WATER OPERATION AND MAINTENANCE

BULLETIN NO. 134

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UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water supply systems. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It it hoped that the reports herein concerning laborsaving devices and less costly equipment and procedures will result in improved efficiency and reduced costs of the systems for those operators adapting these ideas to their needs.

To assure proper recognition of those individuals whose suggestions are published in the bulletins, the suggestion number as well as the person's name is given. All Bureau offices are reminded to notify their Suggestions Award Committee when a suggestion is adopted.

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Cover photograph:

Original Strawberry Dam and Spillway constructed in 1912.

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INTRODUCTION

The article on page 1 details the equalization of the reservoir created by Soldier Creek Dam (Soldier Creek Reservoir) and Strawberry Reservoir, which was necessary prior to the breaching of Strawberry Dam.

One possible use for a scrap rubber seal is the subject of the short article on page 9.

The article on page 10 shows how irrigators in Caddo County, Oklahoma, are getting some engineering help and economic consideration, which may make their pumping dollars go further and cut the demand for electricity at the same time.

See the article on page 15, which shows that even though costs vary widely for the 1985 irrigation season, according to which of the four kinds of energy is being used for center-pivot or gated-pipe irrigation, natural gas is still the cheapest for irrigation pumping.

Periodically the O&M Bulletin will be featuring digest statements of O&M incidents experienced. The first digest statement featured begins on page 17.

THE EQUALIZATION OF STRAWBERRY AND SOLDIER CREEK RESERVOIRS
BONNEVILLE UNIT
CENTRAL UTAH PROJECT

By Ray Moore[1]

Introduction

The Strawberry Valley Project, authorized in 1905, was one of the earliest projects built by the Bureau of Reclamation. It provided the first large scale diversion of water from the Colorado River Basin to the Bonneville Basin through the 3.8-mile Strawberry Tunnel and was one of the first Bureau of Reclamation projects to produce hydroelectric power.[2] Project features included Strawberry Dam and Reservoir, Indian Creek Dike, Strawberry Tunnel, Upper Spanish Fork Powerplant, and numerous canals. Project lands totaled approximately 45,000 acres in the Spanish Fork, Utah area.

Plans to enlarge Strawberry Reservoir to form the major storage facility for the Bonneville Unit of the Central Utah Project included the construction of Soldier Creek Dam and the breaching of Strawberry Dam and Indian Creek Dike. Soldier Creek Dam, located 7 miles downstream from Strawberry Dam, was completed in 1974.

The equalization of the reservoir created by Soldier Creek Dam (Soldier Creek Reservoir) and Strawberry Reservoir was necessary prior to the breaching of Strawberry Dam. The equalization was the only way to assure that filling criteria for Soldier Creek Dam could be met. The simplest way to equalize the reservoirs was through the sluicing tunnel at Strawberry Dam which connected the two reservoirs. The sluice gates in the tunnel, however, had not been opened since 1912. The tunnel's only useful function had been in diverting the Strawberry River around the dam during construction.

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[1] This article was written by Ray Moore, Civil Engineer, Uinta Basin Construction Office. Further information can be obtained by writing to Mr. Moore, Uinta Basin Construction Office, P O Box 420, Duchesne UT 84021.
[2] This information was extracted from *Project Data*, Water and Power Resources Service, United States Government Printing Office, 1981.

Aerial view of Strawberry Dam looking southwest. Soldier Creek Reservoir is to the left of Strawberry Dam in this photograph.

During World War II the outlet portal of the sluicing tunnel was covered with soil to prevent unauthorized entry. This earth cover was removed on July 15, 1974, so that an inspection team could enter the tunnel. The inspection report stated that the downstream face of the sluice gates and the tunnel downstream from the gates were in "remarkable condition".[3] The portal was again covered with earth after the inspection for safety reasons.

The Lower Colorado Regional dive team inspected the inlet portal and the upstream face of the gates in the summer of 1975. Although visibility was poor, the divers were able to determine that the mechanical components of the sluice gates were sound.

In November of 1983, the sluice gates and gate stems were again inspected by the Lower Colorado Regional dive team. This time an underwater video camera was lowered by ropes along each gate stem. The camera produced a video recording of the condition of the stems, guides, and couplings. Visibility was maintained at the highest level possible by keeping movement in the water at a minimum. Divers also inspected the stems and gates by feel. Again the inspection indicated that all components were sound.

The project team met on the day following the dive and recommended that Bureau of Reclamation personnel attempt to raise the gates. The equalization was scheduled to begin in the fall of 1984.

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[3] From the report, "Condition of Major Water System Structures and Facilities–Upper Colorado Region–1974" by W. W. Daehn and D. M. Evans, Bureau of Reclamation, 1975.

Removing earth cover at the Strawberry Dam sluice tunnel outlet portal for inspection of the sluice gates.

North gate (right), south gate (left), and divider as seen from downstream after water had been drained from tunnel.

Preparation to Raise the Sluice Gates

Bureau of Reclamation personnel removed the earth cover on the outlet portal in March of 1984 to assure an open conduit between the reservoirs during the equalization. Heavy spring runoff in 1983 had raised the water level in Soldier Creek Reservoir 25 feet above the top of the outlet portal. Eight months were required to lower the water to a level where available equipment could reach the portal. A small backhoe was airlifted to the site by helicopter. Personnel were transported to the site in "over-snow" vehicles. The entire process of moving equipment in and out and removing the earth cover required 4 days. The work was completed before the spring runoff again inundated the outlet portal.

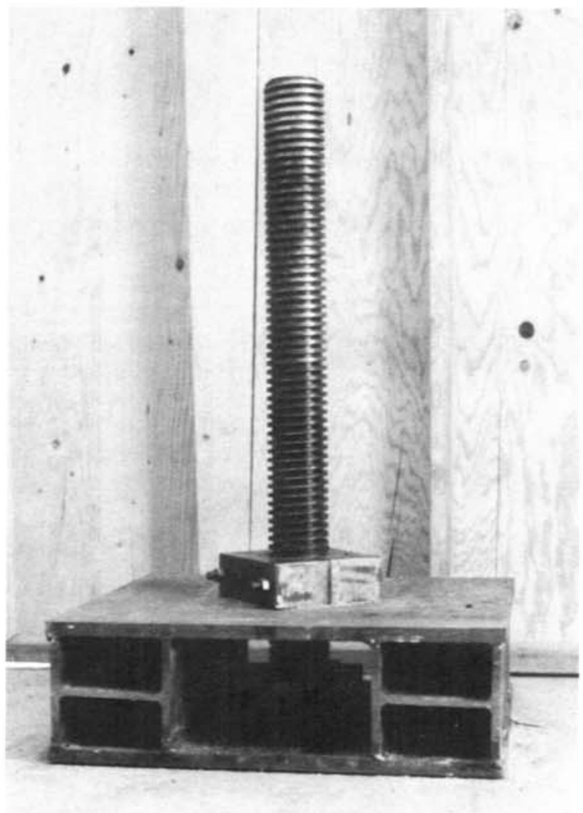
The original cast iron gate hoists, although in excellent condition, were not used to raise the sluice gates. Hollow-center hydraulic cylinders on loan from the Engineering and Research Center in Denver, Colorado, were used in place of the original hoists. The hydraulic cylinders had the advantage of applying a simple tension load to the gate stems. In addition, a pressure gauge in the hydraulic system would indicate the force applied to the gate stem. An accurate measurement of the force applied to the stems by the original hoists would have been difficult.

The concrete supporting the original hoisting mechanism had spalls up to 2 inches deep and was not considered capable of bearing the loads necessary to raise the gates. The original hoists were dismantled and the weathered concrete removed. Steel reinforced concrete 4 inches thick was then placed on the prepared surface. Steel plate 1/2-inch thick was embedded in the new concrete to level the area around the gate stems.

Original Strawberry Dam sluice gates hoisting mechanism. Note square twisted rebar protruding from weathered concrete.

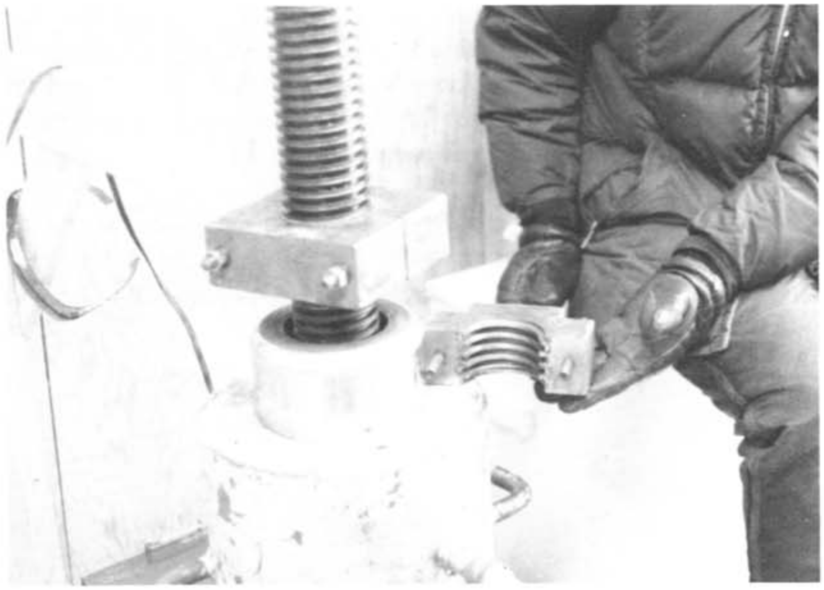
Steel bearing frames were constructed to transfer the load from each cylinder to the concrete at an allowable stress. The bearing frames also provided space to secure the gate stem while the cylinder plunger was lowered during each lift cycle. The frames were constructed of 3/4-inch steel plate and W6 x 25 wide-flange steel sections. The steel plate was sized in the same manner as steel column base plates (American Institute of Steel Construction, design procedure).[4]

Two 3-1/2-inch inside diameter square-threaded split-nuts were machined for each stem. One nut was used to transfer thrust from the hydraulic cylinder to the stem. The other nut was used to secure the stem while the plunger was lowered. The nuts were designed to split in half for ease of installation and removal.



Steel bearing frame centered on 3-1/2-inch diameter threaded bronze gate stem. The lower split nut held the gate stem while the hydraulic cylinder and the upper split nut were lowered.

[4] *Manual of Steel Construction*, American Institute of Steel Construction, Inc., Chicago 1980.



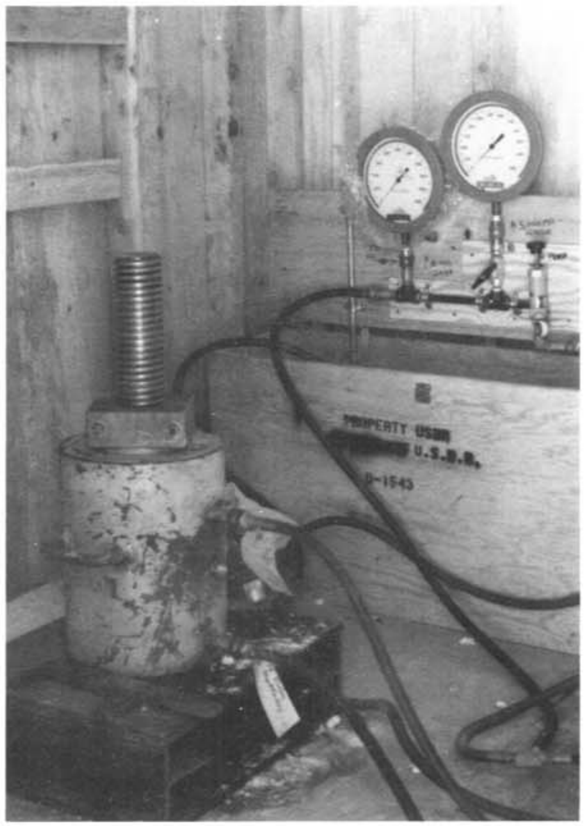
One-half of lower split nut showing threads.

A wooden enclosure was constructed over the hoisting platform to protect the equipment and to provide shelter for personnel during the raising of the sluice gates.

Wooden enclosure over hoisting platform. Note gate stems protruding through roof, both gates were open and water flowing through sluice tunnel.

Raising the Sluice Gates

On the morning of February 4, 1985, hydraulic pressure was applied to the 200-ton hydraulic cylinder on the north gate stem. Pressure was increased slowly, and at approximately 1,600 lb/in^2 (80,000 pounds force) the stem began to move. At the instant the stem moved, the pressure dropped back to around 850 lb/in^2 (42,000 pounds force). The north gate was raised 2 inches and secured. Pressure was then applied to the hydraulic cylinder on the south gate stem, where an almost identical rise and drop in pressure accompanied the initial movement of the stem. The south gate stem was raised 2 inches and secured.



200-ton hydraulic cylinder in place on bearing frame.

By 10 a.m. on February 5, the north gate had been raised 6 inches more; a height equal to the 8-inch lip of the gate frame shown on the "as-built" drawings. A popping noise was heard in the stem and the water in the wet well upstream of the gates dropped 4 inches. The north gate was open and a small quantity of water was flowing through the outlet works. By the end of the day, the north gate was open 4 feet 7 inches, and the south gate was open 2 feet. The water level in the wet well had dropped a total of 4 feet.

On the morning of February 6, a turbulent boil approximately 20 feet in diameter was visible in the water at the outlet portal. The portal was submerged in 30 feet of water. The previous day this area had been covered with ice. By the end of the day, the north gate was open approximately 5 feet 9 inches, and the south gate approximately 5 feet 8 inches. The water level in the wet well had dropped a total of 11 feet. Both gates were within a few inches of the 6-foot full-open position shown on the "as-built" drawings.

Several days later a vortex approximately 1 foot in diameter at the water surface was visible at the inlet portal. The inlet portal was submerged in 50 feet of water.

Equalization – Calculations and Observations

Actual flows through the outlet works closely matched the flows predicted by the Darcy-Weisbach equation. The actual initial flow of 880 ft^3/s was measured by comparing the rise in Soldier Creek Reservoir in a 24-hour period, with Soldier Creek Reservoir capacity curves. The flow predicted by the Darcy-Weisbach equation was 910 ft^3/s. The calculated time to equalize, neglecting stream inflow, was 30 to 40 days. Actual time to equalize within one tenth of a foot was 35 days.

Summary

The successful operation of the Strawberry Dam sluice gates and resulting equalization of Strawberry and Soldier Creek Reservoirs represents a noteworthy event in the history of the Bureau of Reclamation. The serviceable condition of the gates, stems, and guides after 72 years of nonoperation attests to the sound design and conscientious construction of the original Strawberry Valley Project. The difficult and detailed work performed by Bureau of Reclamation personnel to equalize Strawberry and Soldier Creek Reservoirs demonstrates the same kind of conscientious effort.

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SCRAP RUBBER SEAL PUT TO GOOD USE

The photograph below illustrates one possible use for scrap rubber seals, typical of the type used on radial gates. The seal in the photograph serves as weatherstripping for a powerplant doorway and helps cut down on warm or cold air drafts. This seal could also be used on some windows to restrict rodent and bug invasions.

Rubber seals of this type have a long life expectancy.

This information and the photograph for this article were contributed by Gordon Johnston, O&M Specialist, Sacramento, California.

THREE-WAY AID FOR IRRIGATION

By Dan Crummett

Irrigators in the Caddo County area are getting some engineering help and economic consideration which may make pumping dollars go further and cut the demand for electricity at the same time.

In a three-pronged program, engineers from Oklahoma State University and officials of Caddo Electric Cooperative are working together to cut expensive peak electrical demands and to ensure irrigation rigs in the area are pumping as efficiently as possible.

Although not a coordinated effort originally, the efforts by Caddo Electric to lower rates to irrigators who voluntarily shut down their rigs during electrical demand peaks; and the pumping efficiency testing and irrigation scheduling being offered by OSU can add up to increased profitability for irrigators on about 70,000 acres of Caddo and surrounding counties.

"Putting some profitability back in farming is one of our top priorities," said Lonnie Sellers, County Extension Director, "Our farmers have been very receptive and the results of the work here could benefit not only them but homeowners in the area as well."

Sellers, who serves as a representative for producers in planning sessions with co-op officials and the engineers, explained that reduced demand by irrigators during the hottest months of the year could help reduce overall electrical peaks. This, of course, reduces power charges Caddo Electric must pay for electricity it purchases from Western Farmers Electric Cooperative and can result in lower overall charges Caddo collects from all its customers.

Rates

"We've applied with the Oklahoma Corporation Commission for a rate program which would allow us to reduce power charges to irrigators who agree to schedule their watering around peak demand hours," said Lonnie Thomas, Director of Technical Services at Caddo Electric in Binger. "Irrigators represent a large demand for electricity during the hottest months of the summer when the air-conditioning load is also very high," Thomas said, explaining his cooperative is charged all year at a rate set by whatever the peak demand of summer dictates.

"So, if we can reduce the peak, our overall costs for the year will be lower. If we're not successful, rates must continue to climb–just to cover the costs we must pay to Western Farmers."

Currently, an irrigator on Caddo Electric lines pays an annual $24 per horsepower charge flat rate in addition to just under six-cents per kilowatt hour for power consumed. Under the proposed rate change, an irrigator with a 100 horsepower pump motor who consumes no electricity during the peak demand hours would have the horsepower charge cut in half–an automatic $1,200 per year reduction which amounts to about a 15 percent cut in last year's rate.

Reprinted, with permission, from the September 1985 issue of The Oklahoma Farmer-Stockman.

"Although we're in the business of selling electricity, the irrigation load is present only two months of the year," Thomas explained. "But, we have to pay Western Farmers an annual power charge based on the peak we set."

For instance, a 100 horsepower pump operating during the peak will cost us $6,600 throughout the year in demand charges alone, he explained. That means the pump would have to run 134,152 kilowatt hours just to pay the demand charge (not including the actual number of kilowatts it consumes). In actuality, that pump will probably only run 70,000 kilowatt hours, so it costs the cooperative roughly twice what it makes.

For that reason, and the fact that Caddo Electric pays an annual power charge of $7 per kilowatt based on the leak load, Thomas is interested in keeping the ultimate peak of the summer as low as possible. And, that means finding some way to cut power requirements between the hours of 4 p.m. and 8 p.m. during July, August, and September.

"If the Corporation Commission approves our request, we hope the new rates can be in effect during the summer of 1986," Thomas said. "We want the farmer to get all the water he needs for the crop without setting a peak. This program also should help the producer lower his production costs."

To monitor when pumps run and to ensure compliance with the program, Thomas said special watt-hour meters and the cooperation of growers will be essential.

Efficiency

Turning off pumps to shave the peak power demand is fine in theory, but what about those hot days when the sprinklers are running full-bore and the peanuts are still suffering?

That's where the pumping efficiency tests in Caddo County come in.

"Because energy costs aren't going down and plants need a given amount of water to thrive, getting the most use of the water you pay to pump is about the only thing an irrigator can do to keep costs down," said Delbert Schwab, OSU Irrigation Specialist. "That's why the Corporation Commission has funded our testing irrigation wells for pumping efficiency."

Schwab and fellow OSU agricultural engineer Sam Harp have spent much of the past two summers measuring energy inputs and water outputs of Caddo County wells. What they've found is shocking to some producers who quickly realized their cost per acre-inch of water is much too high.

"Last year we tested a well-worn center pivot rig southwest of Binger and found it was costing $4.38 per acre-inch of water pumped," Harp said. "Because of wear, the pump would only support 1.02 acre-inches of water an hour."

The owner spent about $3,000 to service the well and renew the pump bowls and dropped his per acre-inch cost $277 and raised the capacity to 1.54 acre-inches per hour. That figures out to $193.20 in savings for every inch of water applied under a 120-acre circle.

"You can talk about cutting back pumps to lower peak demands all you want, but if a grower can't put on enough water running all day long, he probably isn't going to listen–especially if the crop is suffering," the engineer said. "That's why we're hoping to show producers their pumps will provide additional water for lower costs per acre-inch in many cases if they are running as efficiently as possible."

Schwab and Harp, working with technician Darrel Evans, Apache, hope to test about half the electrically powered irrigation wells in Caddo's territory by the end of the irrigation season.

Scheduling

"If I can't irrigate during peak hours, that means I have to put on sufficient water to supply the crop's needs during the rest of the day. How do I know how much water the crop needs?"

Harp says OSU and Caddo electric are currently cooperating on an irrigation scheduling project to answer that question. The program involves a remote weather station at Ft. Cobb tied directly to a microcomputer in the co-op's Binger office.

"The station records hourly readings of relative humidity, wind speeds, precipitation, solar radiation, and temperature. Then, at the end of the day, those figures are computed to calculate an evapotranspiration coefficient for a reference crop, in this case–alfalfa."

With each day's coefficient, the engineers and their computer can determine how much water was lost through various crops in the area, and that can be translated into how much irrigation water will be needed the following day.

"This information will help the producer know his crop's needs and meet them without overwatering," Harp added.

Darrel Evans, Apache, attaches flow-rate measuring equipment in pumping efficiency tests sponsored by OSU and the state Corporation Commission.

Extension agricultural engineers Delbert Schwab, left, and Sam Harp, examine a remote weather recording station used in irrigation scheduling.

Sellers said when the scheduling service is in full swing producers will have a much more accurate estimate of how much water they really need.

"Many times, a grower with a really good system, or one that has just overhauled a system and brought it back to specifications, will be overwatering. That means increased pod rot on peanuts and higher than needed pumping costs.

"We look for some real changes in equipment across this area as word gets out about efficiency and scheduling."

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NATURAL GAS STILL CHEAPEST FOR IRRIGATION PUMPING

Costs vary widely for the 1985 irrigation season according to which of the four kinds of energy is being used for center-pivot or gated-pipe irrigation.

However, a University of Nebraska-Lincoln extension farm management specialist says natural gas is the cheapest form of energy. Leslie F. Sheffield, Associate Professor of Agricultural Economics, says estimated irrigation pumping costs vary widely in eastern, central, and western Nebraska.

From a 2-day June 1985 sample taken across the State, Sheffield found that for the average of 750 hours of gated-pipe irrigation in eastern Nebraska, the lowest-cost form of energy was natural gas. That was $14.54 an acre. The next lowest cost was for diesel fuel at 90 cents a gallon, or an average cost of $19.91 an acre.

"While the price level for natural gas has been increasing at a higher percentage than for most other forms of energy during the past 3 years, natural gas is still the lowest-cost source of energy to power irrigation pumps in Nebraska," Sheffield says.

He obtained fuel costs from various geographic locations and cited the price variation for electricity based upon the irrigation rate schedules of the 32 REA districts in Nebraska. Each REA district establishes its own rate schedule and the rate structure for different blocks of electricity used for irrigation, as well as the annual hookup fee, or standby horsepower charge, which varies from one district to another, Sheffield points out.

In comparing different forms of energy for powering irrigation pumps in Nebraska for center-pivot and gravity irrigation, he used two different electric rates: 7 cents a kwh and 8 cents a kwh. Both incorporate the annual hookup charges.

Natural gas prices are based on average prices charged June 19, 1985, by KN Energy, Inc., headquartered in Hastings. KN Energy, Inc., is the principal natural gas supplier for irrigation in Nebraska. The average price for "straight rate" customers, about 35 percent of all Nebraska irrigators, is $3.25 per MCF (thousand cubic feet) of natural gas. "Firm-rate" customers pay $14.77 per acre on the average.

In explaining propane—or liquid petroleum—costs, Sheffield says the prices charged for farm delivery vary widely, depending upon freight costs and the competitiveness of different suppliers. He said that, in general, prices obtained for propane delivered to the farm varied from 52 cents to 67 cents a gallon. Diesel fuel prices also vary widely from a low of 88 cents a gallon for semi-load delivery to a high of $1.09 a gallon for small tank-wagon deliveries.

For typical center-pivot irrigation installations in Nebraska, the lowest cost energy source to power irrigation pumps is natural gas for the "straight-rate" irrigators, with an average cast of $16.20 an acre for 600 hours of operation in eastern Nebraska. That's based on gross pumpage of 8.16 acre-inches of water per acre in a season.

Reprinted, with permission, from the August 17, 1985, issue of the Nebraska Farmer.

For central Nebraska irrigators who averaged 900 hours of pumping 12.24 acre-inches of water per acre in a season, the lowest cost would be with natural gas at $23.95 an acre. And for western Nebraska irrigators with an average of 1,200 hours of operation and 16.32 acre-inches a season, the lowest cost with natural gas would be $31.93 an acre.

Sheffield says that eastern Nebraska irrigators using center pivots find that the next lowest cost source of energy after natural gas is diesel fuel at 90 cents a gallon with an average cost of $21.81 an acre. And the next lowest cost is electricity at 7 cents a kwh with an average cost of $23.97 an acre. The highest cost with 600 hours of operation a season is an irrigator who uses propane at an average delivered cost of 65 cents a gallon and an average cost of $28.59 an acre.

Sheffield points out that his assumptions for gravity and center-pivot irrigation are typical of many irrigation installations in Nebraska, except for those in river valleys where there normally is a much shallower irrigation pumping lift.

"Irrigtors who have irrigation well and pump installations which are from 5 to 10 years old or older and haven't been tested for efficiency could benefit considerably by having a pumping plant efficiency test run," Sheffield says. "In many cases, changes in the pumping plant or power unit may be needed to achieve an efficient pumping plant or to provide the desired volume of water at the lowest possible cost."

Most well drillers and some private agricultural consulting firms conduct pumping plant efficiency tests at a minor cost, he adds. Sheffield advised irrigators that if the pumping plant unit is not efficient now and if the changes suggested by the test results are made, energy cost savings over a few years can more than repay the cost of improving the pumping plant.

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O&M EXPERIENCES

Beginning with this issue, O&M (operation and maintenance) digest statements will be included periodically in the Water O&M Bulletin. These digest statements document incidents that have occurred at water facilities and are intended to provide clues to help identify and solve similar incidents at other structures.

The first O&M digest statement featured is a record of the sinkholes which resulted in water loss from Wickiup Reservoir.

Dam: Wickiup
State: Oregon
Active capacity: 200,000 acre-feet

Project: Deschutes
Surface area: 11,200 surface acres

RESERVOIR SEEPAGE

Design Characteristics: Wickiup Dam consists of a 2-1/2-mile-long main dam and a 3,420-foot dike which is adjacent to an ungated, unpaved spillway excavated into competent rock at the right abutment of the dike. The dam is on the Deschutes River and impounds water in a wide, shallow reservoir. The local and regional geology consists of igneous features such as old dormant volcanoes and extensive surface and buried lava flows.

Evidence: Three large sinkholes appeared in the reservoir several miles southeast of the dam and later along a fault line near the dam in 1948. Considerable seepage up to 40 ft^3/s was observed downstream of the East Wickiup Dike and resulted in die-off of native forest and vegetation. Recorded downstream seepage was known to vary in direct proportion to the reservoir elevation. Seepage into other large sinkholes located southeast of the dam near the reservoir rim was estimated at 350 ft^3/s and the outlet or subsurface course of this seepage is unknown. One explored sinkhole was about 60 feet deep and extended an unknown distance beyond.

Incident: As a result of the known extensive seepage of up to 400 ft^3/s, the reservoir was drawn down to permit a more detailed inspection of the known major sinkholes and to survey the newly exposed reservoir floor for surface evidence of additional sinkholes. Although the seepage was extensive, the safety of the dam or dike was not considered impaired nor its safety particularly endangered. The quantity of seepage was excessive; however, the conservation storage capability of the dam was being satisfied.

Causes: The cause of the seepage can be traced to local geologic conditions. The reservoir basin is underlain at depth by lava flows covered with a considerable thickness of sedimentary deposits but both were found to be cut by young faults. Because the young faults have disturbed the sedimentary deposits and volcanic rocks, the sediments do not form an adequate seal over the entire reservoir floor. The postconstruction surface expressions of the faults have occurred as a result of erosion of the surface formations by wave action and seepage of the reservoir.

In addition to the in situ conditions which contribute to sinkhole formation, surface soils from the reservoir were mined for use in construction of the dam. This action likely contributed to the formation of sinkholes.

Remedy: The reservoir was visually surveyed by jeep and airplane to identify and map any other existing or potential sinkholes. Later, and in order to reduce the seepage, identified sinkhole crevices were sluiced, backfilled, and compacted with material similar to that used for earth embankments. A 3-mile collection channel was excavated downstream of the dam to collect surface seepage and lower the water table.

At the present time (1985), the reservoir is routinely inspected for new sinkholes or changes in old sinkholes. Loss due to seepage continues, but at an acceptably reduced rate.

THE BIG LEAK AT BASE OF DAVIS MOUNTAIN
5-27-48–Bureau of Reclamation photo by R.A. Baker.

Picture was taken on hillside a few feet above and possibly 35 feet back from the designed reservoir flow line, looking slightly east of north. Dark-colored mountain at upper right is Round Mountain. Water surface is at elevation 4328.0 or 4.2 feet below designed flow line. An estimated 350 second-feet of water is flowing past boat toward footbridge where most of the water disappears. Collar of sinkhole in right foreground is nearly 4 feet above and possibly 50 feet back from highest shoreline reached that year. The sinkhole is due to the removal of the underlying clayey silt and pumice by the escaping water. A crooked crack trending southward was found in the pumice soil near trees at left, and another one was seen south of the sinkhole. An earthen dike, being constructed to stop the leakage into this channel, is shown in upper left part of picture, possibly 160 feet north from the sinkhole. Several vertical-sided holes were observed in the reservoir floor north of the dike, but they did not appear to be taking much water on the day this picture was taken.

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The purpose of this Bulletin is to serve as a medium of exchanging operation and maintenance information. Its success depends upon your help in obtaining and submitting new and useful O&M ideas.

Advertise your district's or project's resourcefulness by having an article published in the Bulletin! So let us hear from you soon.

Prospective material should be submitted through your Bureau of Reclamation Regional Office.

Mission of the Bureau of Reclamation

The Bureau of Reclamation of the U.S. Department of the Interior is responsible for the development and conservation of the Nation's water resources in the Western United States.

The Bureau's original purpose "to provide for the reclamation of arid and semiarid lands in the West" today covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river navigation; river regulation and control; fish and wildlife enhancement; outdoor recreation; and research on water-related design, construction, materials, atmospheric management, and wind and solar power.

Bureau programs most frequently are the result of close cooperation with the U.S. Congress, other Federal agencies, States, local governments, academic institutions, water-user organizations, and other concerned groups.