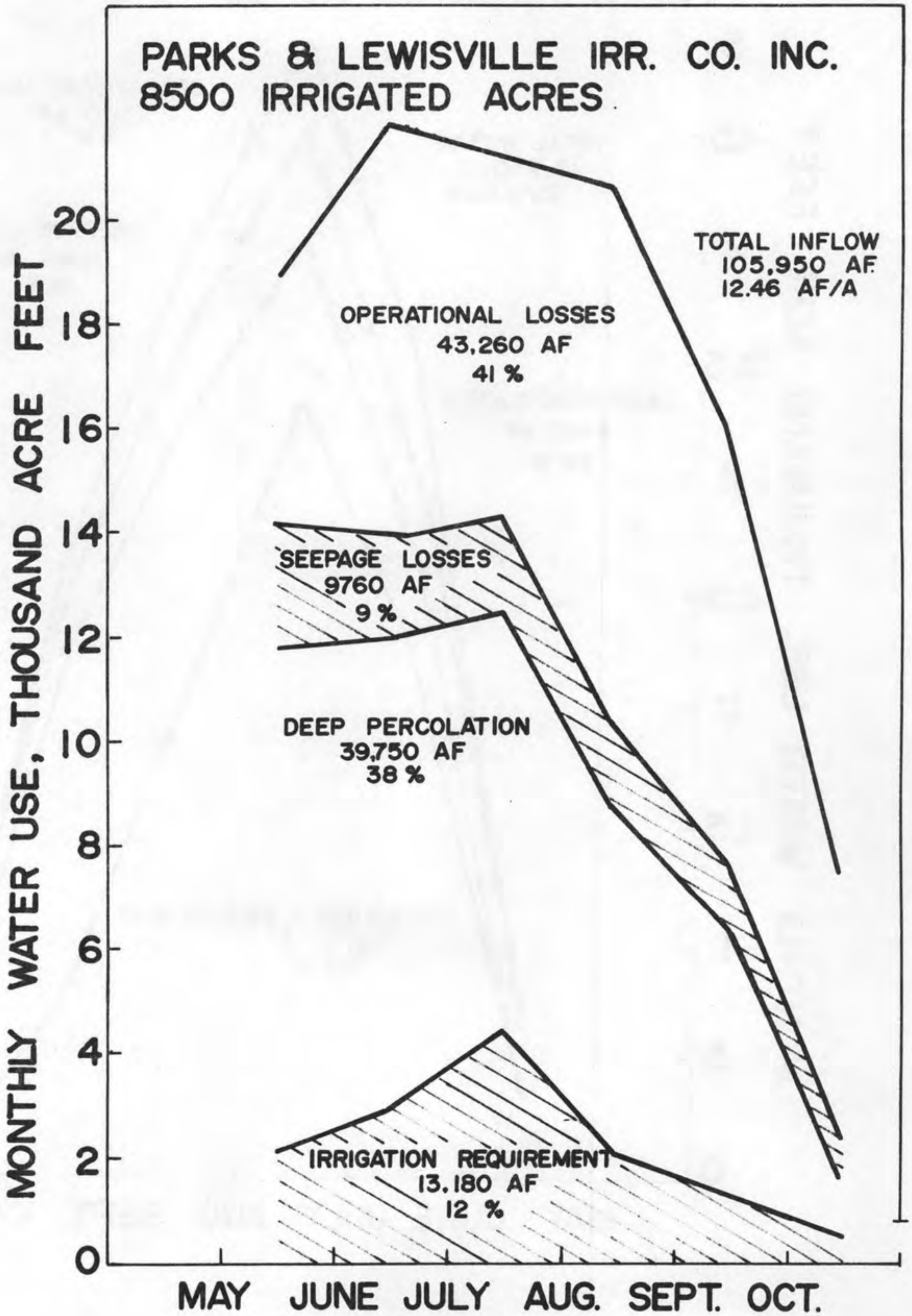
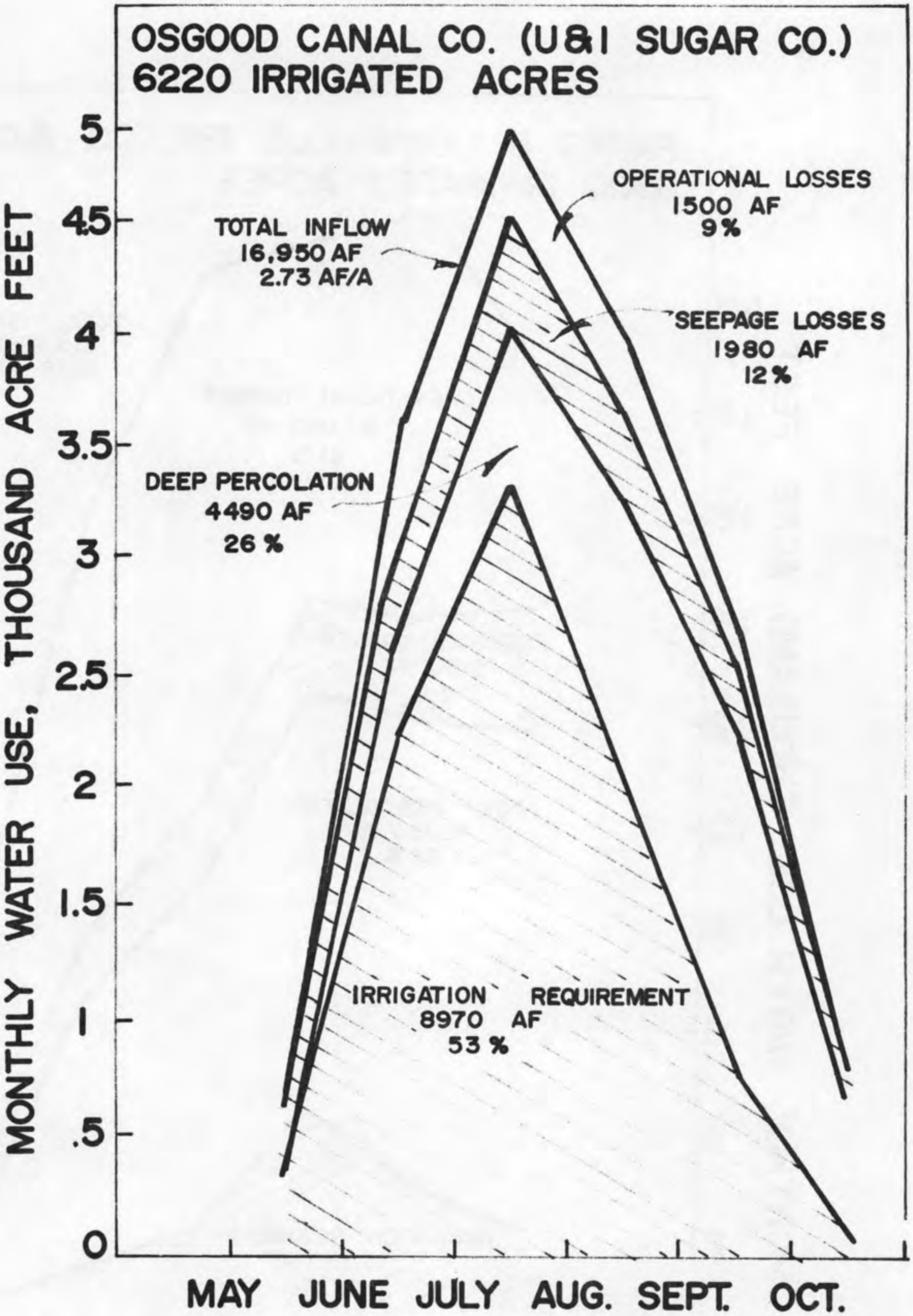
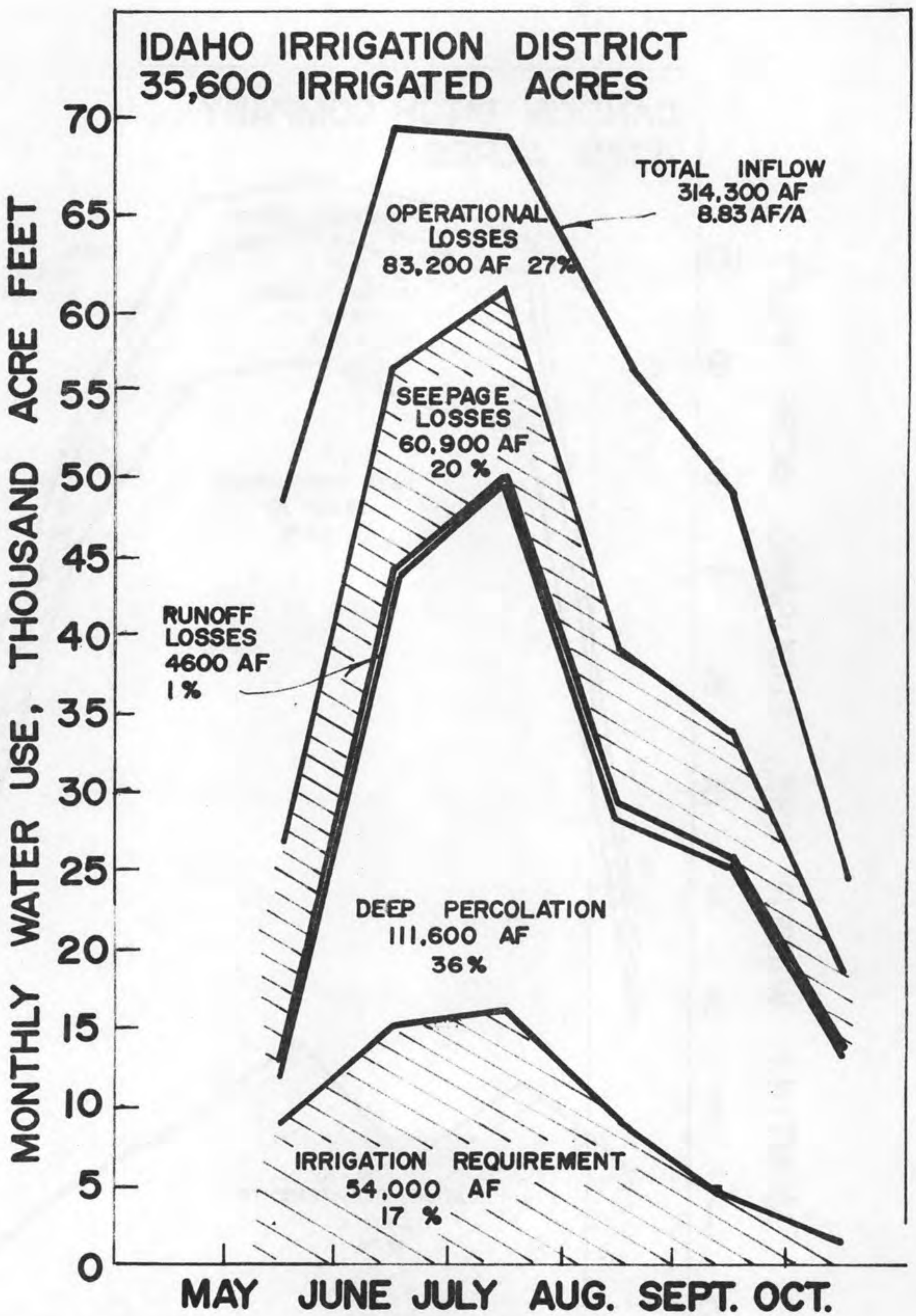

ENTERPRISE IRRIGATION DISTRICT
5970 IRRIGATED ACRES
TOTAL INFLOW
20,100 AF
3.37 AF/A
OPERATIONAL LOSSES
1370 AF
7%
SEEPAGE LOSSES
2680 AF
13%
RUNOFF LOSSES
2730 AF
14%
DEEP PERCOLATION
4540 AF
22%
IRRIGATION REQUIREMENT
8780 AF
44%
MONTHLY WATER USE, THOUSAND ACRE FEET
0
.5
1
1.5
2
2.5
3
3.5
4
4.5
5
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

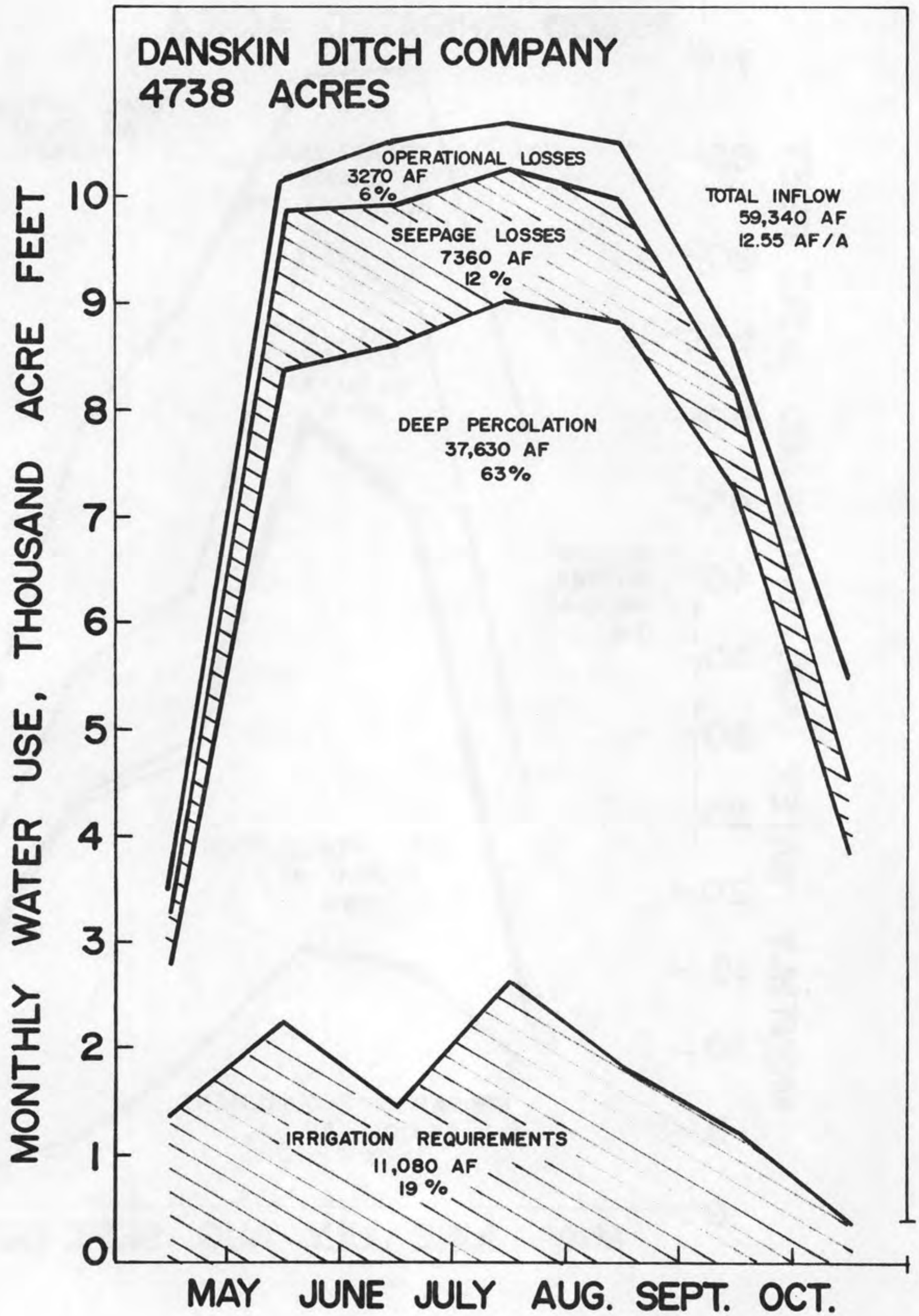

PARKS & LEWISVILLE IRR. CO. INC.
8500 IRRIGATED ACRES
TOTAL INFLOW
105,950 AF
12.46 AF/A
OPERATIONAL LOSSES
43,260 AF
41 %
SEEPAGE LOSSES
9760 AF
9 %
DEEP PERCOLATION
39,750 AF
38 %
IRRIGATION REQUIREMENT
13,180 AF
12 %
MONTHLY WATER USE, THOUSAND ACRE FEET
0
2
4
6
8
10
12
14
16
18
20
MAY
JUNE
JULY
AUG.
SEPT.
OCT.



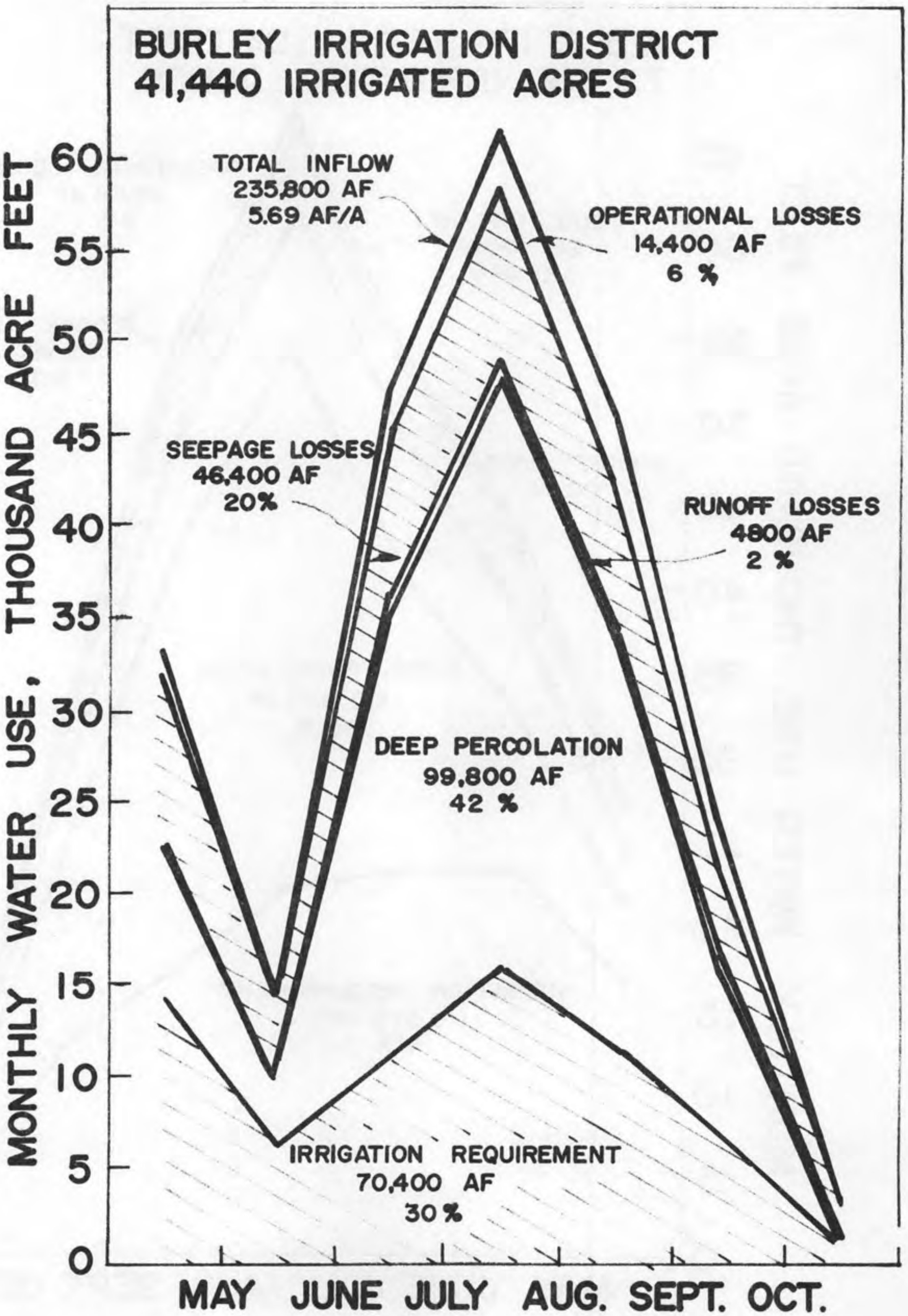
OSGOOD CANAL CO. (U&I SUGAR CO.)
6220 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
5
4.5
4
3.5
3
2.5
2
1.5
1
.5
0
TOTAL INFLOW
16,950 AF
2.73 AF/A
OPERATIONAL LOSSES
1500 AF
9%
SEEPAGE LOSSES
1980 AF
12%
DEEP PERCOLATION
4490 AF
26 %
IRRIGATION REQUIREMENT
8970 AF
53 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

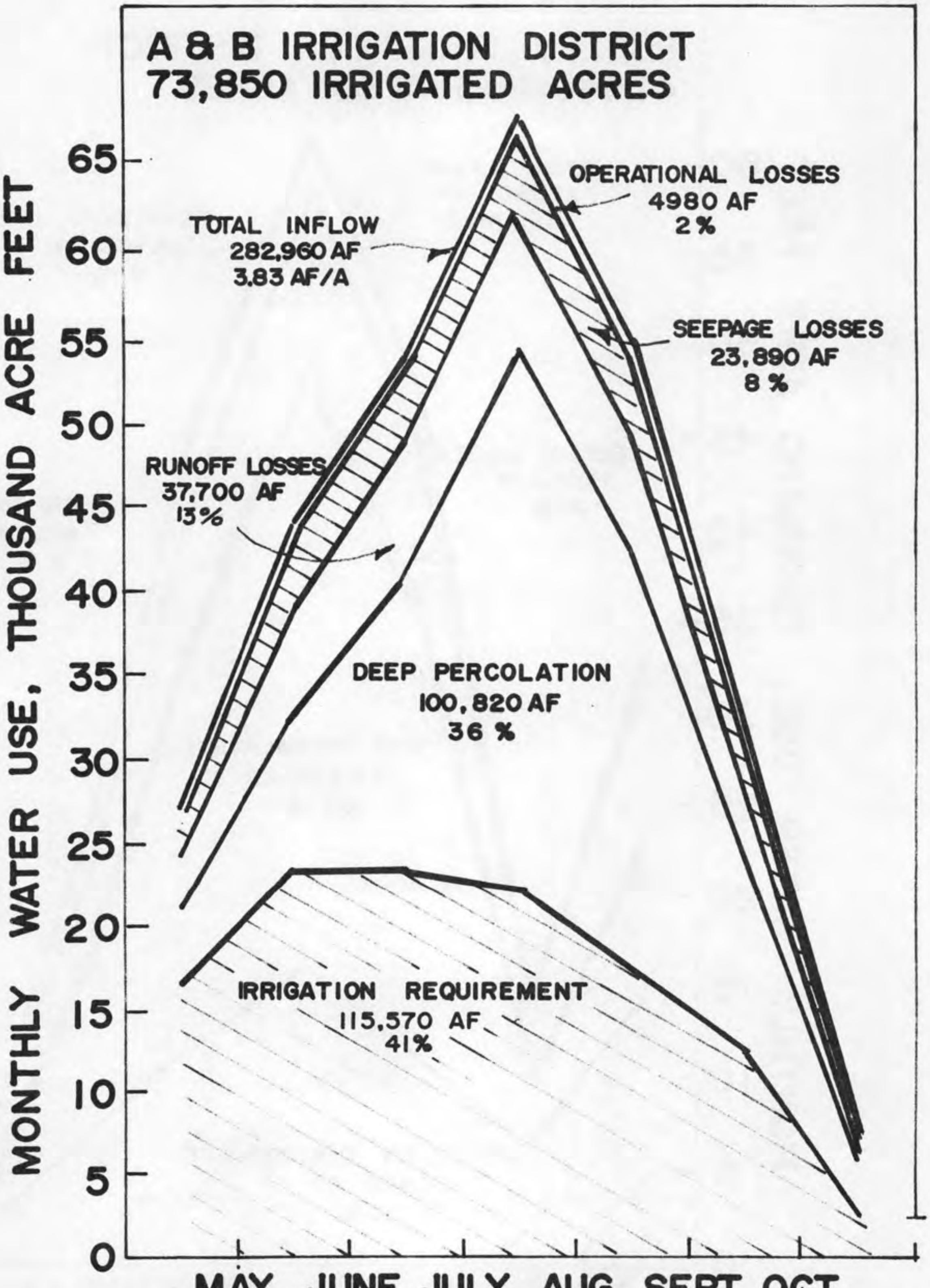


IDAHO IRRIGATION DISTRICT
35,600 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
TOTAL INFLOW
314,300 AF
8.83 AF/A
OPERATIONAL
LOSSES
83,200 AF 27%
SEEPAGE
LOSSES
60,900 AF
20 %
RUNOFF
LOSSES
4600 AF
1 %
DEEP PERCOLATION
111,600 AF
36%
IRRIGATION REQUIREMENT
54,000 AF
17 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

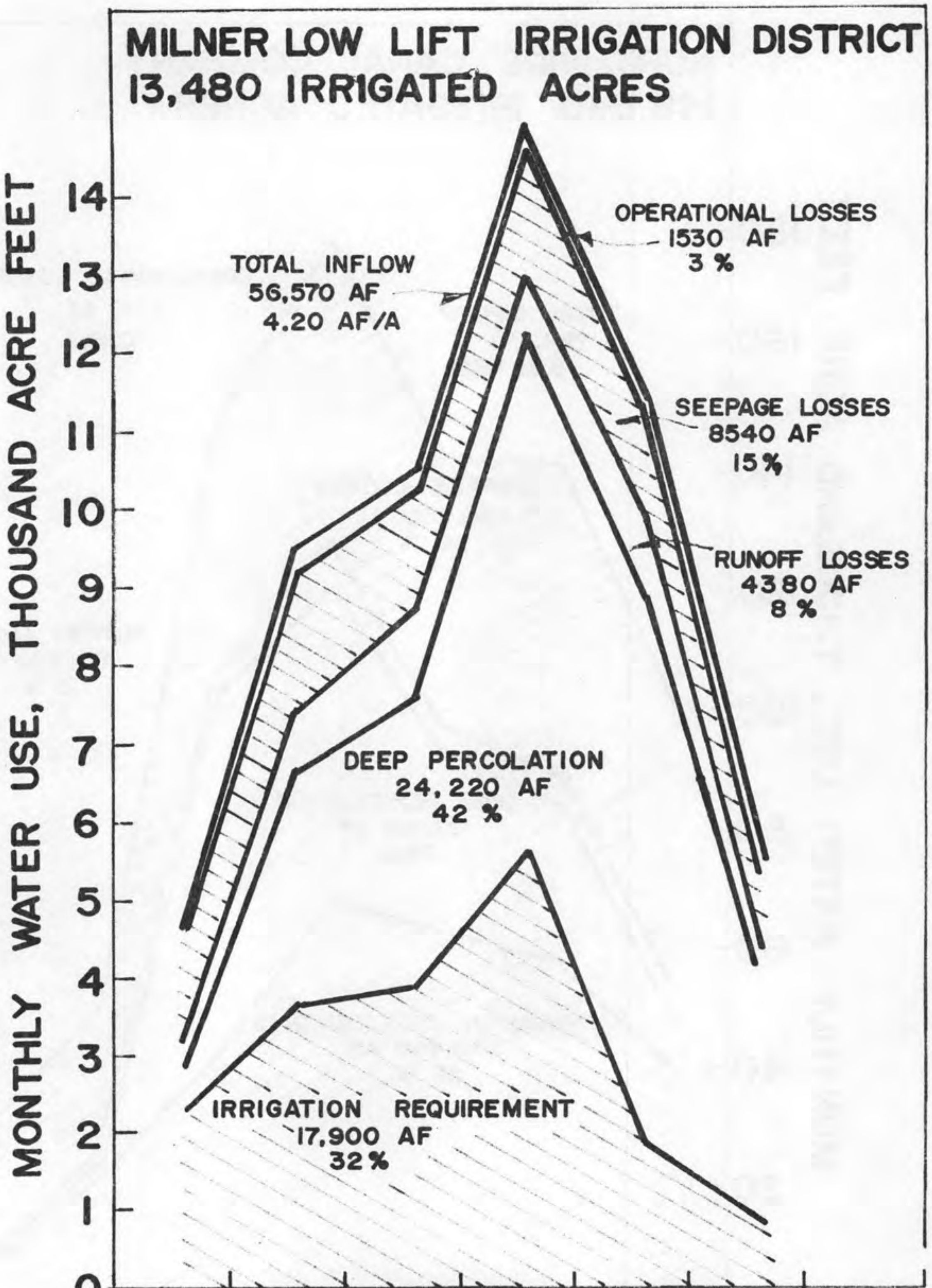


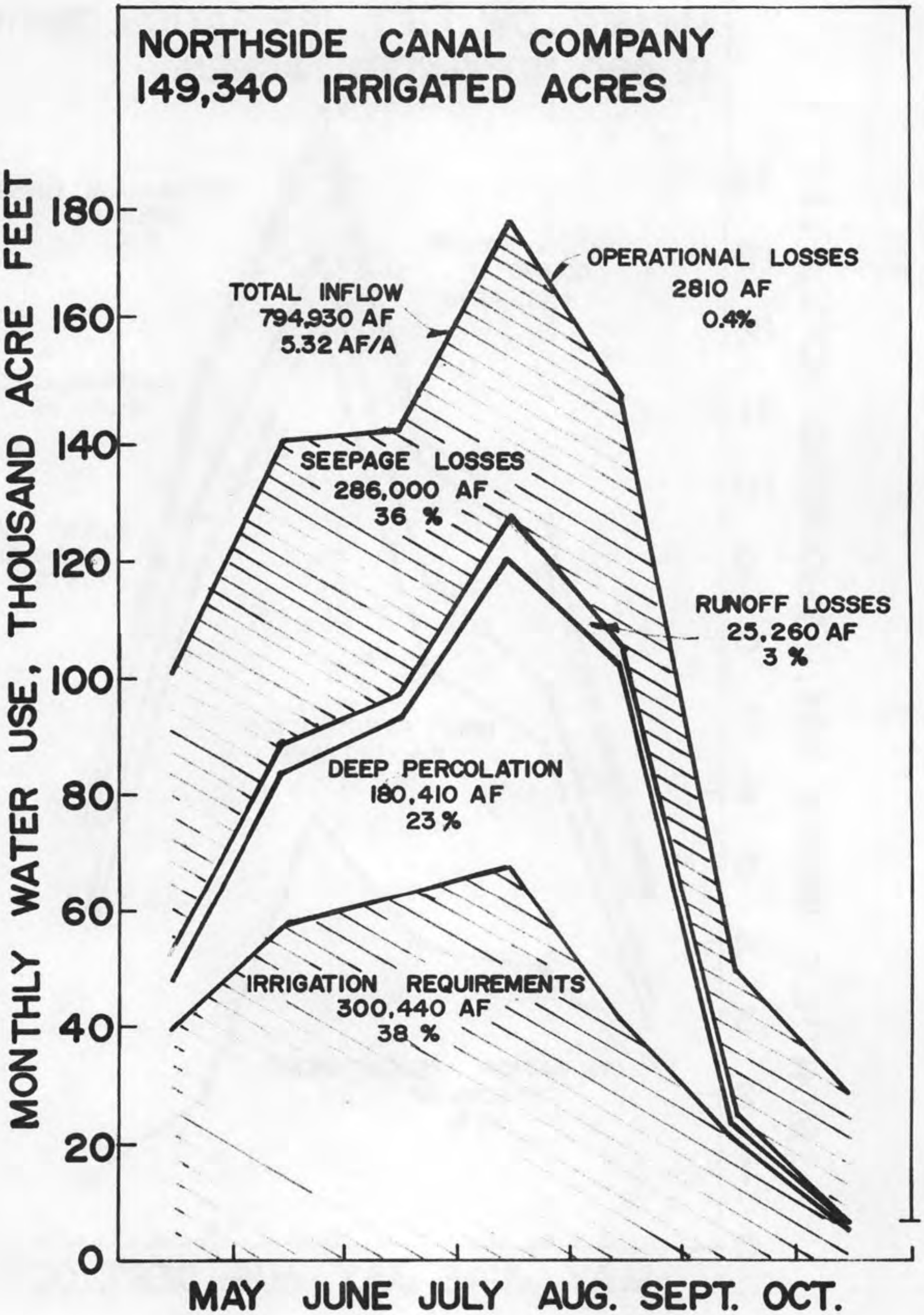
DANSKIN DITCH COMPANY
4738 ACRES
OPERATIONAL LOSSES
3270 AF
6%
SEEPAGE LOSSES
7360 AF
12 %
TOTAL INFLOW
59,340 AF
12.55 AF/A
DEEP PERCOLATION
37,630 AF
63%
IRRIGATION REQUIREMENTS
11,080 AF
19 %
MONTHLY WATER USE, THOUSAND ACRE FEET
0
1
2
3
4
5
6
7
8
9
10
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


BURLEY IRRIGATION DISTRICT
41,440 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
60
55
50
45
40
35
30
25
20
15
10
5
0
TOTAL INFLOW
235,800 AF
5.69 AF/A
OPERATIONAL LOSSES
14,400 AF
6 %
SEEPAGE LOSSES
46,400 AF
20%
RUNOFF LOSSES
4800 AF
2 %
DEEP PERCOLATION
99,800 AF
42 %
IRRIGATION REQUIREMENT
70,400 AF
30 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

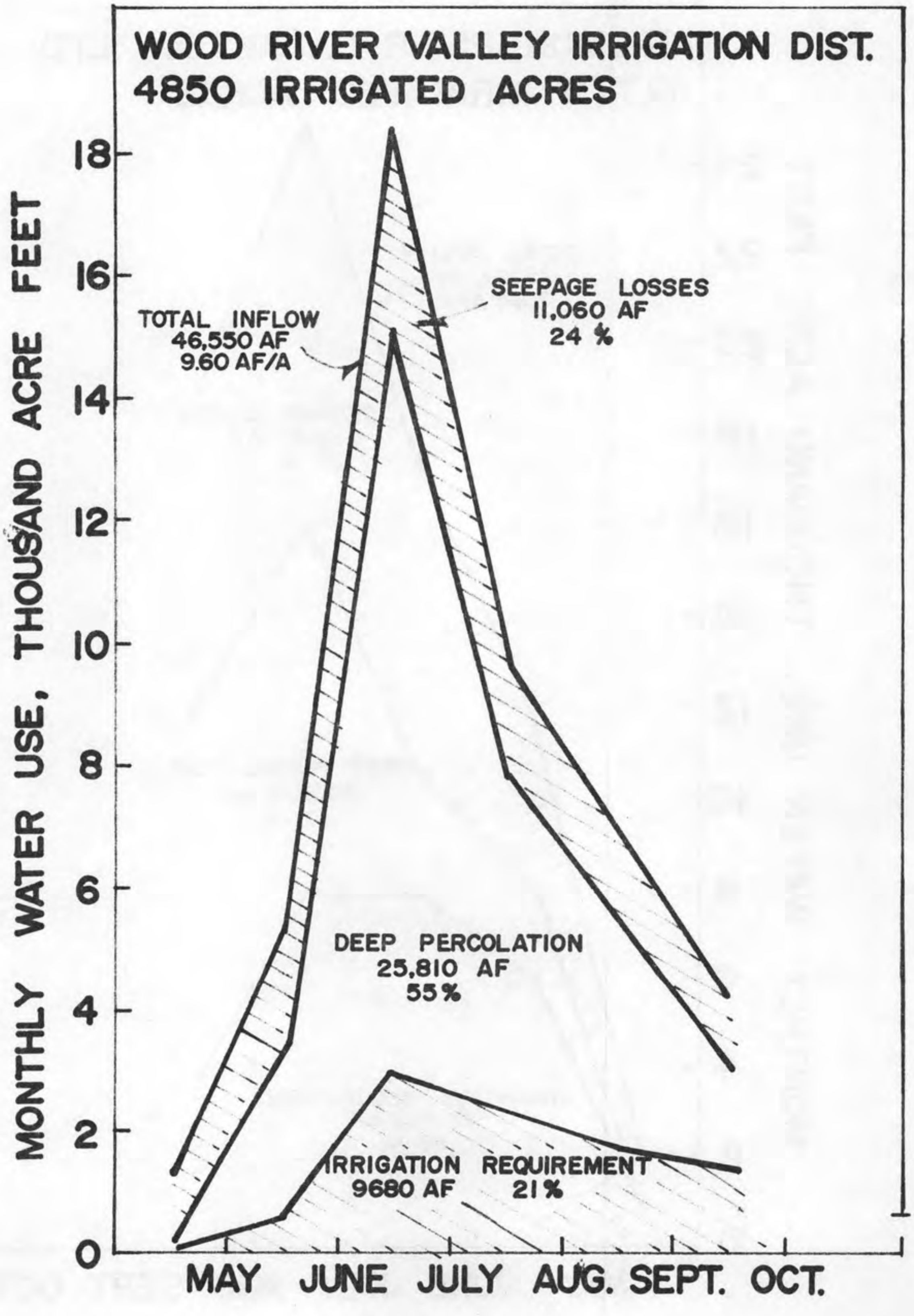


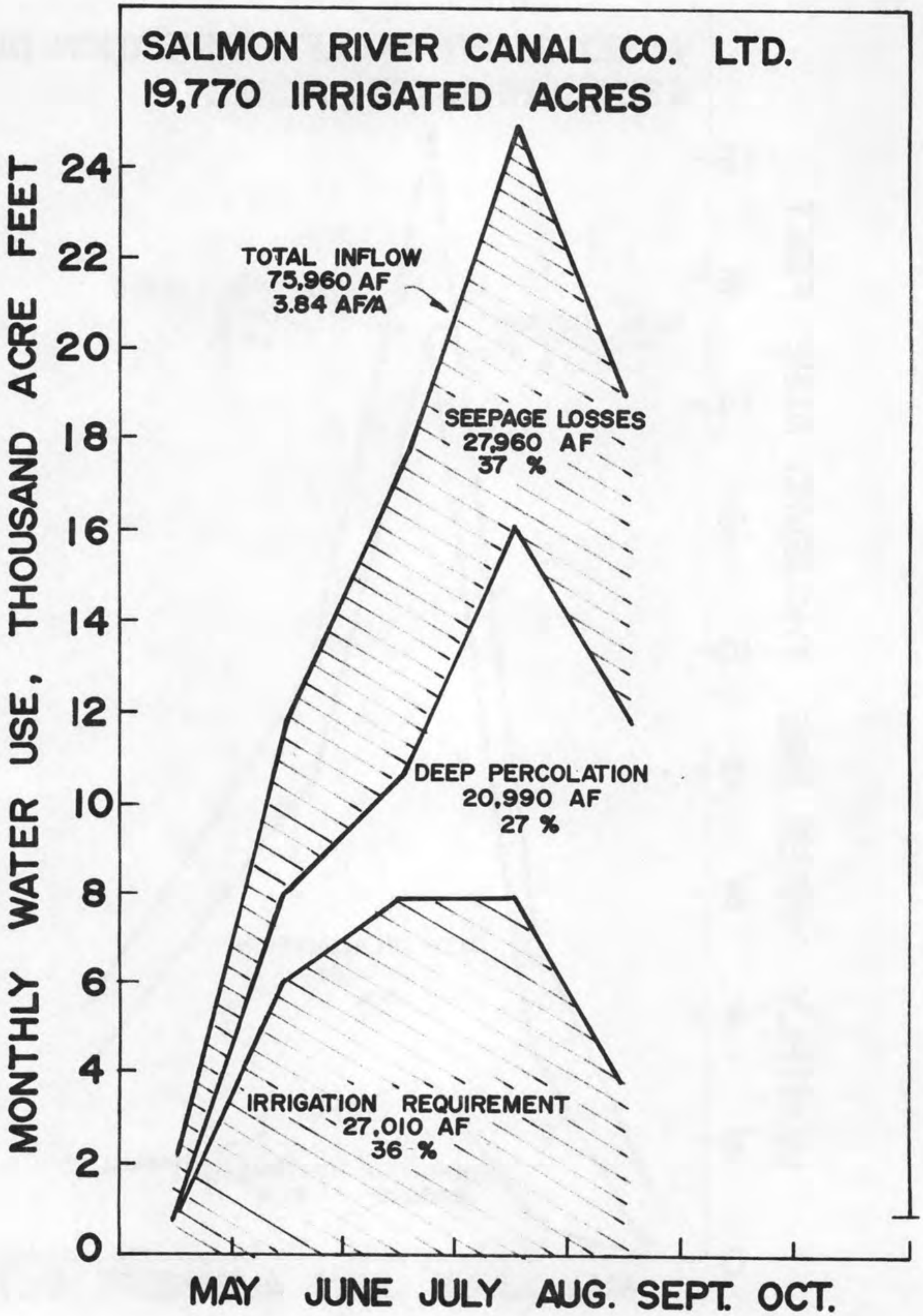
A & B IRRIGATION DISTRICT
73,850 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
65
60
55
50
45
40
35
30
25
20
15
10
5
0
OPERATIONAL LOSSES
4980 AF
2 %
TOTAL INFLOW
282,960 AF
3.83 AF/A
SEEPAGE LOSSES
23,890 AF
8 %
RUNOFF LOSSES
37,700 AF
13%
DEEP PERCOLATION
100,820 AF
36 %
IRRIGATION REQUIREMENT
115,570 AF
41%
MAY JUNE JULY AUG. SEPT. OCT.

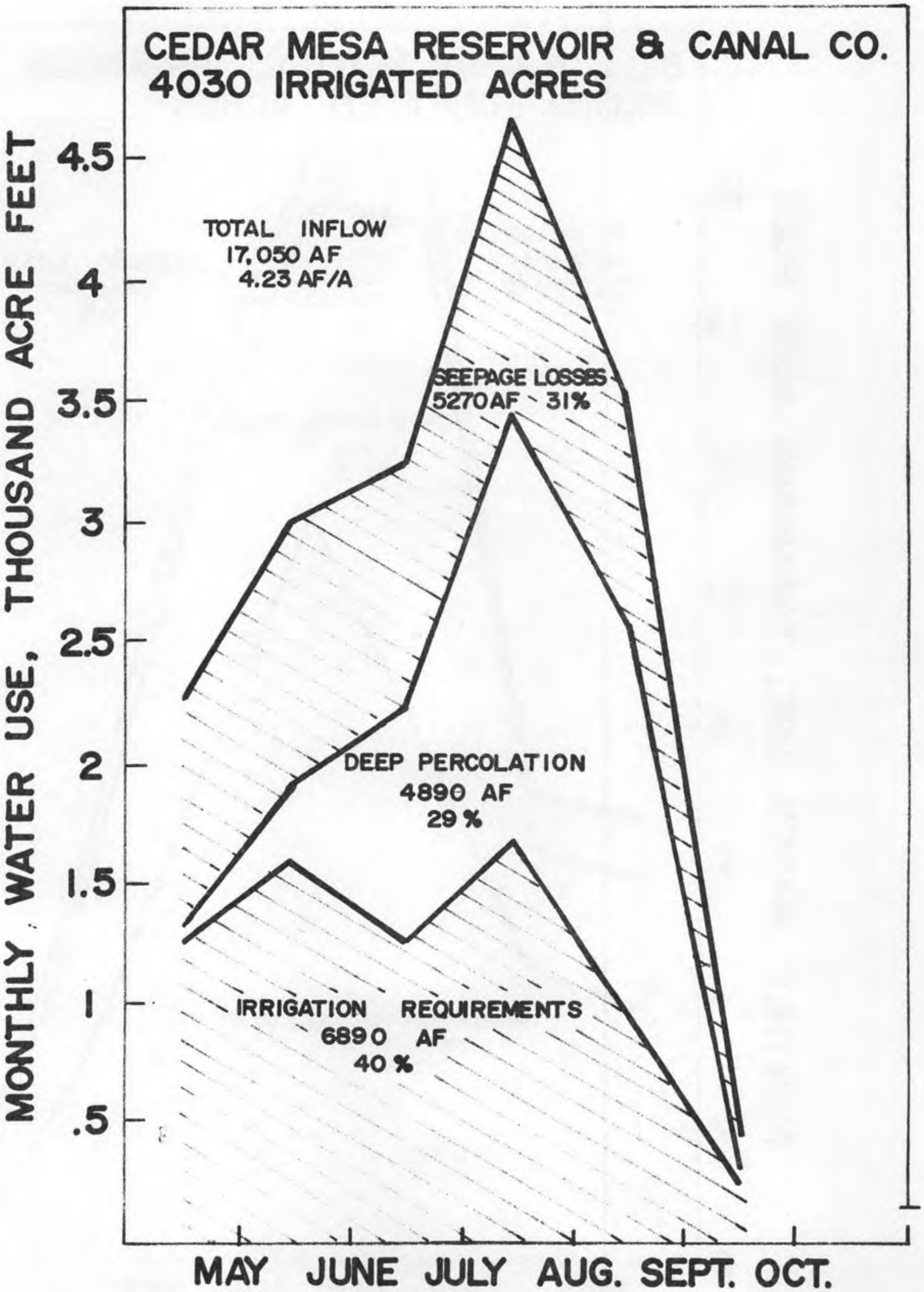

MILNER LOW LIFT IRRIGATION DISTRICT
13,480 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
TOTAL INFLOW
56,570 AF
4.20 AF/A
OPERATIONAL LOSSES
1530 AF
3 %
SEEPAGE LOSSES
8540 AF
15 %
RUNOFF LOSSES
4380 AF
8 %
DEEP PERCOLATION
24,220 AF
42 %
IRRIGATION REQUIREMENT
17,900 AF
32 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

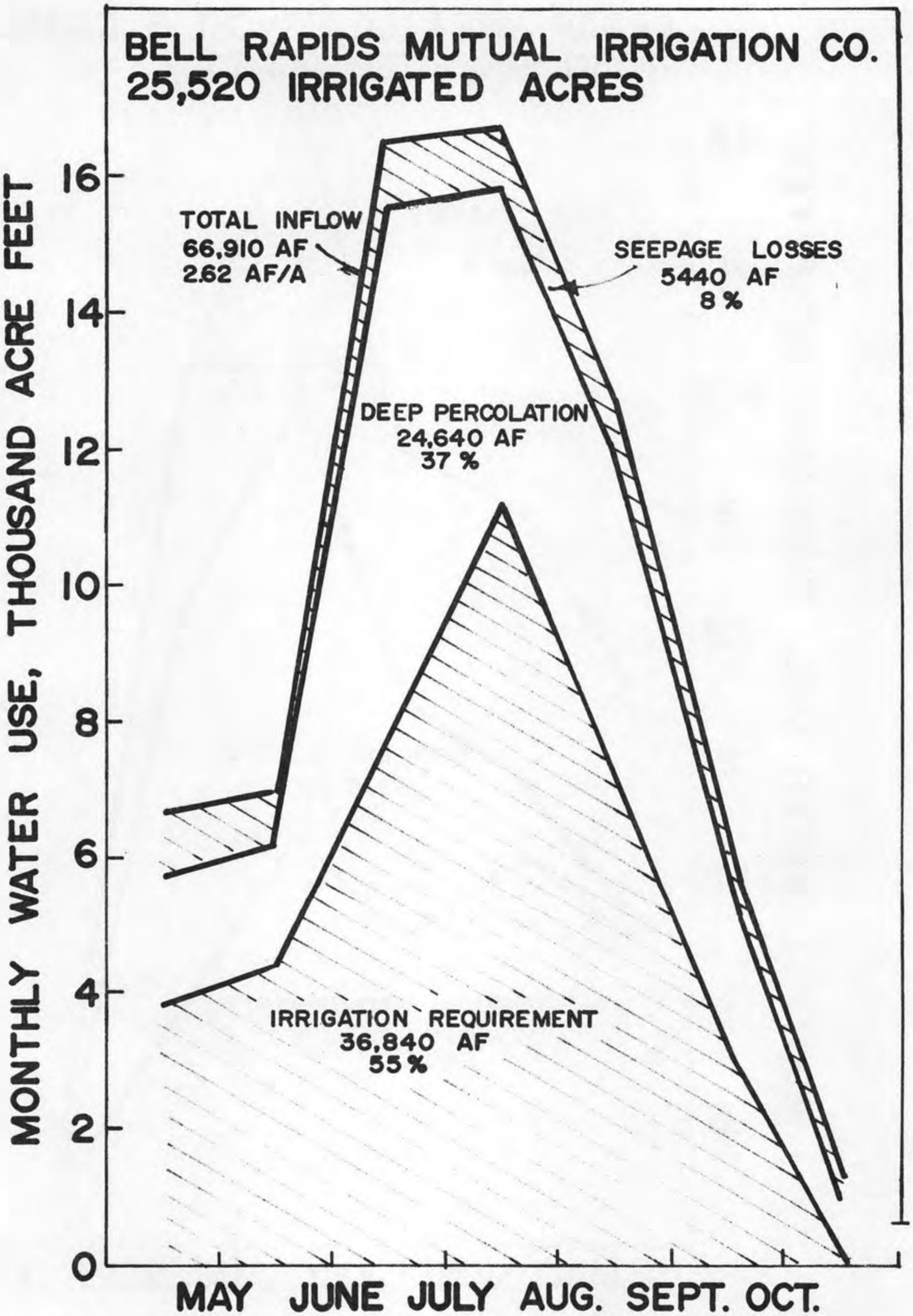


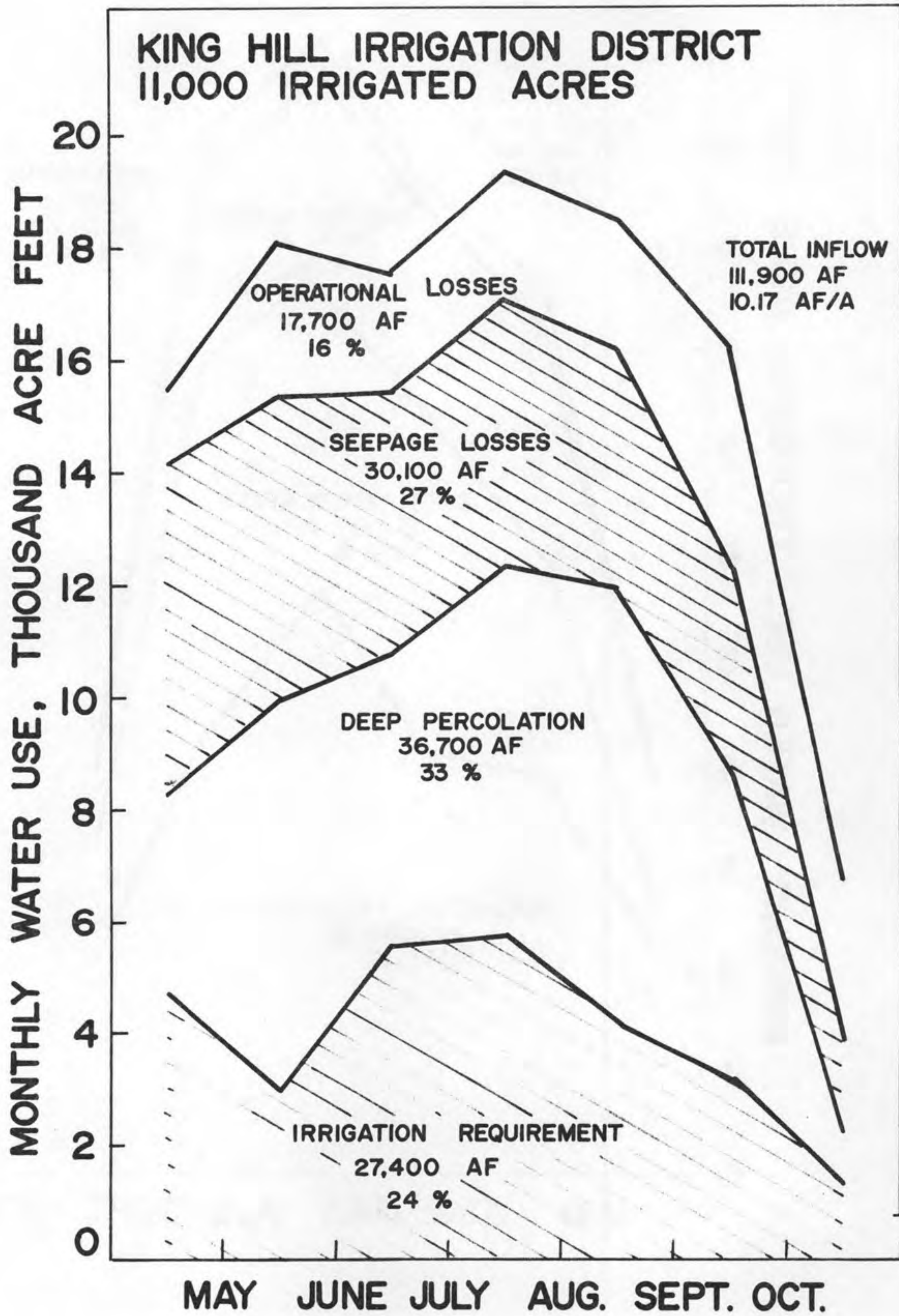
NORTHSIDE CANAL COMPANY
149,340 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
180
160
140
120
100
80
60
40
20
0
TOTAL INFLOW
794,930 AF
5.32 AF/A
OPERATIONAL LOSSES
2810 AF
0.4%
SEEPAGE LOSSES
286,000 AF
36 %
RUNOFF LOSSES
25,260 AF
3 %
DEEP PERCOLATION
180,410 AF
23 %
IRRIGATION REQUIREMENTS
300,440 AF
38 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

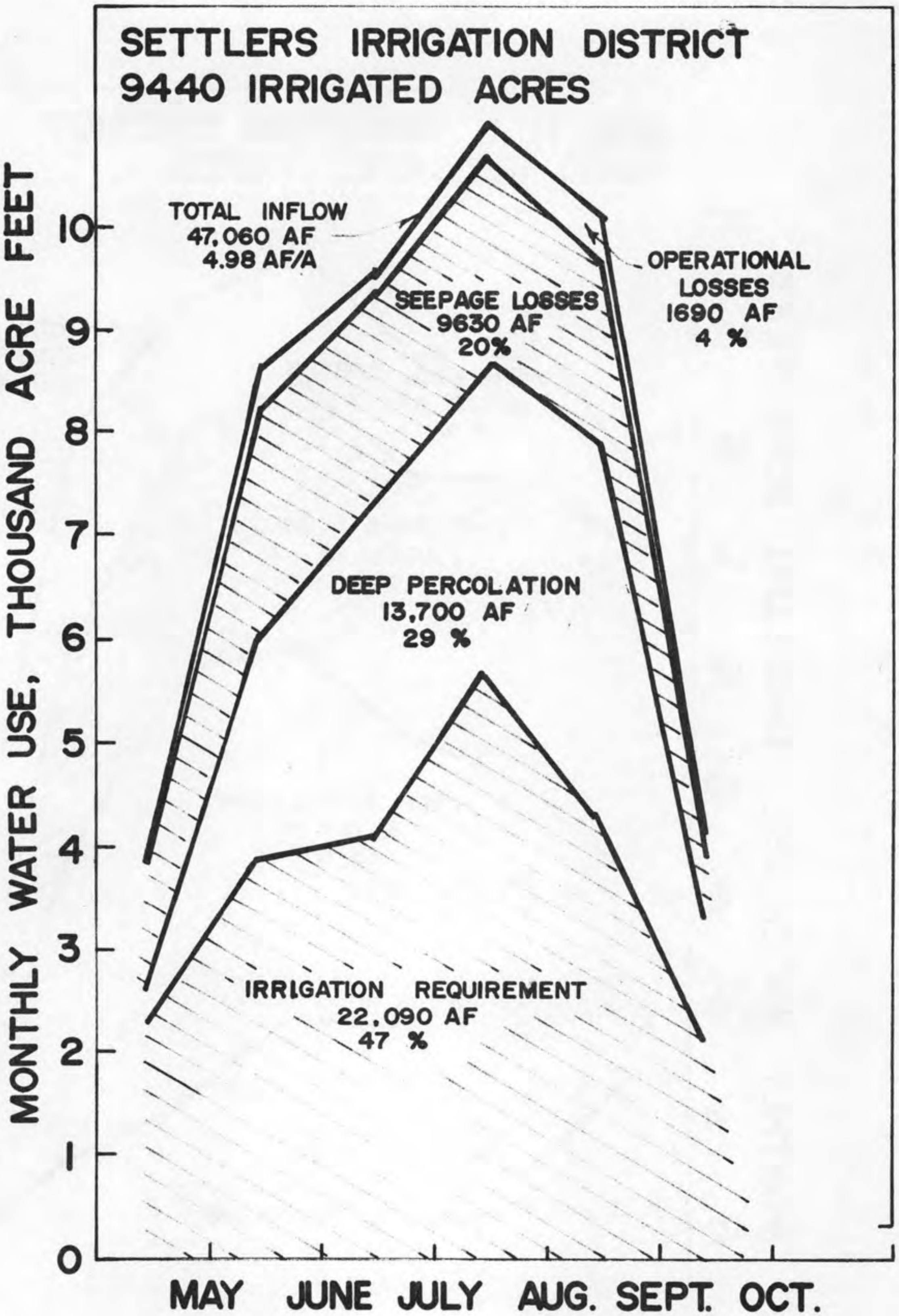

WOOD RIVER VALLEY IRRIGATION DIST.
4850 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
18
16
14
12
10
8
6
4
2
0
TOTAL INFLOW
46,550 AF
9.60 AF/A
SEEPAGE LOSSES
11,060 AF
24 %
DEEP PERCOLATION
25,810 AF
55%
IRRIGATION REQUIREMENT
9680 AF 21%
MAY JUNE JULY AUG. SEPT. OCT.

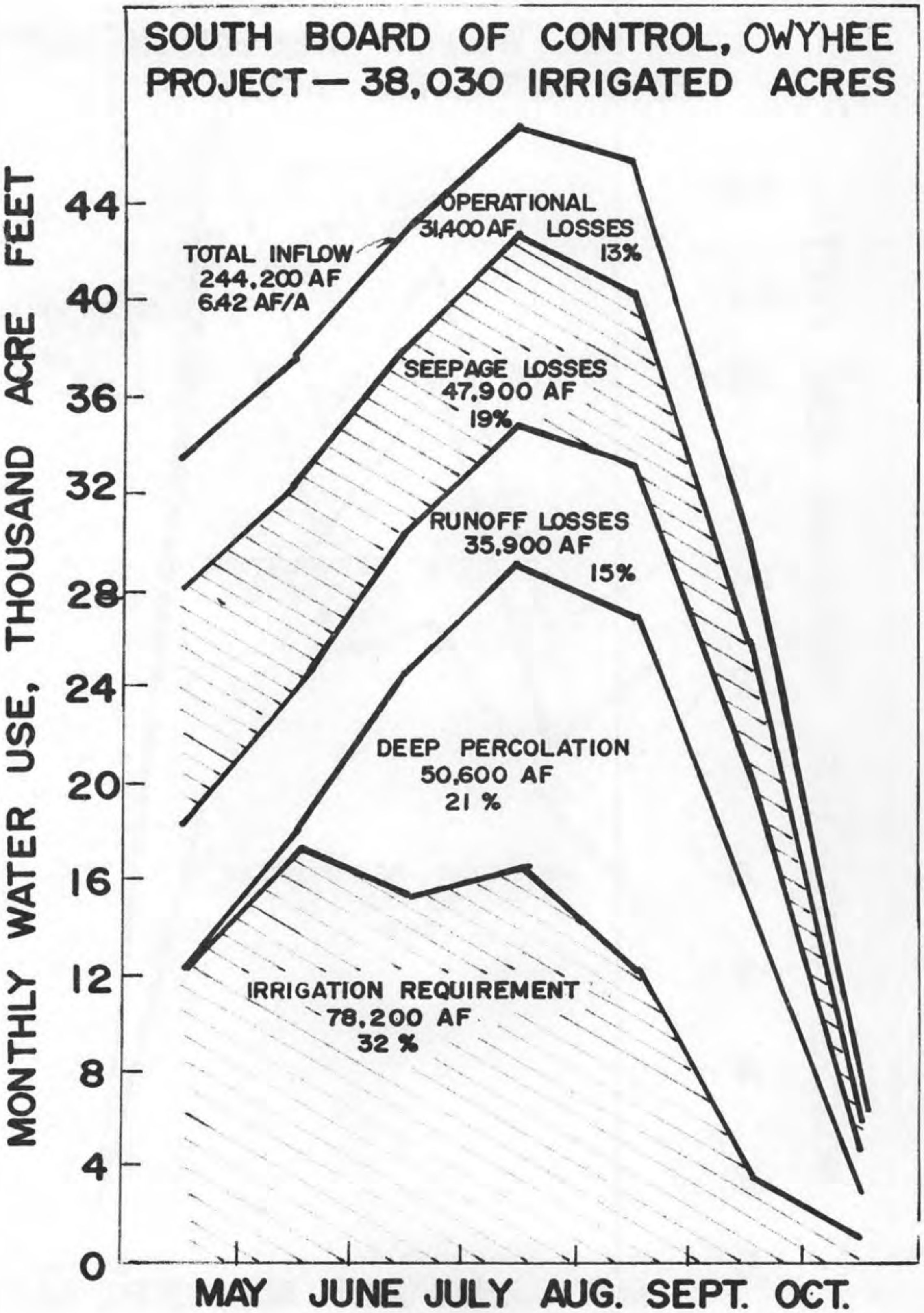

SALMON RIVER CANAL CO. LTD.
19,770 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
0
2
4
6
8
10
12
14
16
18
20
22
24
TOTAL INFLOW
75,960 AF
3.84 AF/A
SEEPAGE LOSSES
27,960 AF
37 %
DEEP PERCOLATION
20,990 AF
27 %
IRRIGATION REQUIREMENT
27,010 AF
36 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

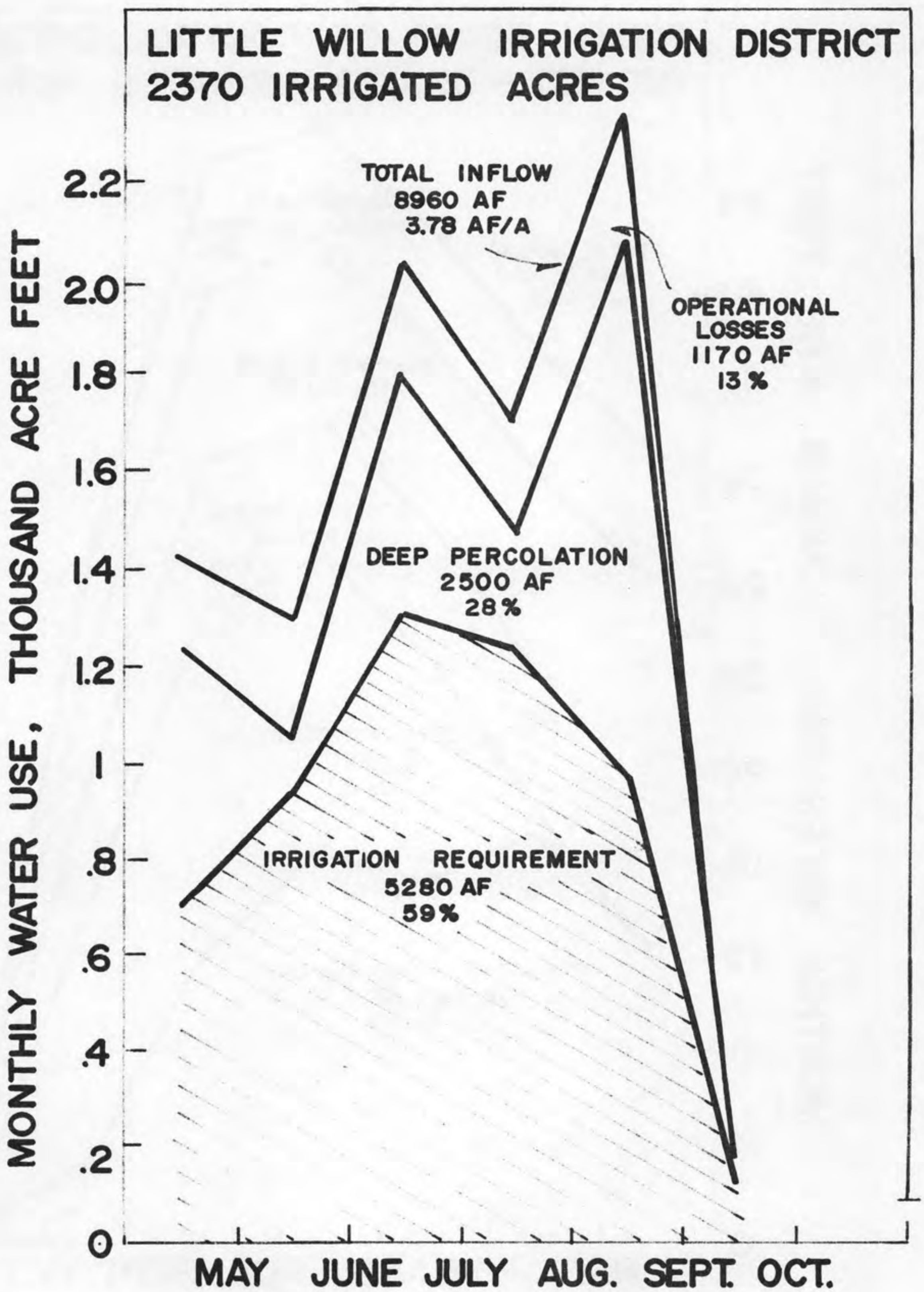

CEDAR MESA RESERVOIR & CANAL CO.
4030 IRRIGATED ACRES
TOTAL INFLOW
17,050 AF
4.23 AF/A
SEEPAGE LOSSES
5270 AF 31%
DEEP PERCOLATION
4890 AF
29 %
IRRIGATION REQUIREMENTS
6890 AF
40 %
MONTHLY WATER USE, THOUSAND ACRE FEET
4.5
4
3.5
3
2.5
2
1.5
1
.5
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


BELL RAPIDS MUTUAL IRRIGATION CO.
25,520 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
16
14
12
10
8
6
4
2
0
TOTAL INFLOW
66,910 AF
2.62 AF/A
SEEPAGE LOSSES
5440 AF
8 %
DEEP PERCOLATION
24,640 AF
37 %
IRRIGATION REQUIREMENT
36,840 AF
55 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


KING HILL IRRIGATION DISTRICT
11,000 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
20
18
16
14
12
10
8
6
4
2
0
TOTAL INFLOW
111,900 AF
10.17 AF/A
OPERATIONAL LOSSES
17,700 AF
16 %
SEEPAGE LOSSES
30,100 AF
27 %
DEEP PERCOLATION
36,700 AF
33 %
IRRIGATION REQUIREMENT
27,400 AF
24 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


SETTLERS IRRIGATION DISTRICT
9440 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
0
1
2
3
4
5
6
7
8
9
10
TOTAL INFLOW
47,060 AF
4.98 AF/A
OPERATIONAL
LOSSES
1690 AF
4 %
SEEPAGE LOSSES
9630 AF
20%
DEEP PERCOLATION
13,700 AF
29 %
IRRIGATION REQUIREMENT
22,090 AF
47 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


SOUTH BOARD OF CONTROL, OWYHEE PROJECT — 38,030 IRRIGATED ACRES
MONTHLY WATER USE, THOUSAND ACRE FEET
44
40
36
32
28
24
20
16
12
8
4
0
TOTAL INFLOW 244,200 AF 6.42 AF/A
OPERATIONAL LOSSES 31,400 AF 13%
SEEPAGE LOSSES 47,900 AF 19%
RUNOFF LOSSES 35,900 AF 15%
DEEP PERCOLATION 50,600 AF 21 %
IRRIGATION REQUIREMENT 78,200 AF 32 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


LITTLE WILLOW IRRIGATION DISTRICT
2370 IRRIGATED ACRES
TOTAL INFLOW
8960 AF
3.78 AF/A
OPERATIONAL
LOSSES
1170 AF
13 %
DEEP PERCOLATION
2500 AF
28 %
IRRIGATION REQUIREMENT
5280 AF
59 %
MONTHLY WATER USE, THOUSAND ACRE FEET
2.2
2.0
1.8
1.6
1.4
1.2
1
.8
.6
.4
.2
0
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

APPENDIX F

GRAPHS OF APPLICATION, CONVEYANCE AND IRRIGATION EFFICIENCIES OF COOPERATING IRRIGATION PROJECTS DURING 1977

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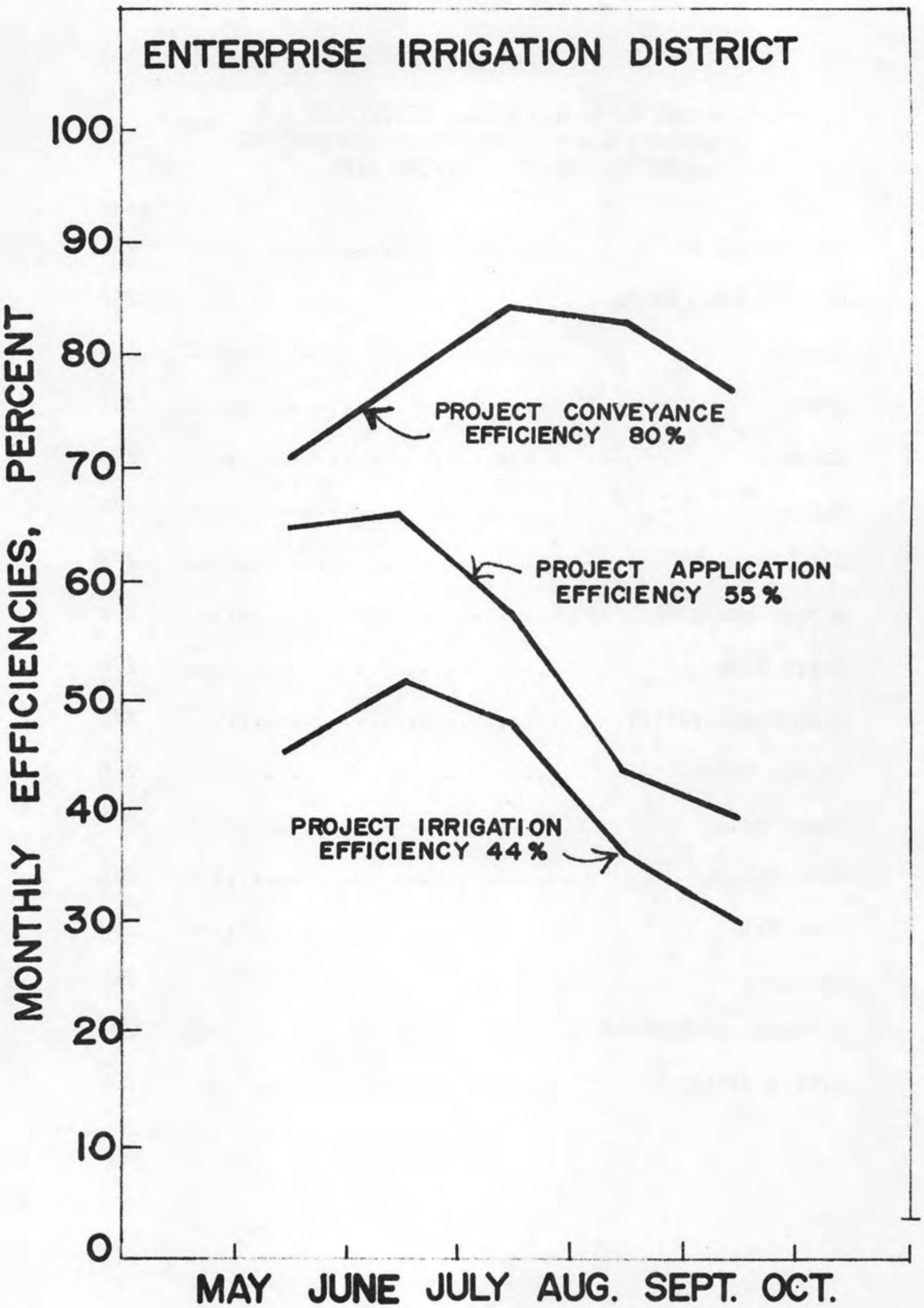
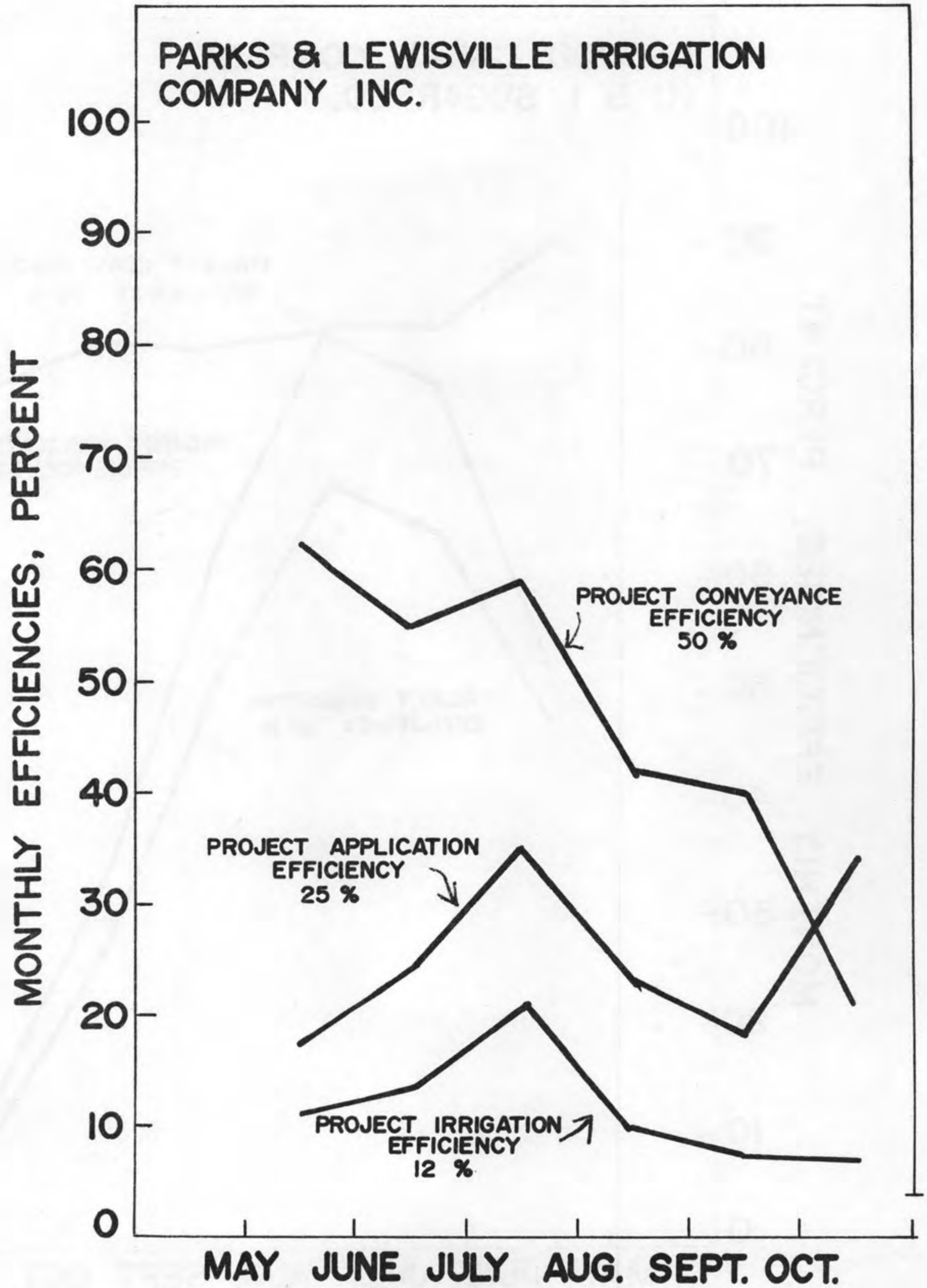
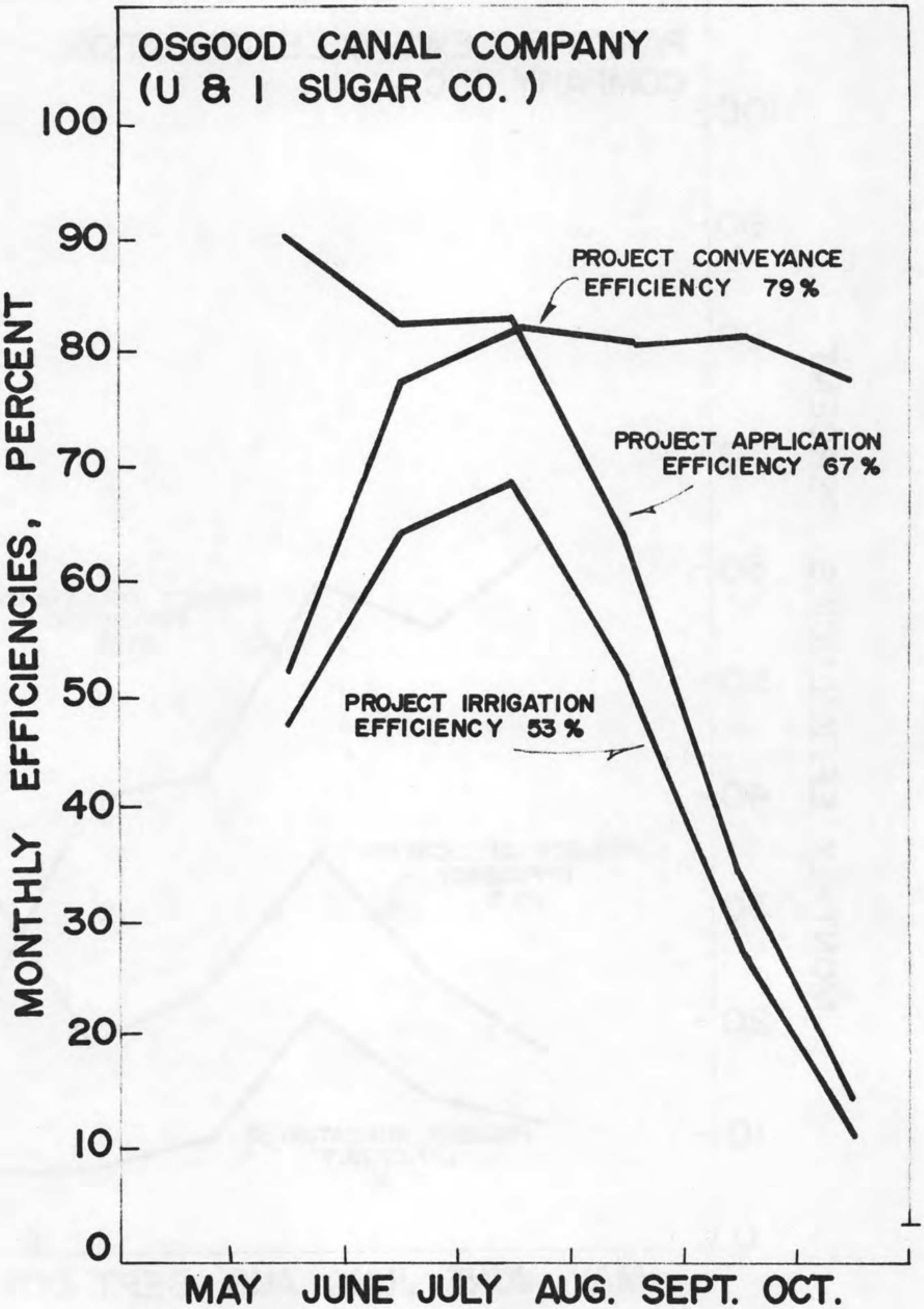
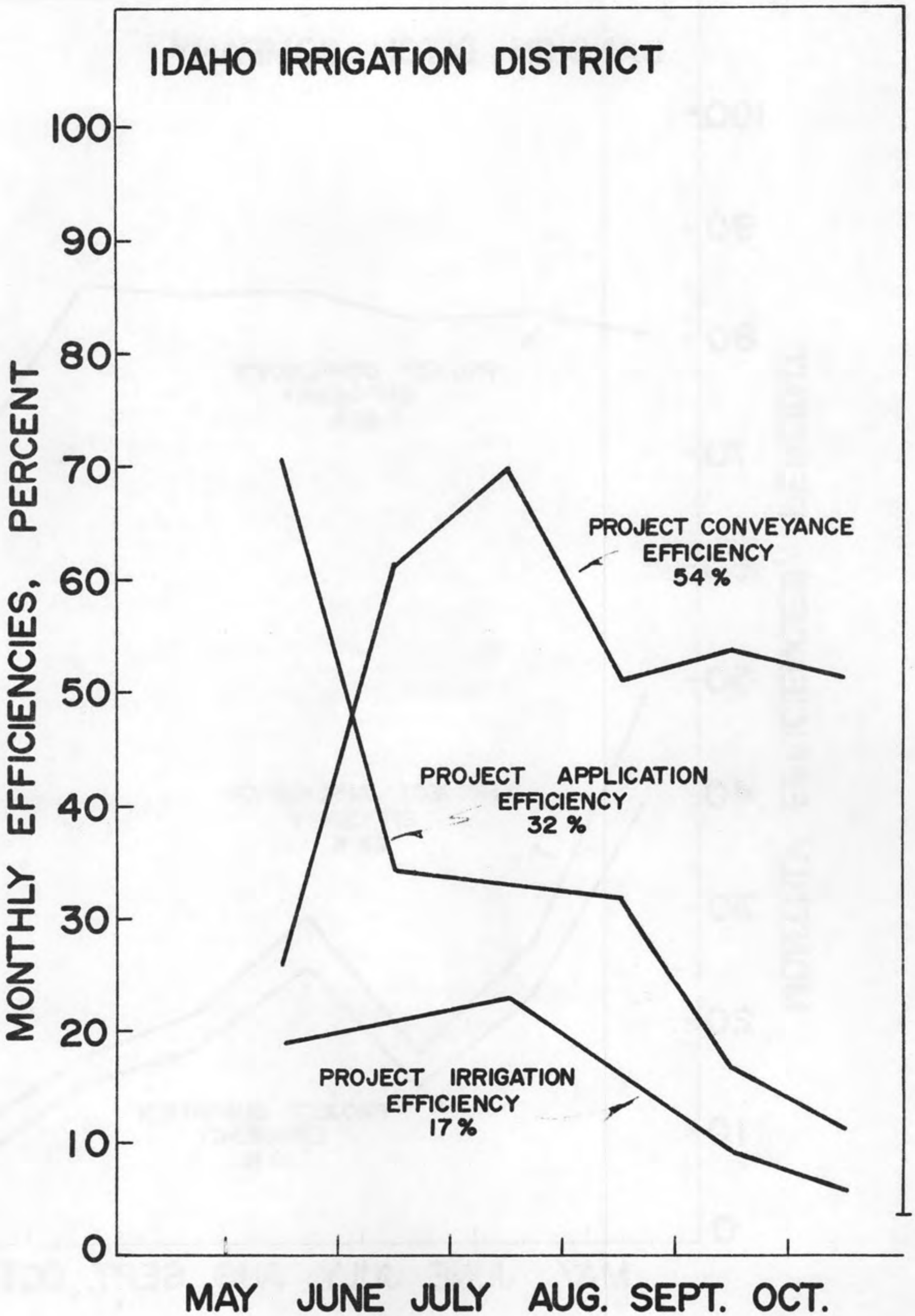
A & B	....	272
Milner Low Lift	....	273
North Side	....	274
Wood River Valley	....	275
Salmon River	....	276
Cedar Mesa	....	277
Bell Rapids	....	278
King Hill	....	279
Settlers	....	280
S. Board of Control	....	281
Little Willow	....	282

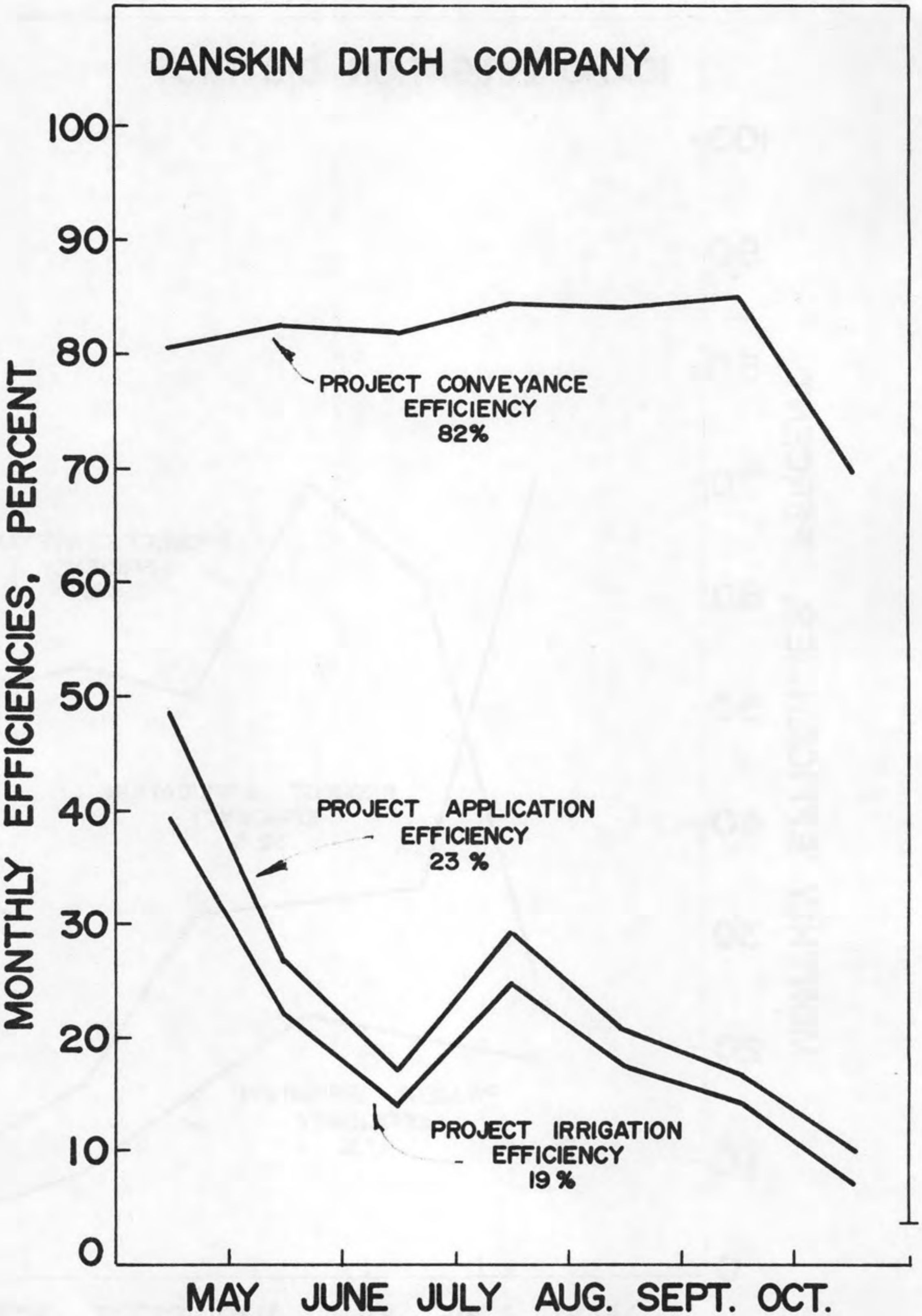

ENTERPRISE IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 80%
PROJECT APPLICATION EFFICIENCY 55%
PROJECT IRRIGATION EFFICIENCY 44%
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

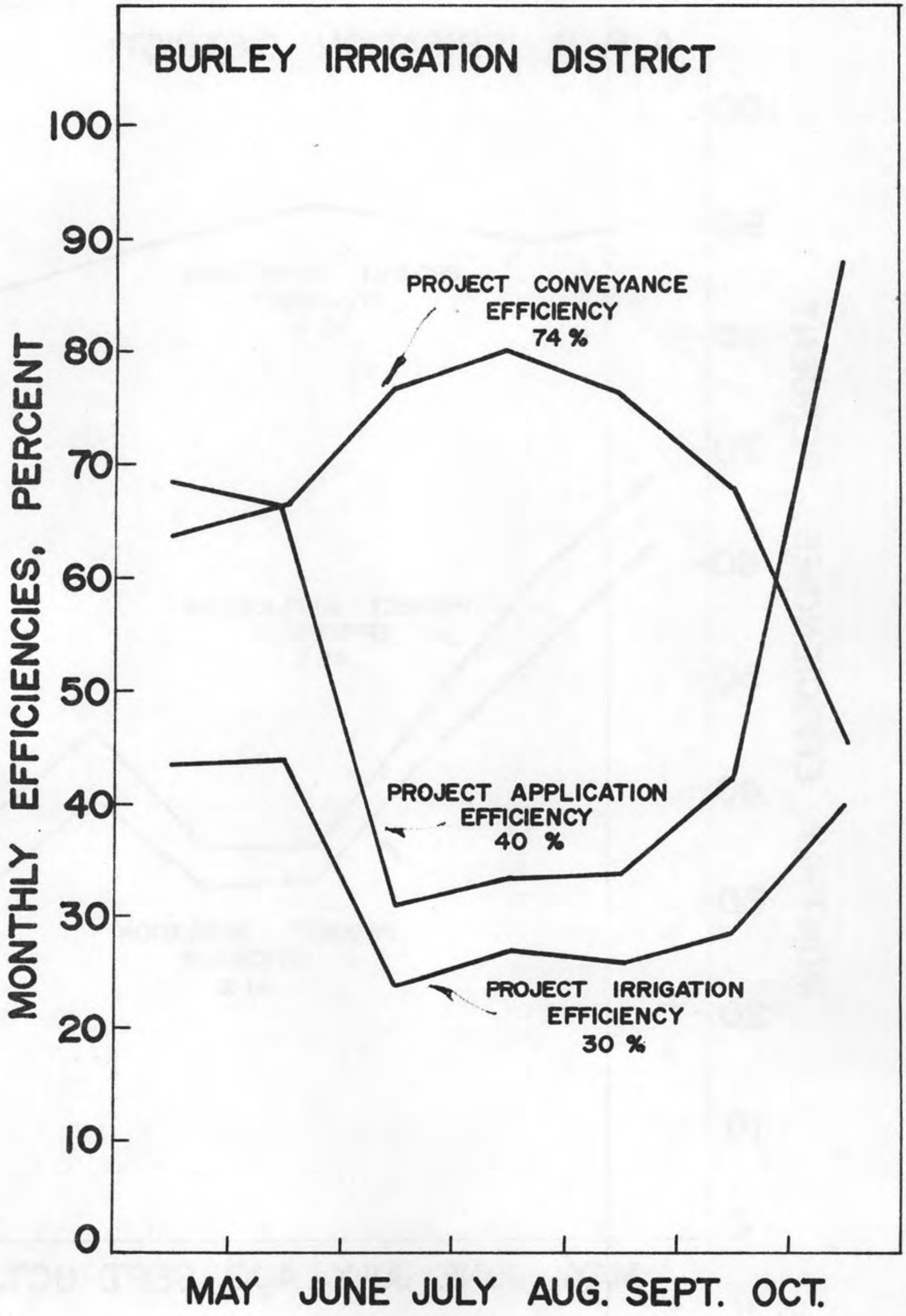


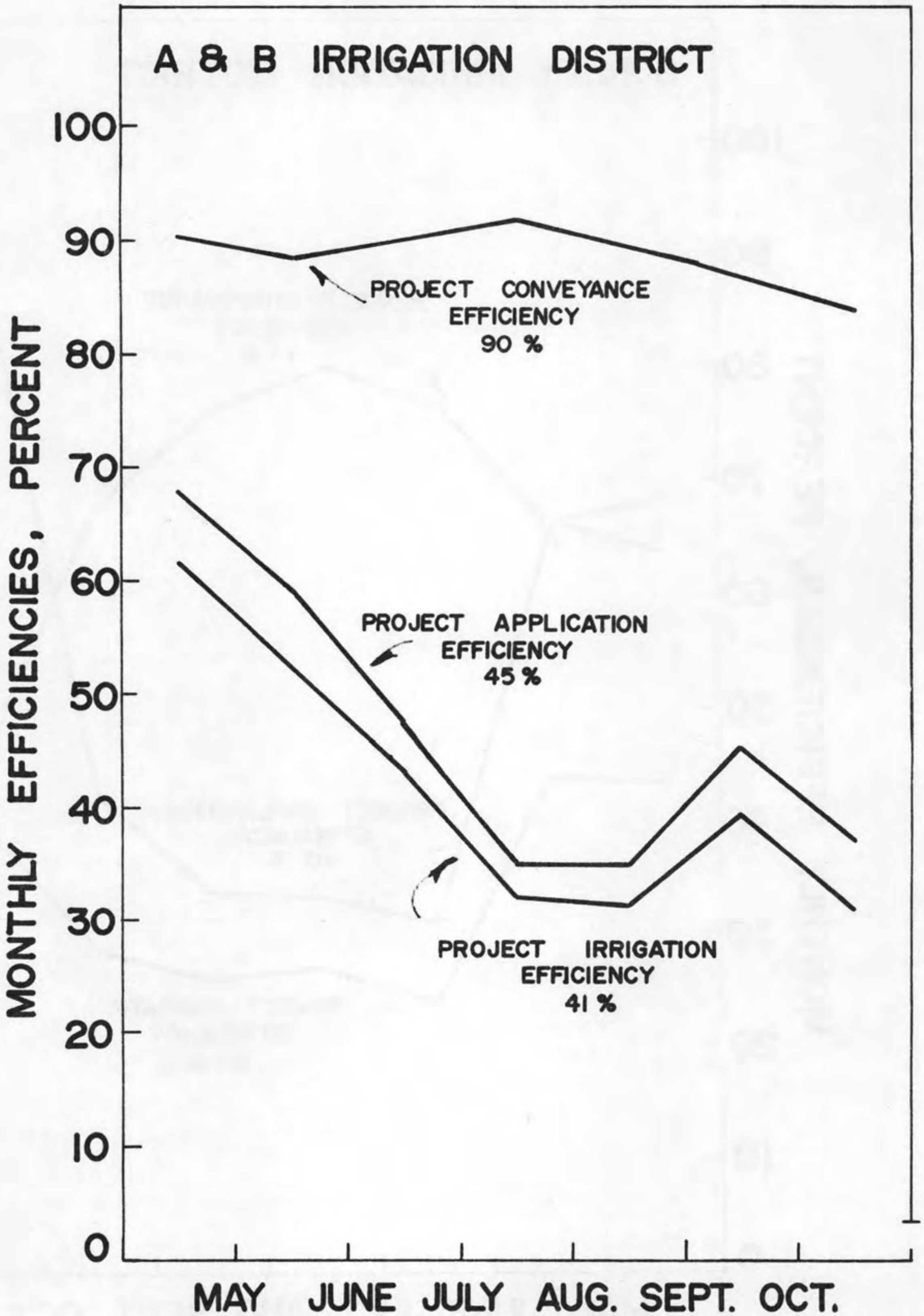
PARKS & LEWISVILLE IRRIGATION COMPANY INC.
100
90
80
70
60
50
40
30
20
10
0
MONTHLY EFFICIENCIES, PERCENT
PROJECT CONVEYANCE EFFICIENCY 50 %
PROJECT APPLICATION EFFICIENCY 25 %
PROJECT IRRIGATION EFFICIENCY 12 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

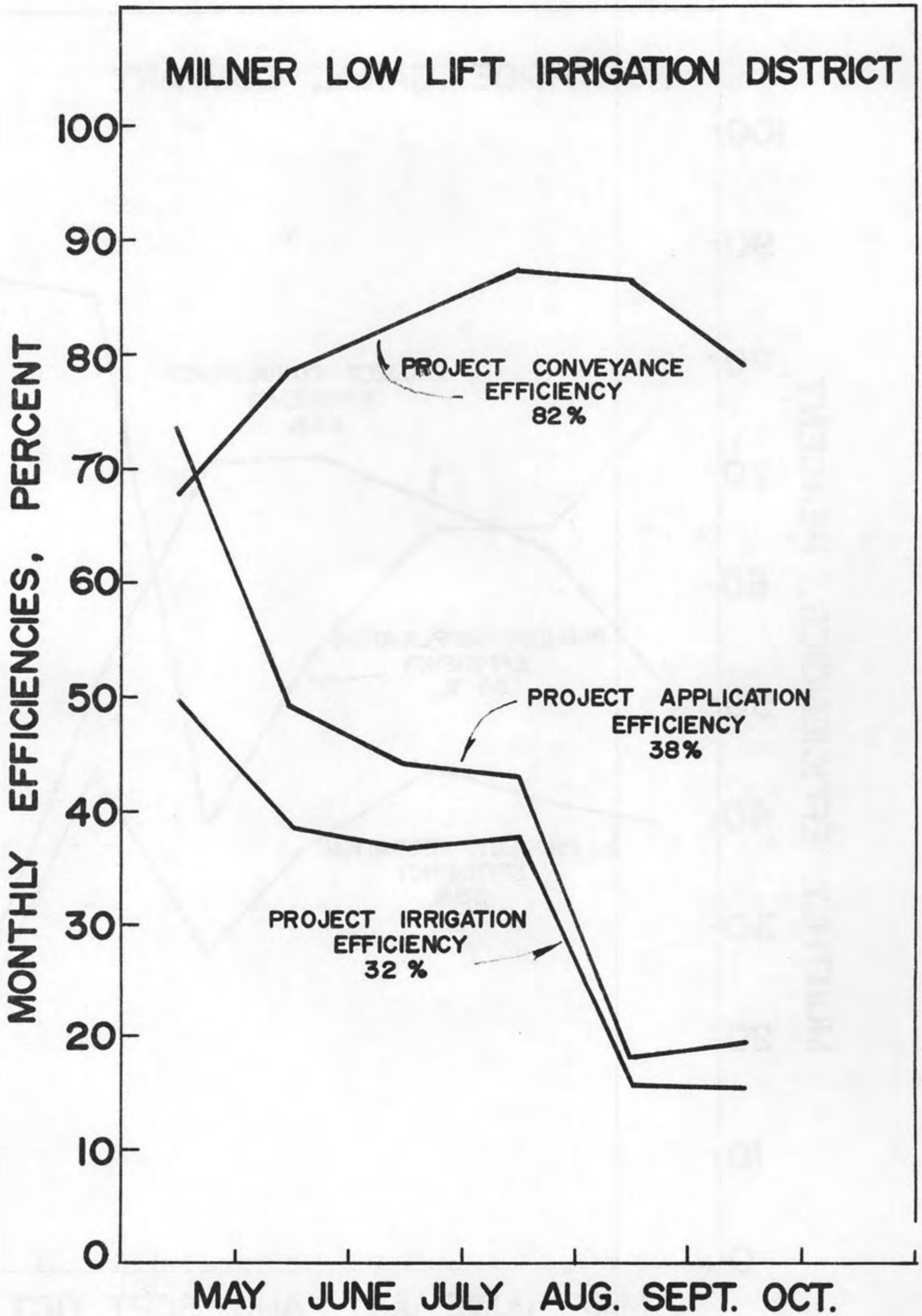

OSGOOD CANAL COMPANY
(U & I SUGAR CO.)
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
PROJECT CONVEYANCE EFFICIENCY 79%
PROJECT APPLICATION EFFICIENCY 67%
PROJECT IRRIGATION EFFICIENCY 53%

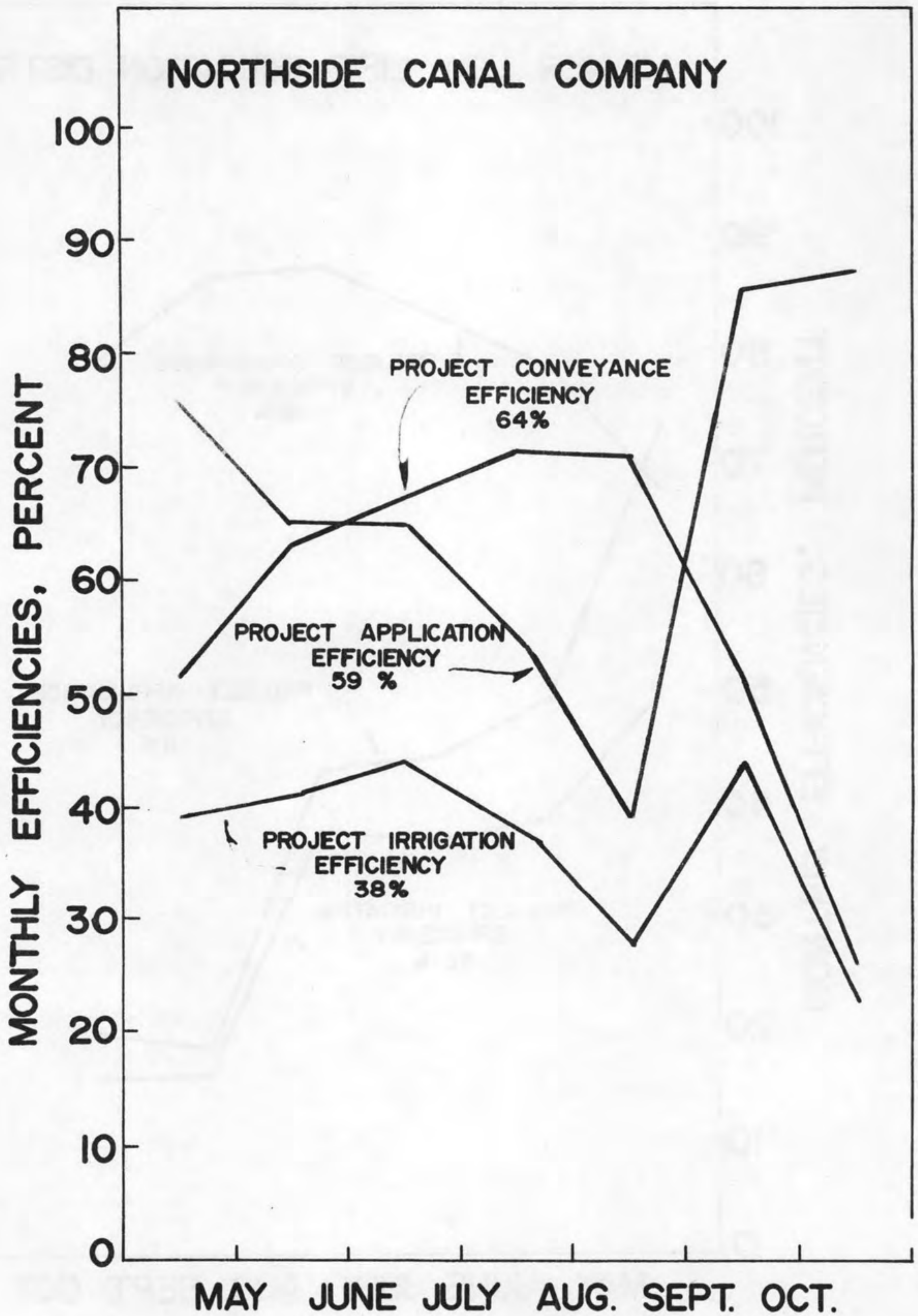

IDAHO IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 54 %
PROJECT APPLICATION EFFICIENCY 32 %
PROJECT IRRIGATION EFFICIENCY 17 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

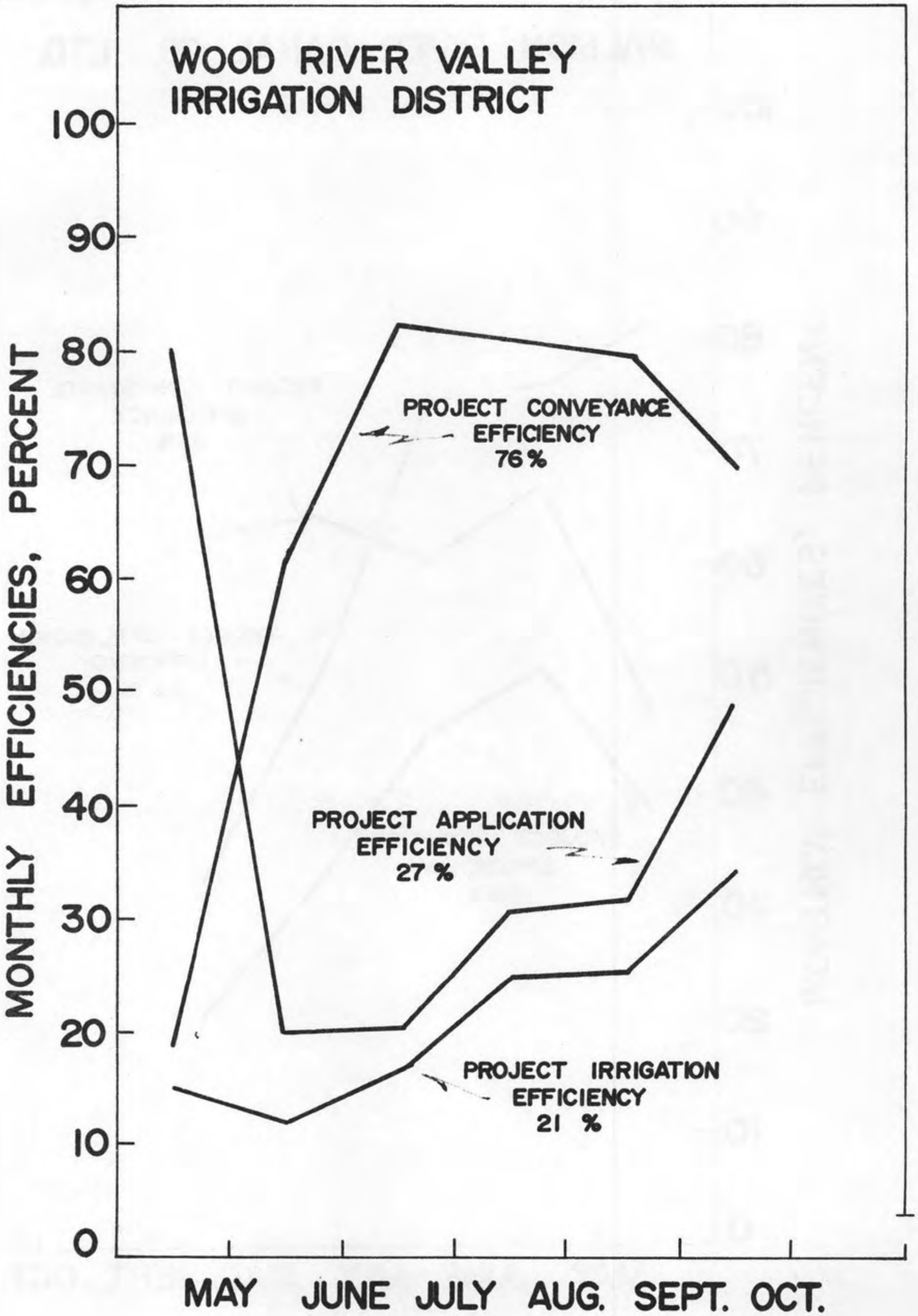

DANSKIN DITCH COMPANY
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 82%
PROJECT APPLICATION EFFICIENCY 23 %
PROJECT IRRIGATION EFFICIENCY 19 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

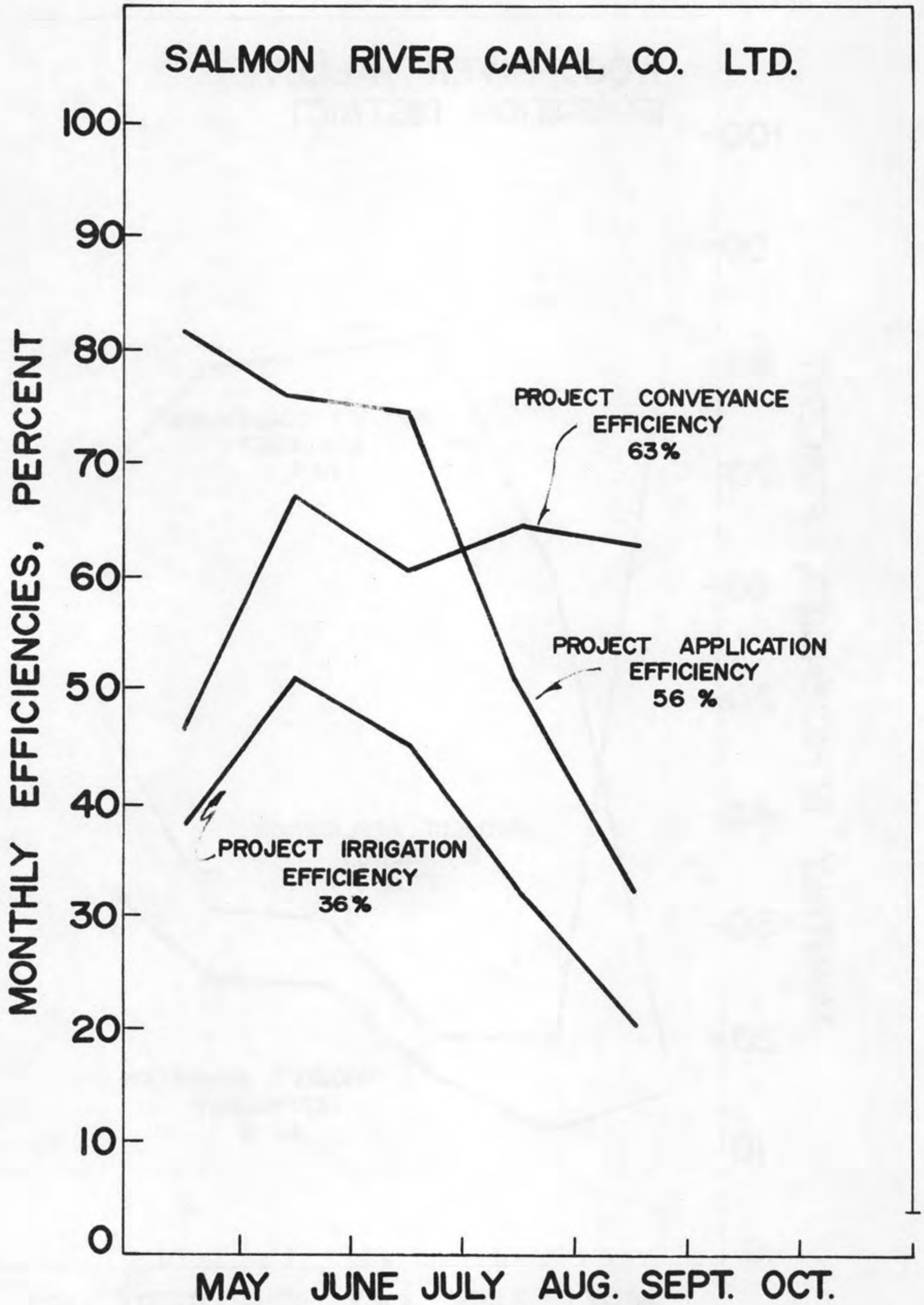

BURLEY IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 74 %
PROJECT APPLICATION EFFICIENCY 40 %
PROJECT IRRIGATION EFFICIENCY 30 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

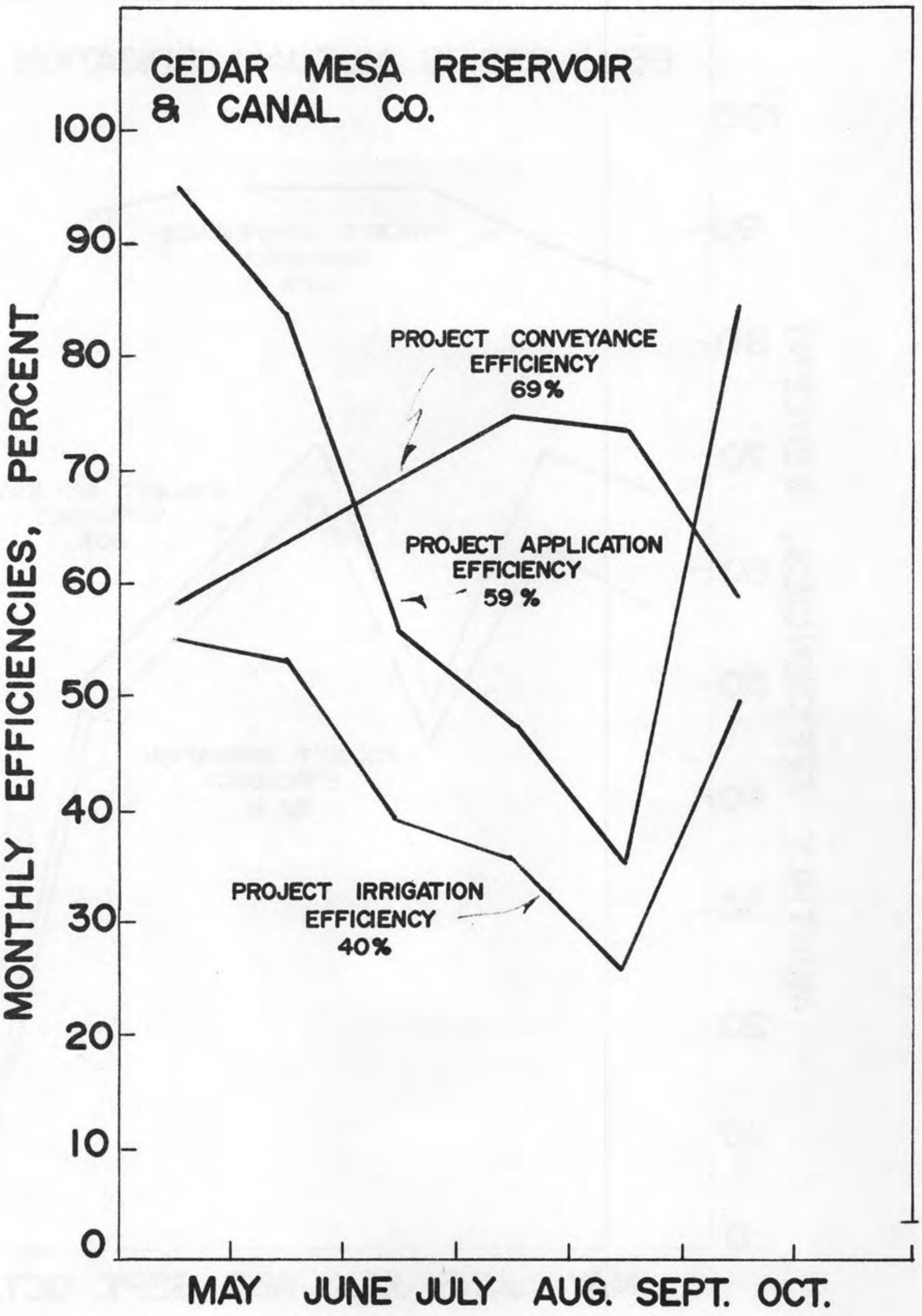

A & B IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 90 %
PROJECT APPLICATION EFFICIENCY 45 %
PROJECT IRRIGATION EFFICIENCY 41 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


MILNER LOW LIFT IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 82%
PROJECT APPLICATION EFFICIENCY 38%
PROJECT IRRIGATION EFFICIENCY 32 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

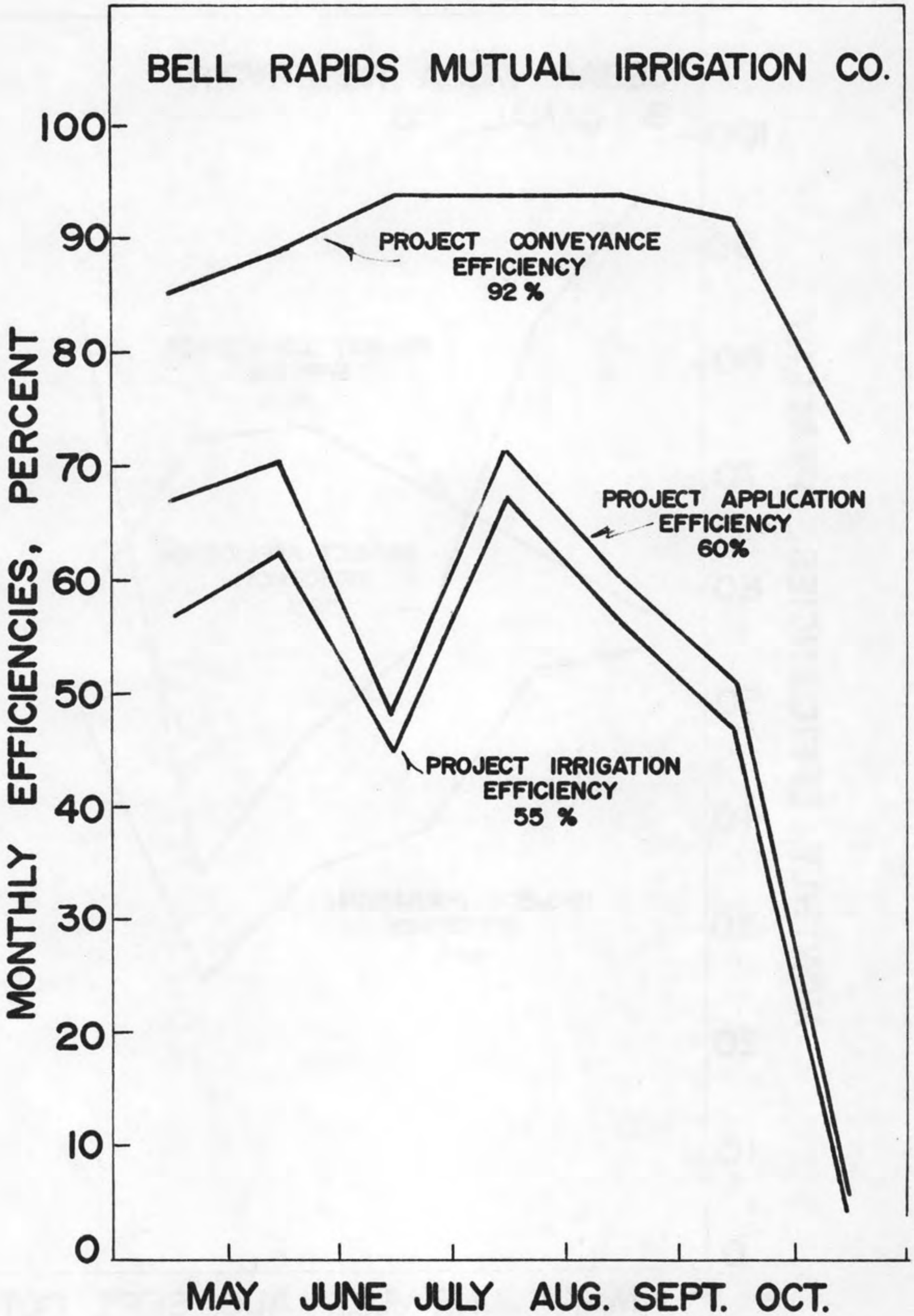

NORTHSIDE CANAL COMPANY
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 64%
PROJECT APPLICATION EFFICIENCY 59 %
PROJECT IRRIGATION EFFICIENCY 38%
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

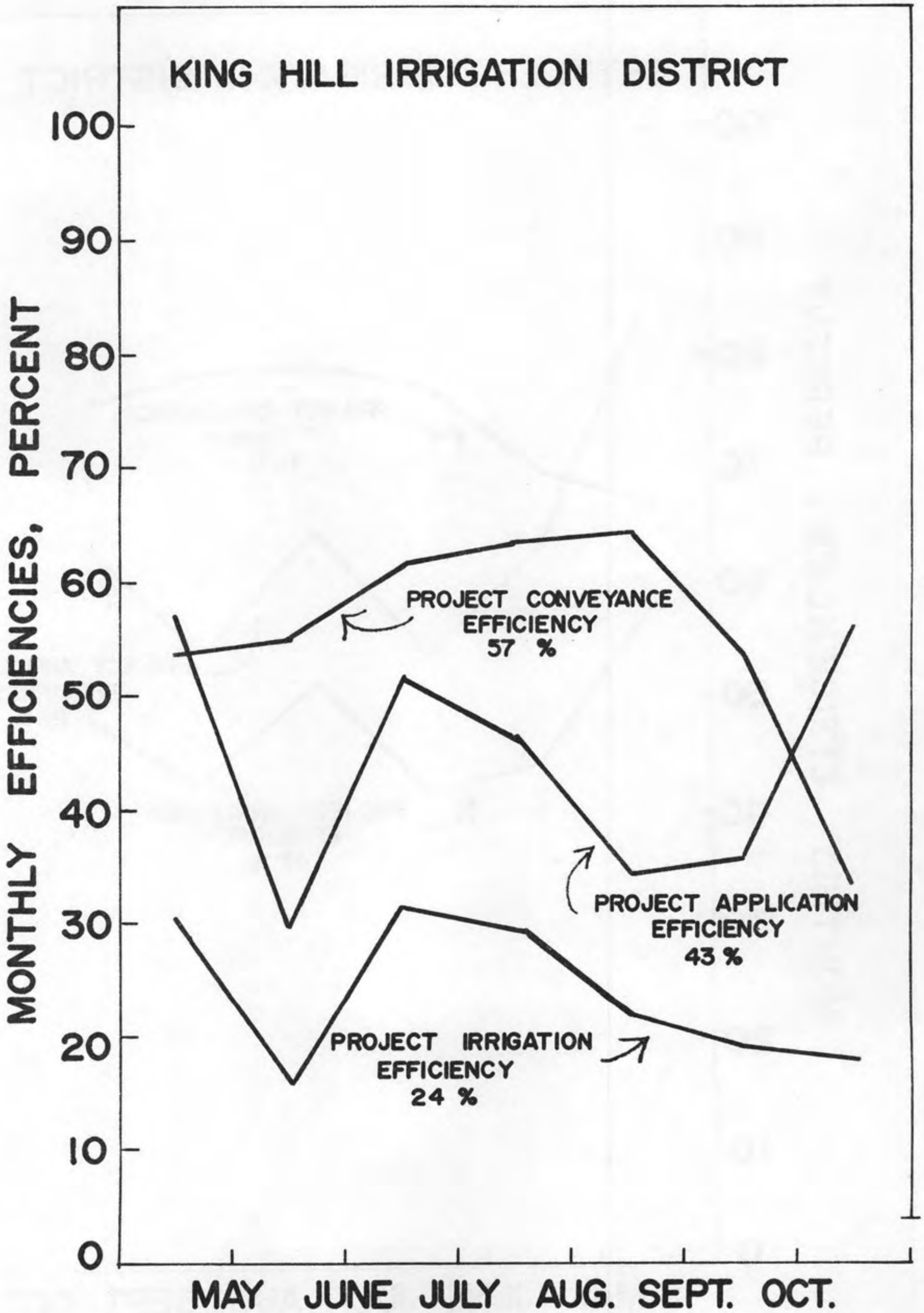

WOOD RIVER VALLEY
IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE
EFFICIENCY
76%
PROJECT APPLICATION
EFFICIENCY
27 %
PROJECT IRRIGATION
EFFICIENCY
21 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

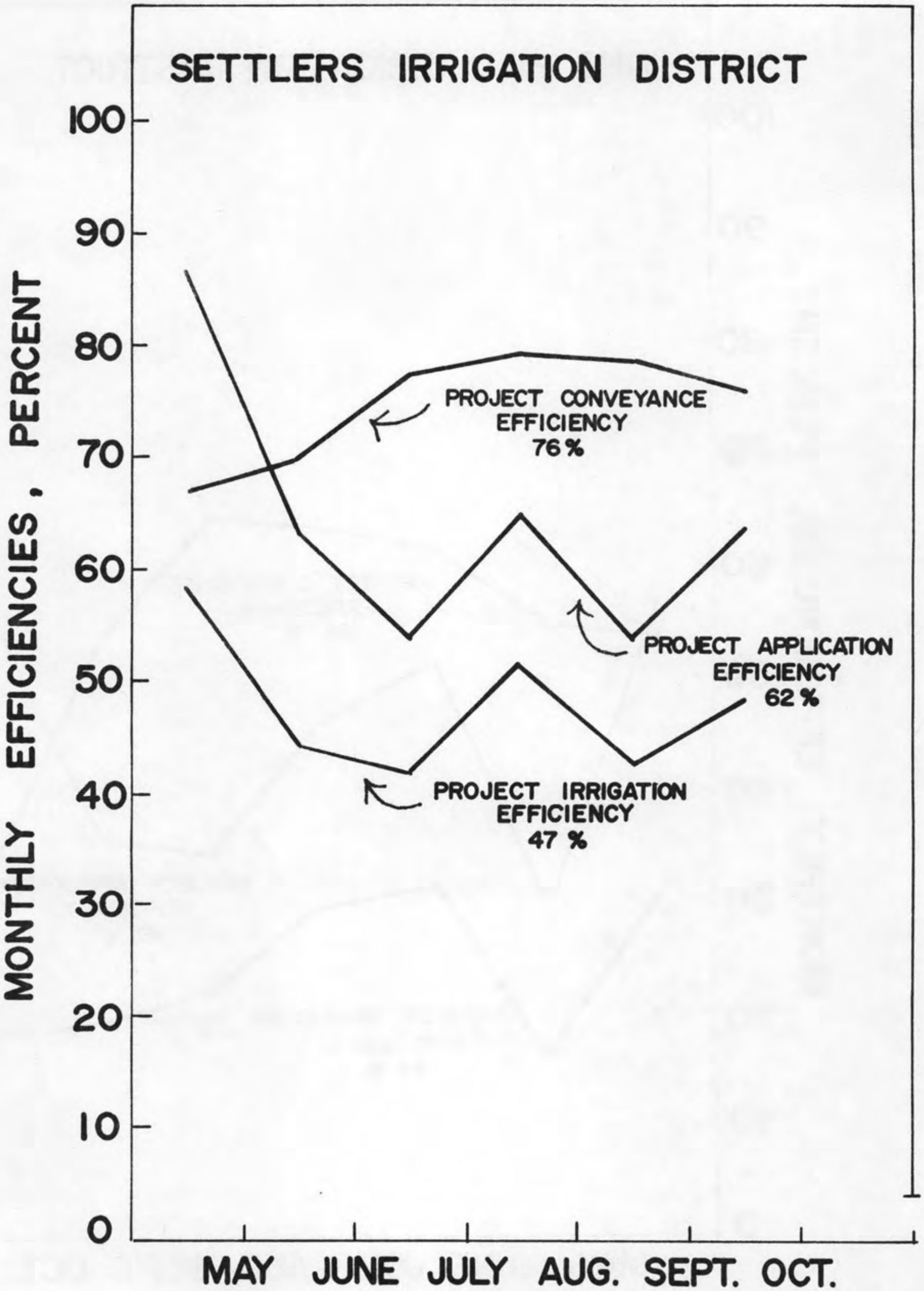

SALMON RIVER CANAL CO. LTD.
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 63%
PROJECT APPLICATION EFFICIENCY 56 %
PROJECT IRRIGATION EFFICIENCY 36%
MAY
JUNE
JULY
AUG.
SEPT.
OCT.



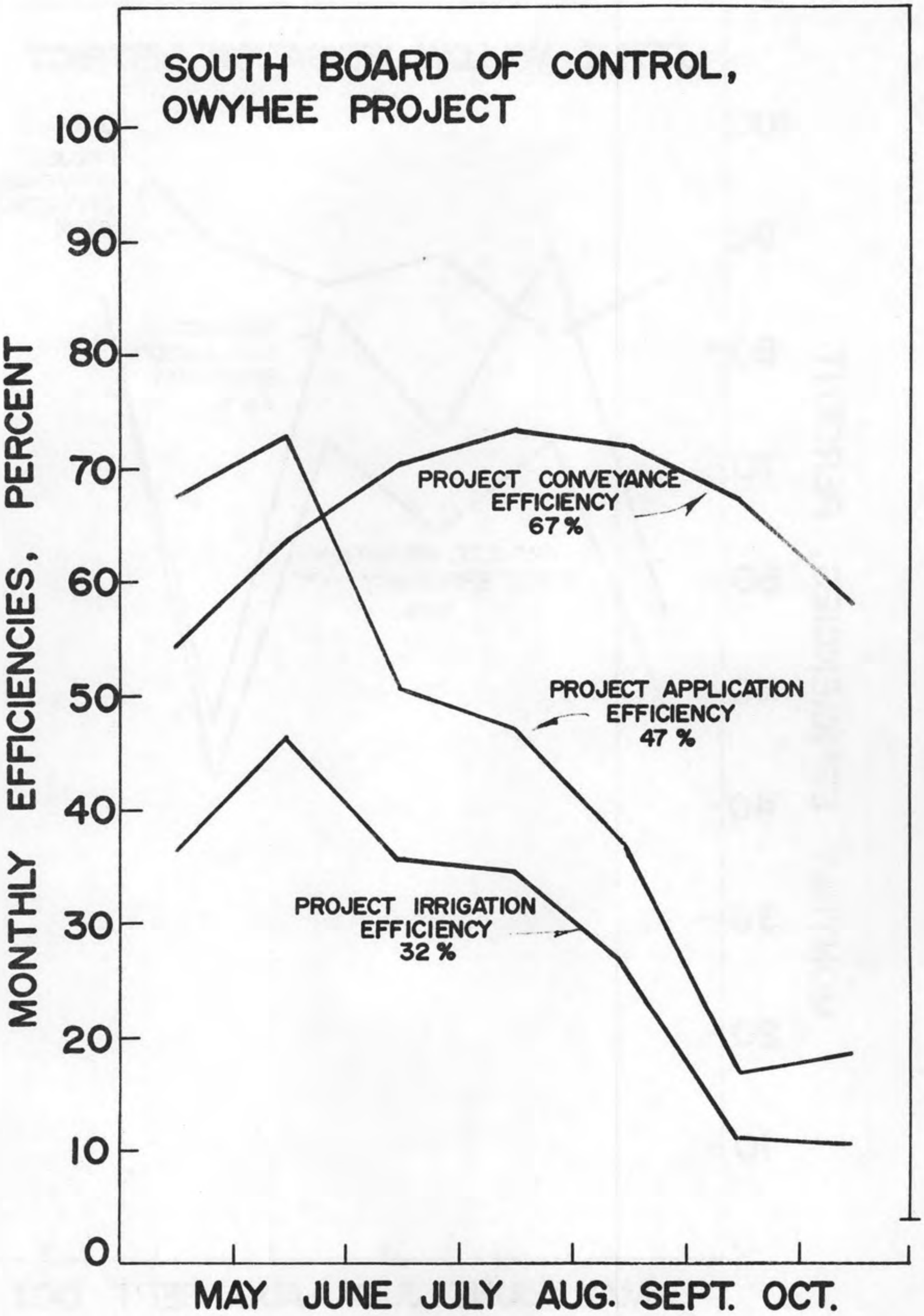
CEDAR MESA RESERVOIR
& CANAL CO.
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE
EFFICIENCY
69%
PROJECT APPLICATION
EFFICIENCY
59 %
PROJECT IRRIGATION
EFFICIENCY
40%
MAY
JUNE
JULY
AUG.
SEPT.
OCT.


BELL RAPIDS MUTUAL IRRIGATION CO.
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 92 %
PROJECT APPLICATION EFFICIENCY 60%
PROJECT IRRIGATION EFFICIENCY 55 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.

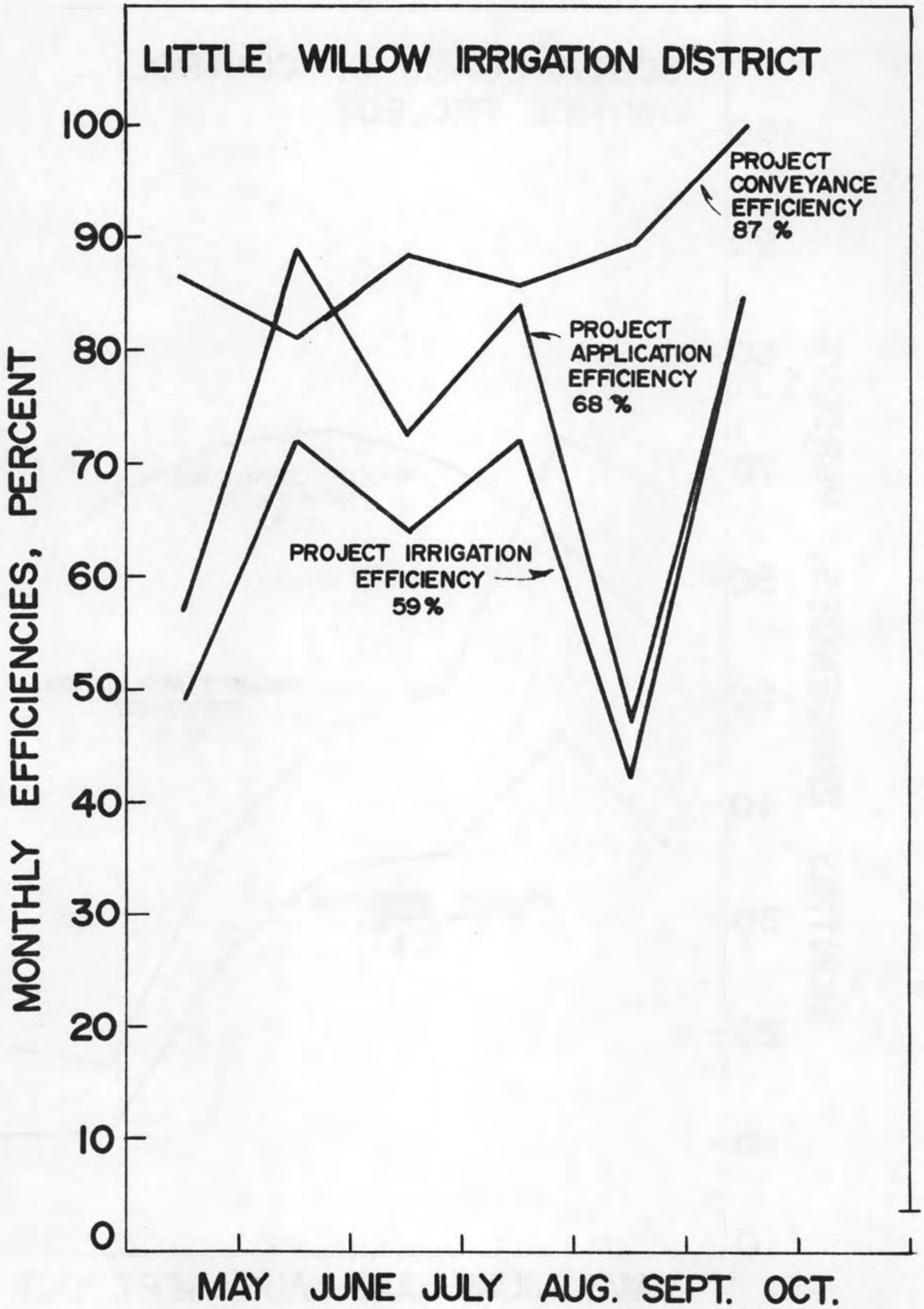

KING HILL IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 57 %
PROJECT APPLICATION EFFICIENCY 43 %
PROJECT IRRIGATION EFFICIENCY 24 %
MAY
JUNE
JULY
AUG.
SEPT.
OCT.



SETTLERS IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
PROJECT CONVEYANCE EFFICIENCY 76%
PROJECT APPLICATION EFFICIENCY 62%
PROJECT IRRIGATION EFFICIENCY 47%
MAY
JUNE
JULY
AUG.
SEPT.
OCT.



SOUTH BOARD OF CONTROL, OWYHEE PROJECT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
PROJECT CONVEYANCE EFFICIENCY 67%
PROJECT APPLICATION EFFICIENCY 47%
PROJECT IRRIGATION EFFICIENCY 32%


LITTLE WILLOW IRRIGATION DISTRICT
MONTHLY EFFICIENCIES, PERCENT
100
90
80
70
60
50
40
30
20
10
0
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
PROJECT CONVEYANCE EFFICIENCY 87 %
PROJECT APPLICATION EFFICIENCY 68 %
PROJECT IRRIGATION EFFICIENCY 59 %

APPENDIX G

Project Parameters, Costs, and Water Use Variables Used in Statistical Analysis

1	1977	Irrigated area, acres
2		Project distribution system length, miles
3		Water users > 20 acres
4		System turnouts
5		Irrigated acres/mile of system
6	1977	Inflow, af
7	1977	Canal seepage, af
8	1977	Operational losses, af
9	1977	Farm deliveries, af
10	1977	Effective precipitation, af
11	1977	Farm runoff in return flow, af
12	1977	Farm deep percolation, af
13	1977	Evapotranspiration, af
14	1977	Irrigation requirement, af
15	1977	Project return flow, af
16	1977	Groundwater pumped, af
17	1977	Inflow, af/A
18	1977	Canal seepage, af/A
19	1977	Operational losses, af/A
20	1977	Farm deliveries, af/A
21	1977	Effective precipitation, af/A
22	1977	Farm runoff in return flow, af/A
23	1977	Deep percolation, af/A
24	1977	Evapotranspiration, af/A
25	1977	Irrigation requirement, af/A
26	1977	Return flow, af/A
27	1977	Groundwater pumped, af/A
28	1977	Canal seepage, % inflow
29	1977	Operational losses, % inflow
30	1977	Farm deliveries, % inflow
31	1977	Effective precipitation, % inflow
32	1977	Farm runoff, % inflow
33	1977	Deep percolation, % inflow
34	1977	Evapotranspiration, % inflow
35	1977	Irrigation requirement, % inflow
36	1977	Return flow, % inflow
37	1977	Groundwater pumped, % inflow
38	1977	Effective precipitation % inflow farm deliveries
39	1977	Farm runoff, % farm deliveries
40	1977	Deep percolation, % farm deliveries
41	1977	Evapotranspiration, % farm deliveries
42	1977	Irrigation requirement, % farm deliveries
43	1977	Return flow, % farm deliveries
44	1977	Project conveyance efficiency, %

45	1977	Project application efficiency, %
46	1977	Project irrigation efficiency, %
47	1977	Project O & M assessment, $
48	1977	Project O & M assessment, $/irrigated acre
49		Project administration costs
50		Project water control costs, $
51		Project maintenance costs, $
52	1977	Project power costs, $
53	1977	Project reservoir O & M costs, $
54		Project O & M costs, $
55		Project costs, $
56	Total	System costs, $
57		Project administration costs, % system costs
58		Project water control costs, % system costs
59		Project maintenance costs, % system costs
60	1977	Project power costs, % system costs
61	1977	Project reservoir O & M costs, % system costs
62		Project O & M costs, % total system costs
63	Total	Project costs, % total system costs
64		Project administrative costs, % O & M costs
65		Project water control costs, % O & M costs
66		Project maintenance costs, % O & M costs
67		Project administrative costs, $/acre
68		Project water control costs, $/acre
69		Project maintenance costs, $/acre
70	1977	Project power costs, $/acre
71	1977	Project reservoir costs, $/acre
72		Project O & M costs, $/acre
73	Total	Project costs, $/acre
74	Total	System costs, $/acre
75		Project administration costs, $/mile
76		Project water control costs, $/mile
77		Project maintenance costs, $/mile
78	1977	Project power costs, $/mile
79	1977	Project reservoir costs, $/mile
80		Project O & M costs, $/mile
81	Total	Project costs, $/mile
82	Total	system costs, $/mile
83		Project administrative costs, $/user
84		Project water control costs $/user
85		Project maintenance costs, $/user
86	1977	Project power costs, $/user
87	1977	Project reservoir costs, $/user
88		Project O & M costs, $/user
89	Total	Project costs, $/user
90	Total	System costs, $/user
91		Project admistration costs, $/acrefoot
92		Project water control costs, $/af
93		Project maintenance costs, $/af
94	1977	Project power costs, $/af
95	1977	Project reservoir costs, $/af
96		Project O & M costs $/af
97	Total	Project costs, $/af
98	Total	System costs, $/af

99		Administrative personnel costs, $
100		Water control personnel costs, $
101		Maintenance perosnnel costs, $
102	Total	Personnel costs, $
103		Administrative personnel costs, % total personnel
104		Water control personnel costs,% TPC
105		Maintenance personnel costs % TPC
106	Total	Personnel costs, % Project O & M costs
107	Total	Personnel costs, % total system costs
108		Administrative personnel costs, $/acre
109		Water control personnel costs, $/acre
110		Maintenance personnel costs, $/acre
111		Total personnel costs, $/acre
112		Administrative personnel requirement, man-years
113		Water control personnel requirement, man-years
114		Maintenance personnel requirement, man-years
115		Total personnel requirement, man-years
116		Administrative personnel requirement man-years/acre
117		Water control personnel requirement, my/acre
118		Maintenance personnel requirement my/acre
119		Total personnel requirement, my/acre
120		Administrative personnel requirement, my/mile
121		Water control personnel requirement, my/mile
122		Maintenance personnel requirement, my/mile
123		Total personnel requirement, my/mile
124		Administrative personnel requirement, my/user
125		Water control personnel requirement, my/user
126		Maintenance personnel requirement, my/user
127		Total personnel requirement, my/user
128		1977 Project electrical power consumption, kwh
129		1977 Project electrical power consumption, kwh/acre
130	1977	Project electrical power consumption kwh/mile
131	1977	Project electrical power consumption kwh/user
132	1977	Project electrical power costs, $/kwh
133		Maintenance material costs (Inc. weed control)
134		Maintenance material costs, $/a
135		Maintenance material costs, $/mile
136		Maintenance material costs, % Total O & M costs
137		Project equipment depreciation, $
138		Project equipment depreciation, $/a
139		Project equipment depreciation, $/mile
140		Other equipment and vehicle depreciation, $
141		Total equipment depreciation, $
142		Total equipment depreciation, $/a
143		Total equipment depreciation, $/mile
144	1977	Total crop value, $\$X10^6$
145	1977	Average Crop Value, $/a
146		System Turnouts, #/a
147		System Turnouts, #/mile
148		System Turnouts, % measured
149		System Turnouts, % Checked daily
150		Number of project ditchriders
151		Irrigated area served by ditchrider, A/dr

152 System length served by ditchrider, miles/dr
153 System turnouts served by ditchrider, T.O./dr
154 Daily distance driven by ditchrider, miles/day
155 Percent of system-open-channel, %
156 Percent of system-lined-open channel
157 Percent of system-pipe, %
158 Percent of system-lined channel+Pipe, %
159 Percent of water delivered at high pressure, %
160 Percent of high pressure water pressurized by project system %
161 Percent of high pressure water pressurized on the farm, %
162 Surface/gravity application systems, % total
163 Sprinkler application systems, % total
164 Project perimeter, miles
165 Project compactness ratio
166 Maximum project elevation, feet
167 Elevation differential, feet
168 Elevation differential, feet/acre
169 Elevation Differential, feet/mile of system
170 Average project farm size, acres
171 Average terrain code
172 Average soil type code
173 Average soil depth, inches
174 Average water holding capacity, inches/foot
175 Water delivery type code
176 Earliest flow right, date
177 Average flow right (weighted), date
178 Total flow right, cfs
179 Total flow right, cfs/a
180 Total flow right, cfs/af of 1977 inflow
181 Storage right, af
182 Storage right, af/A
183 Storage right, AF of 1977 inflow
184 Project origin (Federal vs non-Federal) code
185 # Production irrigation wells operated by project
186 1977 Abailable reservoir storage, af
187 1977 Available reservoir storage af/A
188 1977 Available reservoir storage, af/af of 1977 inflow
189 Average salary of district personnel, $/man-year
190 1977 Potato acreage, % total
191 1977 Alfalfa acreage, % total
192 1977 Grain acreage, % total
193 1977 Alfalfa + Grain acreage, % total
194 Canal wetted area, acre
195 Canal Maximum seepage rate, acre-feet/day
196 Average canal maximum seepage rate, cubic feet/sq foot/day
197 Irrigated area per canal wetted area
198 Available 1977 reservoir storage/reservoir storage right, %
199 Users/ditchriders
200 Personnel costs/mile
201 1977 crop value/acre-foot of inflow
202 1977 crop value/acre-foot of evapotranspiration
203 1977 assessed area,acre
204 1977 irrigated area/assessed area, acres.

205 Daily ditchrider mileage/miles of system per
206 Maximum conveyance capacity, cfs
207 Maximum conveyance capacity, cfs/acre
208 Total number of pumps operated by pr
209 Total irrigated area/pump, A/pump
210 Total project pump horsepower,
211 Total project pump horsepower
212 Total water supply pumped b
213 Total water supply route
% total inflow

APPENDIX H

UNITED STATES BUREAU OF RECLAMATION

RATION AND MAINTENANCE COST INDEX[1]

1956 = 1.00

Index
1.00
1.00
1.04
.07

1958	
1959	[illegible]
1960	1.09
1961	1.10
1962	1.12
1963	1.11
1964	1.14
1965	1.15
1966	1.18
1967	1.22
1968	1.27
1969	1.30
1970	1.38
1971	1.43
1972	1.49
1973	1.55
1974	1.63
1975	1.75
1976	1.92
1977	2.09

Corresponding index numbers with a base year other than 1956 may be obtained by use of a simple ratio. For example, new index numbers with a base 1967 = 1.00 may be obtained by multiplying the index numbers listed above by the ratio $\frac{1}{1.22}$.

[1] from "Irrigation Operation and Maintenance trends" United States Department of the Interior, Bureau of Reclamation. Engineering and Research Center, Division of Water Operation and Maintenance, Denver, Colorado, July, 1978.

205 Daily ditchrider mileage/miles of system per ditchrider, %
206 Maximum conveyance capacity, cfs
207 Maximum conveyance capacity, cfs/acre
208 Total number of pumps operated by project
209 Total irrigated area/pump, A/pump
210 Total project pump horsepower, hp
211 Total project pump horsepower/acre, hp/A
212 Total water supply pumped by project, % total inlfow
213 Total water supply routed through project or private pumps, % total inflow

APPENDIX H

UNITED STATES BUREAU OF RECLAMATION

IRRIGATION OPERATION AND MAINTENANCE COST INDEX[1]
1956 = 1.00

Year	Index
1956	1.00
1957	1.00
1958	1.04
1959	1.07
1960	1.09
1961	1.10
1962	1.12
1963	1.11
1964	1.14
1965	1.15
1966	1.18
1967	1.22
1968	1.27
1969	1.30
1970	1.38
1971	1.43
1972	1.49
1973	1.55
1974	1.63
1975	1.75
1976	1.92
1977	2.09

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[1] from "Irrigation Operation and Maintenance trends" United States Department of the Interior, Bureau of Reclamation. Engineering and Research Center, Division of Water Operation and Maintenance, Denver, Colorado, July, 1978.

[illegible]

[illegible]

[illegible]

19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]
19[illegible]

Corresponding labor [illegible] 1950 [illegible] [illegible] [illegible]

[illegible]