WATER OPERATION AND MAINTENANCE

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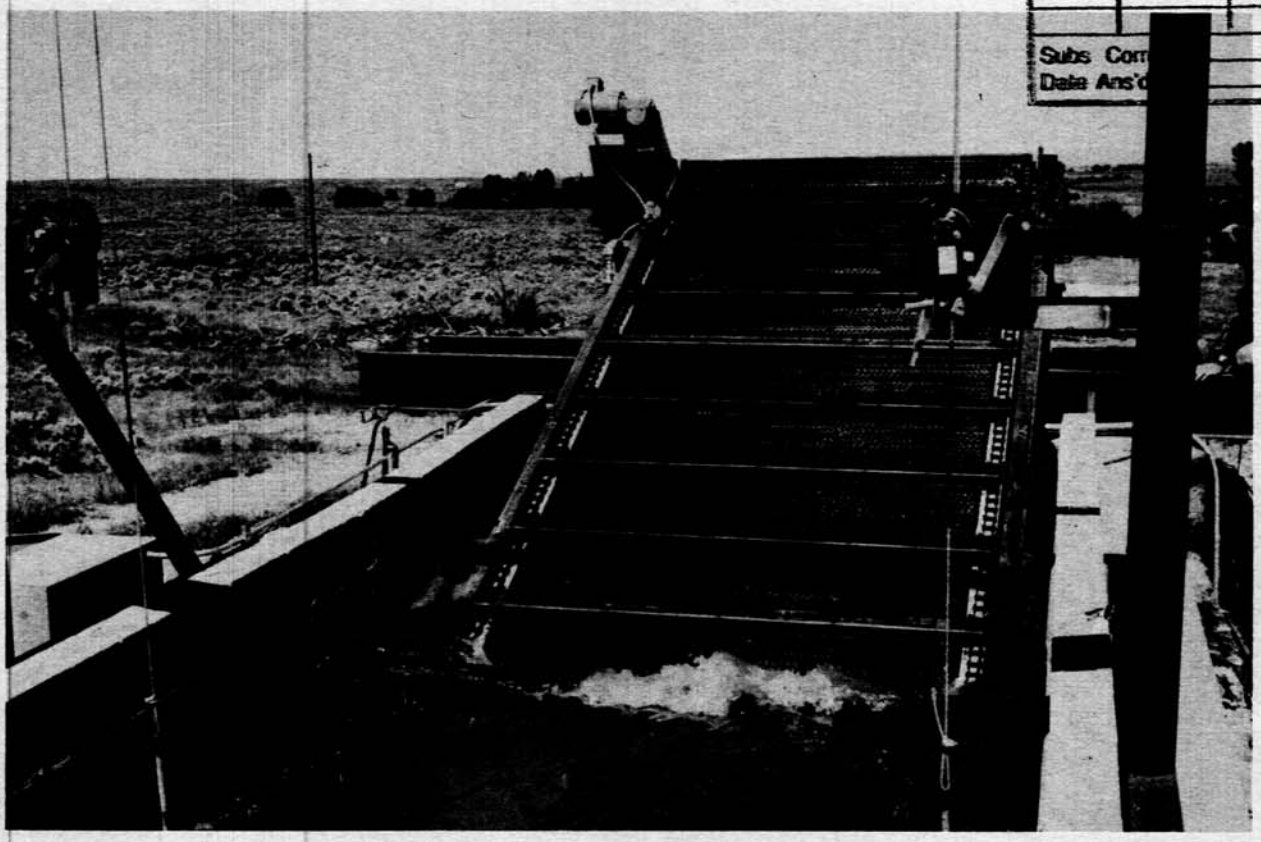

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UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

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 is 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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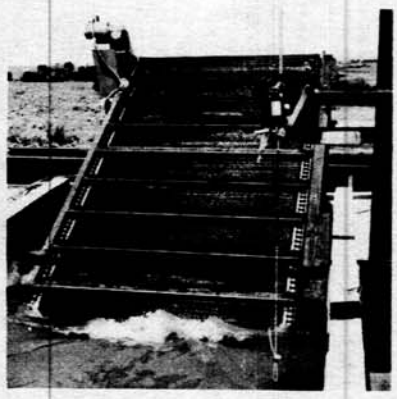

Cover photograph:

Power-driven trash screen for canals and laterals.

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WATER OPERATION AND MAINTENANCE
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INTRODUCTION

One of the most persistent problems that many irrigators face is that of trash in their irrigation water. The article beginning on page 1 describes two innovative trash screen developments that perform well.

An interesting article on laboratory and field research conducted by the Bureau of Reclamation on synthetic materials engineered for use as waterproof membrane linings is detailed beginning on page 5.

Unique, saw-toothed, laser-guided concrete ditches, the "poor man's automated furrow irrigation," are proving to be very popular in eastern Arizona. See page 9.

See page 13 for a pickup truck sprayer designed for safety and convenience, and also serves a useful purpose around the farm.

Page 17 lists some simple tests for use of agricultural chemicals.

The article on page 19 describes a trailer that would transport chemicals safely.

Having trouble with bats? Three bat control methods are described on page 20.

On pages 21 and 22 are two excellent maintenance procedures.

NEW INNOVATIONS IN TRASH SCREENS INCREASE CANAL EFFICIENCY[1]

by Allan Humpherys

One of the most persistent problems that many irrigators face is that of trash in their irrigation water. This problem is almost universal where water is distributed in open canal and ditch systems. Trash and debris in the water not only obstruct irrigation ditches and structures, but clog sprinkler nozzles, siphon tubes, gated pipe openings, and other discharge outlets and flow measuring devices.

A considerable amount of debris, particularly during high spring flows, originates in the streams from which irrigation water is diverted. Most of the troublesome material, however, is generated within the open irrigation distribution system itself. This includes moss, snails, garbage, windblown debris, vegetative material, and soil particles from the irrigation channels and trash contained in irrigation runoff or tailwater which is returned to the canal system.

Figure 1.–Power-driven trash screen for canals and laterals.

Thus, trash screens and debris removal equipment are needed at farm turnouts and other locations within the system as well as at stream diversions. On a project basis, it may be more efficient for the canal company or other organizational entity, which operates the distribution system, to install trash removal equipment. The extra cost to deliver clean water may be less than for each irrigator to install his own trash cleaners.

Two general classes or types of self-cleaning trash removal equipment are needed. The first includes that designed for use in canals and laterals at diversion points and at other strategic locations within the distribution system. These are usually relatively large size screens which are power driven (figs. 1

[1] Reprinted by permission of the Editor, Irrigation Age. Allan Humpherys is an Agricultural Engineer at USDA's ARS Snake River Conservation Research Center at Kimberly, Idaho.

and 3). The other class of screens is smaller and is used at farm turnouts and on individual farms. Various designs and configurations of each class of screen have been, and are being, used with varying degrees of success. There are two recent innovative screen developments that are performing well.

Custom-designed Screens

The self-cleaning trash machine is usually custom-designed for a given site and can be made for channels from 4 ft (1.2 m) wide to 15 ft (4.6 m) or greater. The screen consists of short sections or segments of double-weave screen made from 6- to 14-gage galvanized cold-rolled wire.

Each screen segment is independently supported from a heavy cross bar. The screen openings can vary from 1/4 in (6 mm) to 1-1/2 in (40 mm), depending upon the size of the debris to be removed. The 1/4-in (6-mm) size has a 50-percent open area. The machine is mounted on a pivot which is supported by a cross beam. The screen can be lifted or tilted out of the water by a winch at its upstream end for repair or inspection.

A UHMW (ultra-high molecular weight) plastic is used for the rails on which the side chains glide, and for the bushings on the roller at the underwater end of the screen. This material is water lubricated and has excellent wear qualities when used under water.

The machine is powered by a 1-hp (745.7-W) motor and controlled by a percentage timer in combination with a float which detects differences in water level, so that the running time can be varied from several minutes per hour to continuous, depending upon the amount of debris to be removed. Intermittent running extends the life of the machine.

The machine is specially designed to remove moss. One 15-ft (4.6-m) wide unit removed 1 ton of moss per hour at a site where, previously, several men worked continuously during the irrigation season to clean a fixed grate. Where the volume of trash is large, the machine can be equipped with a side conveyor.

One unit even removed a dead cow from the canal. The machine also is being used with small hydroelectric plants to remove ice blocks and trash that otherwise would damage the plant's turbines. This trash cleaner was developed by R. D. Critser (Critser, Inc., Jerome, Idaho).

Variety of Screens

A variety of on-farm screens are needed to satisfy the many different field conditions encountered and a number of good self-cleaning screens are commercially available. One such innovative screen recently developed is a water-powered, turbine-driven trash remover that can be used in lined or unlined farm ditches. The rotary screen and screen wipers are driven directly by a drive shaft from a water-powered turbine wheel without using drive belts or pulleys.

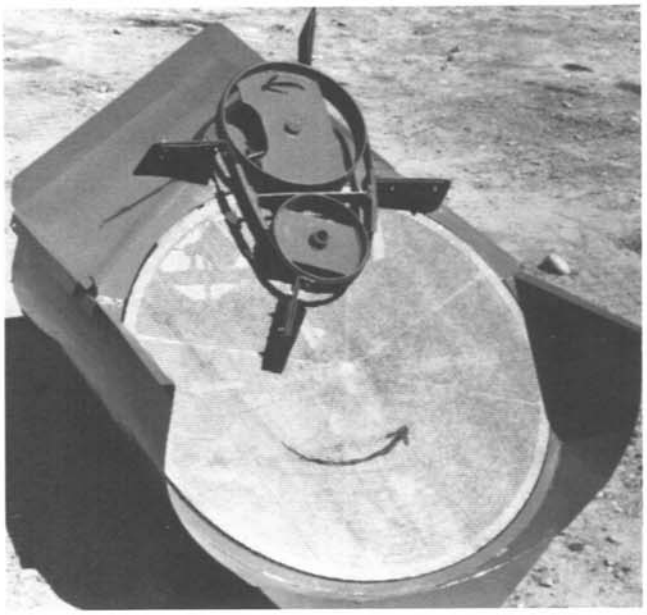

Figure 2.–Turbine water-powered trash remover.

A unique feature of this cleaner is the cleaning action of the rubber wiper paddles (fig. 2). The cleaning is done above the water surface where water pressure cannot force loosened trash particles through the screen and back into the water. Each point on the rotating screen is wiped three times as it passes beneath the wiper blades. Trash removed from the screen is collected on a sloping platform and deposited on the side of the ditch where it cannot reenter the water. The machine has been effective in removing moss, grass clippings, and other debris.

The standard model is made with 1:1 sides and a 12-in (300-mm) bottom. With sufficient water velocity, it can operate in 3 in (76.2 mm) of water and can handle 5 ft^3/s (141.6 L/s). The screen has 3/16-in (5-mm) diameter by 1/4-in (6-mm) staggered holes in an 18-gage galvanized perforated metal plate with 50 percent open area. This trash remover has very low maintenance and was developed by Ed Oest (Irrigation Systems Co., Fruita, Colorado) and Phillip Burnham, a local farmer.

Development Continues

Work is continuing on the development of improved self-cleaning weed and trash screens at the USDA-ARS Snake River Conservation Research Center in Kimberly, Idaho. Turbulent fountain screens, horizontal screens with turbulence inducers, and wheel-type screens continue to be effective in removing trash from water.

Figure 3.–Side view of canal-type screen. Note the single point pivot mount and the side conveyor.

A submerged screen is now being developed by James Bondurant. This screen is installed in a modified canal turnout which uses a pipe submerged in the canal or lateral for the farm delivery. A section of the submerged pipe wall is removed and covered with a screen to form the intake.

Screens at the Research Center are being developed to remove weed seed, as well as trash, from the irrigation water. Tests conducted at the Research Center have shown that a significant portion of the weed population in an irrigated field originates from seeds carried in the irrigation water. Eliminating these seeds could be an economic benefit to the irrigation farmer.

* * * * *

FLEXIBLE MEMBRANE LININGS

by Bill Morrison[2]

Background

Since the end of World War II, the rapid development of synthetic polymers has made a host of new construction materials available. In cooperation with industry, the Bureau of Reclamation has conducted extensive laboratory and field research on many of these synthetic materials engineered specifically for use as waterproof membrane linings. This work has led to the development of FML (flexible membrane linings) for seepage control in irrigation canals, reservoirs, and ponds.

The FML are thin, tough, impermeable plastic or elastomeric films ranging in thickness from 10 to 100 mils (0.2540 to 2.540 mm) – 1 mil equals 0.001 in (0.0254 mm). The term "geomembrane" has recently been coined for FML.

The most common membrane linings include the following materials:

1. PVC (polyvinyl chloride).

2. LDPE (low-density polyethylene). This plastic is the type used in manufacturing trash bags, such as "Hefty," "Glad," etc. For comparative purposes, trash bags range in thickness from 1-1/2 to 2 mils (0.0381 to 0.0508 mm). Also, LDPE is quite often called "Visqueen."

3. HDPE (high-density polyethylene).

4. CPE (chlorinated polyethylene).

5. CSPE (chorosulfonated polyethylene). This material is also called Hypalon, which is DuPont's trade name for the compound.

6. Butyl rubber.

7. EPDM (ethylene propylene diene monomer).

Some of these linings (No. 4 through 7) can be manufactured with a reinforcing scrim to improve tear strength properties and dimensional stability (shrink resistance).

Canal Linings

Much of the development work on plastic canal linings has been accomplished under the Bureau's LCCL (Lower Cost Canal Lining) program, terminated in 1967, and its replacement, the OCCS (Open and Closed Conduit Systems) program.

The use of plastic linings has primarily been in conjunction with the rehabilitation of old, unlined canals (figs. 4 and 5). Also, this work involving the procedures listed below is generally accomplished during the nonirrigation season, and it often involves wintertime construction.

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[2] Bill Morrison is a supervisor/coordinator in the Materials Science Section, Division of Research and Laboratory Services, Bureau of Reclamation, Engineering and Research Center, Denver, Colorado.

1. Excavation of the existing canal a minimum of 1 ft (0.3 m).

2. Subgrade preparation.

3. Installation of the membrane lining.

4. Placement of an earth cover – 12 to 18 in (300 to 450 mm) in depth – to protect the membrane from the elements and physical damage.

Because of the requirement of an earth cover, membrane linings are restricted to canals having low-velocity flows – 1 to 3 ft/s (0.3 to 0.9 m/s).

Figure 4.–Installation of membrane.

Figure 5.–Placement of protective earth cover.

Either PVC or LDPE can be used in plastic canal lining work. The decision to use PVC or PE is made on the basis of local conditions and service requirements for each specific installation. Because PVC is more resistant to punctures, more readily available in larger sheets – up to 70 ft wide and 1,000 ft in length (21 m wide and 304.8 m in length), depending on thickness – and more easily repaired and field spliced with solvent-type cement, it has been used more extensively than PE in Bureau work. Although PE possesses better low-temperature properties and aging characteristics than PVC, it is more difficult to handle and currently is available only in seamless rolls up to 40 ft wide and 200 ft in length (12 m wide and 60 m in length). Consequently, it requires more field seams. These shortcomings have recently been discussed with United States manufacturers of PE film.

The first PVC installation under a Bureau construction specifications was in 1968 on the Helena Valley Canal, Montana. Since then, PVC has been used widely on the East Bench Unit, Montana, and the Riverton Unit, Wyoming.

For this work, PVC of 10-mil (0.2540-mm) thickness was used. However, based on field and laboratory performance studies conducted the past few years, 20-mil (0.5080-mm) PVC is now being specified in Bureau work. The additional cost of the heavier gage material will be minimal. With a 100-percent increase in thickness of the membrane, the overall cost of construction will only increase by 15 percent.

Plastic linings are now being specified for new construction. For example, 20-mil (0.5080-mm) PVC will be used on the San Luis Project, Colorado, to line a conveyance channel for delivering salvaged ground water to the Rio Grande River. The first of five specifications for this work was issued in May 1983. The installation on the San Luis Project will be the largest use to date of PVC lining in canal construction in the United States.

Since 1975, the Bureau has been involved in a joint study with the Soviet Union on the use of plastic films for canal linings. Highlights of this study include the following:

1. Exchange of technical information on plastic linings used in both countries.—(The Soviets primarily use PE in their canal construction work. In small canals, they use 8-mil (0.2032-mm) PE under concrete; and in larger canals, they use two layers of 8-mil (0.2032-mm) film covered with about 3 ft (0.9 m) of earth in the bottom and precast concrete slabs on the side slopes at the waterline for erosion control.)

2. Installation of nine experimental canal lining systems at the Ukrainian Field Test Station, Black Sea Canal.—The Soviets constructed the test sections in accordance with Bureau specifications and using Bureau-furnished materials. Based on the results of these tests, two lining systems have been selected for further study in an operating canal on the Kakhovka Project in the Ukraine. The two systems are a 10-mil (0.2540-mm) PVC with a concrete cover and a 20-mil (0.5080-mm) polyolefin lining with a concrete cover.

3. Installation of a PE and a PVC study section on the Amarillo Canal, Navajo Indian Irrigation Project, New Mexico.—Included in the study will be determination of the performance of several different protective earth cover materials. Special seepage monitoring stations were also installed to determine the effectiveness of the plastic linings for seepage control.

An interim report is now being prepared, summarizing the joint studies to date.

Reservoir Linings

The Bureau has been involved in two major projects: the Kualapuu Reservoir, Molokai Project, Hawaii, and the Mt. Elbert Forebay Reservoir, Fryingpan-Arkansas Project, Colorado.

The Kualapuu Reservoir, built during 1968-1969, is the principal storage facility for the Molokai Project, Hawaii. This is a State venture, federally funded in part under the Small Reclamation Projects Act of 1956. The storage capacity of the reservoir is 4300 acre-feet ($5.3 \times 10^6 m^3$, with a maximum head of 50 ft (15 m)).

Since onsite clay materials were borderline in regard to satisfactory seepage control, a 1/32-in (0.8-mm), nylon-reinforced butyl rubber lining was installed in the reservoir to control seepage. The Bureau provided technical assistance for this 160-acre (56.7-ha) installation.

Bureau O&M personnel have made periodic inspections of the reservoir. They report that occasional repairs of the seams have been required. Also, slope protection material has been placed at the waterline to minimize damage from wind and wave action.

During the summer of 1980, the Bureau installed 290 acres (117 ha) of 45-mil (1.1430-mm) CPER (reinforced chlorinated polyethylene) flexible membrane lining in Mt. Elbert Forebay Reservoir, near Leadville,

Colorado (fig. 6). The forebay reservoir and adjacent Mt. Elbert Pumped Storage Powerplant are part of the Fryingpan-Arkansas Project, Colorado.

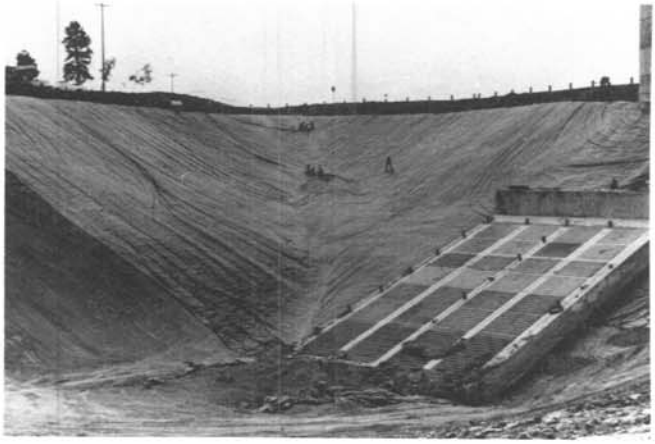

Figure 6.–Installation of CPER flexible membrane lining around inlet-outlet structure in Mt. Elbert Forebay Reservoir. After the lining was installed, earth cover materials were placed over it for protection from the elements and physical damage.

The installation at Mt. Elbert constitutes the world's largest single-cell flexible membrane lining application to date, and it is the first time that such a material has been used in a pumped-storage reservoir for seepage control. To meet the Bureau requirement of July 15, 1981, for power-on-line for the powerplant, the installation had to be accomplished in one construction season to allow sufficient time to fill the reservoir and conduct acceptance tests on the generating units and accessory equipment.

The purpose of installing the lining was to prevent seepage from entering the hillside between the reservoir and lower Twin Lakes. A portion of the hillside has been geologically mapped as an ancient landslide, and considerable concern was expressed that seepage from the reservoir might reactivate the slide.

A report, REC-ERC-82-2, has been published which summarizes the construction work associated with the installation of the membrane lining, the quality control program conducted during the installation, and the research program being implemented to monitor the performance of the lining.

Equipment Acquisition

The Bureau recently acquired the following equipment to enhance and update its capability in evaluating flexible membrane linings:

1. Automated Hydrostatic Test Facility for pressure-testing flexible membrane linings over various subgrades and under different operating conditions.–This equipment was designed and built in-house. In the future, it will be used in testing and research on other hydraulic barrier materials, geotechnical fabrics, and soils.

2. An Instron 1123 testing machine to determine the tensile and tear properties of flexible membrane linings.

3. A GC/MS (gas chromatography/mass spectrometry) analyzer to determine the chemical properties of linings.–The analyzer will be useful in the obtaining of a chemical "fingerprint" of linings and the determination of what changes have occurred chemically after "X" years of service.

* * * * *

NOTCHED DITCH IDEA CATCHING ON IN GRAHAM COUNTY[3]

Perhaps you farm in an area where the river water you irrigate with is trashy. Or perhaps you never knew how much tailwater your neighbor on higher ground will be sending you – the old "uneven flow" syndrome.

If you suffer from any of these complaints, and many who farm near the Gila River in Graham County do, you might consider notched irrigation ditches – the poor man's automated furrow irrigation (fig. 7).

The story here is not that these unique, saw-toothed, laser-guided concrete ditches are now being used by growers in Arizona's eastern counties. The real story is that such water and labor-conscious producers of food and fiber can't seem to get enough of them.

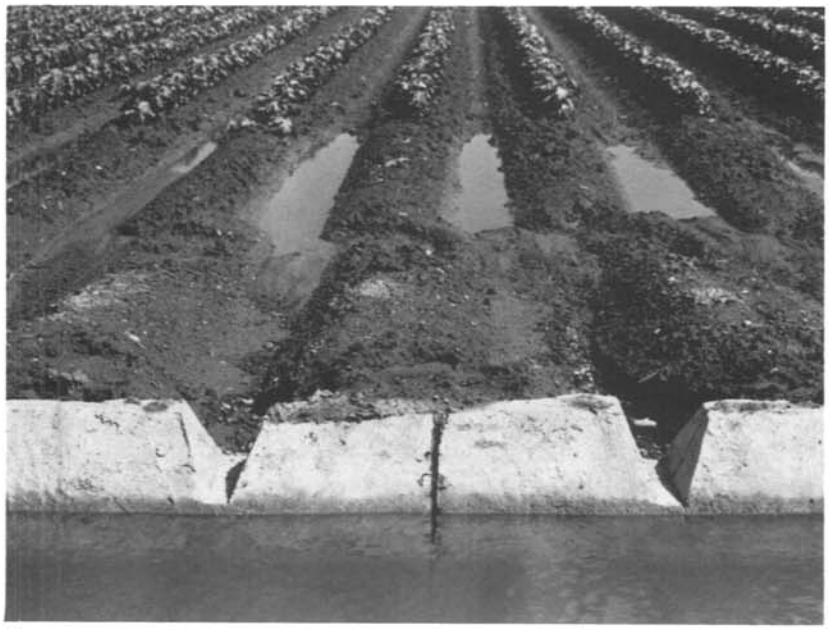

Figure 7.–Notched irrigation ditches – the poor man's automated furrow irrigation.

A champion of the idea, Ron Cluff, Graham County Agricultural Agent, told Arizona Farmer-Ranchman during early December that over a dozen growers already have the notched ditches and the sky's the limit when it comes to the future.

Cluff said that each ditch is similar to a conventional concrete-lined ditch, except the field side has a line of notches cut from 6 to 8 in (152 to 203 mm) deep into the freeboard. Water in this ditch is able to spill freely into the furrows without needing siphon tubes for delivery (figs. 8 and 9).

And, the water is evenly distributed into the furrows with the flow rate being determined by size of the waterhead.

"With these notched ditches," said Cluff, "growers can say goodbye to siphon tubes jammed with river trash and dry rows caused by too much brush coming into the ditches."

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[3] Article reprinted by permission of the Editor, Arizona Farmer-Ranchman, from January 1984 issue. Photographs by Ron Cluff.

Figure 8.–Saw-toothed, laser-guided concrete ditches do not need siphon tubes for efficient water delivery.

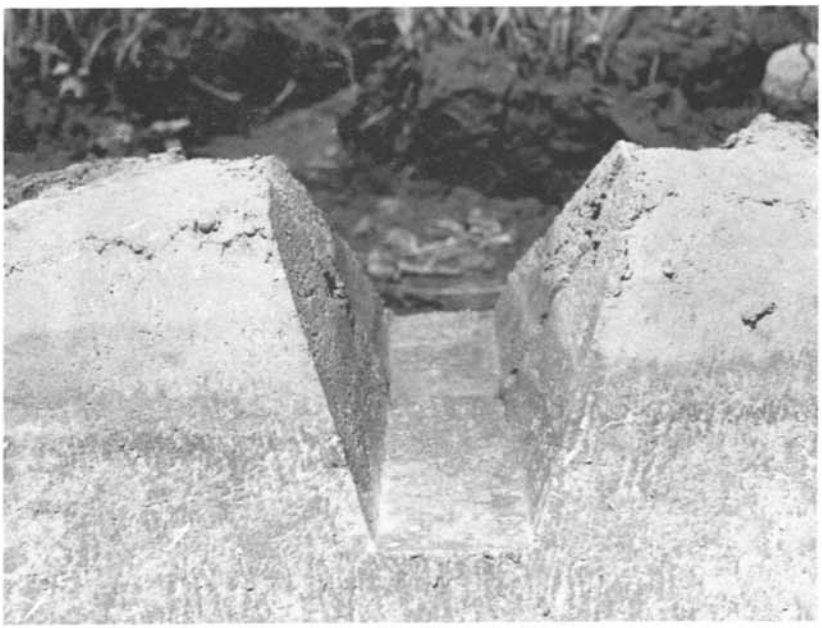

Figure 9.–The notches are formed 6 to 8 in (152 to 203 mm) deep into the freeboard and will spill freely.

Developer of the notched ditch idea is a transplanted Wyoming resident named Ned Shelley who has several patents on the idea. Shelley's Concrete Auto-Liner is laser guided and can lay 1,400 ft (426.7 m) of 18-in (457.2-mm) wide ditch each day. The cost? At least $8 per foot (about $25 per meter), according to Cluff. Conventional ditches are running from $5 to $6 per foot (about $18 per meter), he added.

"It's true that the notched ditches will cost more," Cluff pointed out, "but you do get a lot more for your money. For instance, because the notched ditches are thicker, they tend to last longer. By manipulating the size of the waterhead, they're easy to regulate and they'll obviously distribute any amount of water entering the ditch. That's good news for those running tailwater and who never know what to expect in terms of water volume."

Cluff also noted that growers can save a great deal by foregoing the siphon tubes which will run around $3.50 each.

"But keep in mind that growers with the notched ditches might not want to get rid of all their siphon tubes.

"If a grower sees that he has a slow furrow (meaning that the intake rate of a furrow is so high as to prevent water from keeping up with that in other furrows), then he can always throw on a siphon tube between a notch and increase the flow to that particular furrow."

Growers who wish to irrigate every other row may do so by inserting small tin gates between selected notches, he added. See figure 10.

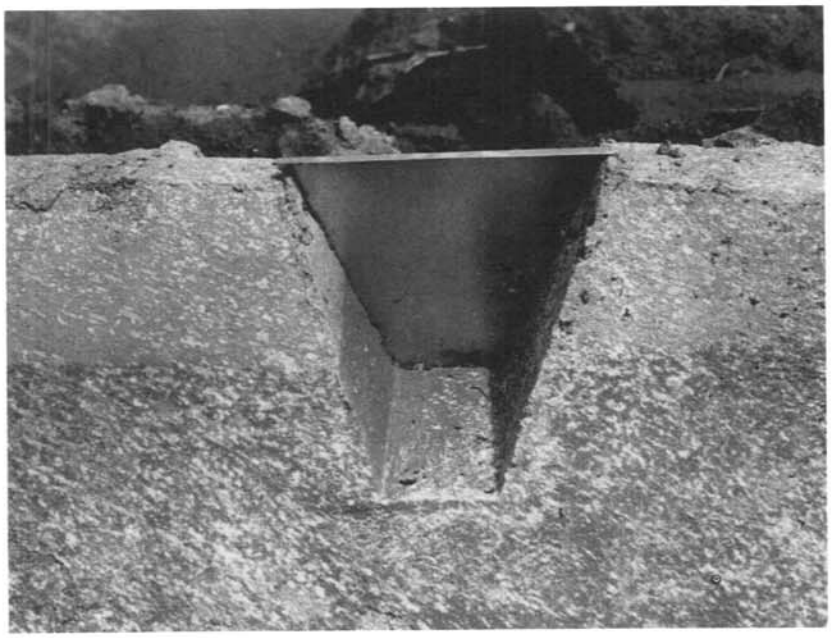

Figure 10.–Inserting small tin gates between selected notches makes it possible to irrigate every other row.

Because the delivery of water from the notched ditches is so uniform, and because level fields increase the water efficiency, some growers are reporting a savings of up to half their water. Or, as some growers like to think of it, the same amount of a grower's water can be run on more ground to water more crops.

An added incentive for local growers is that ASCS (Agricultural Stabilization and Conservation Service) will cost share such innovations.

According to Pedro A. (Tony) Gonzales of of the State ASCS office in Phoenix, that USDA agency will cost share 65 percent of the actual cost of the ditches, not to exceed $4 per foot. Contact Wes Morris, Graham County ASCS Executive Director, for details.

* * * * *

A SPRAYER DESIGNED FOR SAFETY[4]

One summer day a few years back, Jody Novak found himself hanging in midair on his tractor.

He was spraying his pastures in Republic County with a small International tractor. Suddenly, as he headed up a steep embankment, the ground leveled off. The front end of the tractor went jutting straight up into the air as the rear wheels continued to climb.

He put the brakes on, popped the clutch in, and sat there, hoping the tractor wouldn't flip over on him. After staying like that for a while, he finally released the brakes. Luckily, the tractor rolled on back down the embankment.

"I always told myself, after that, that if I ever got the chance to build a sprayer I could put in the back of a pickup, I'd do it," Novak recalls.

Spraying from a pickup truck rather than a tractor would be much safer and more convenient, he reasoned.

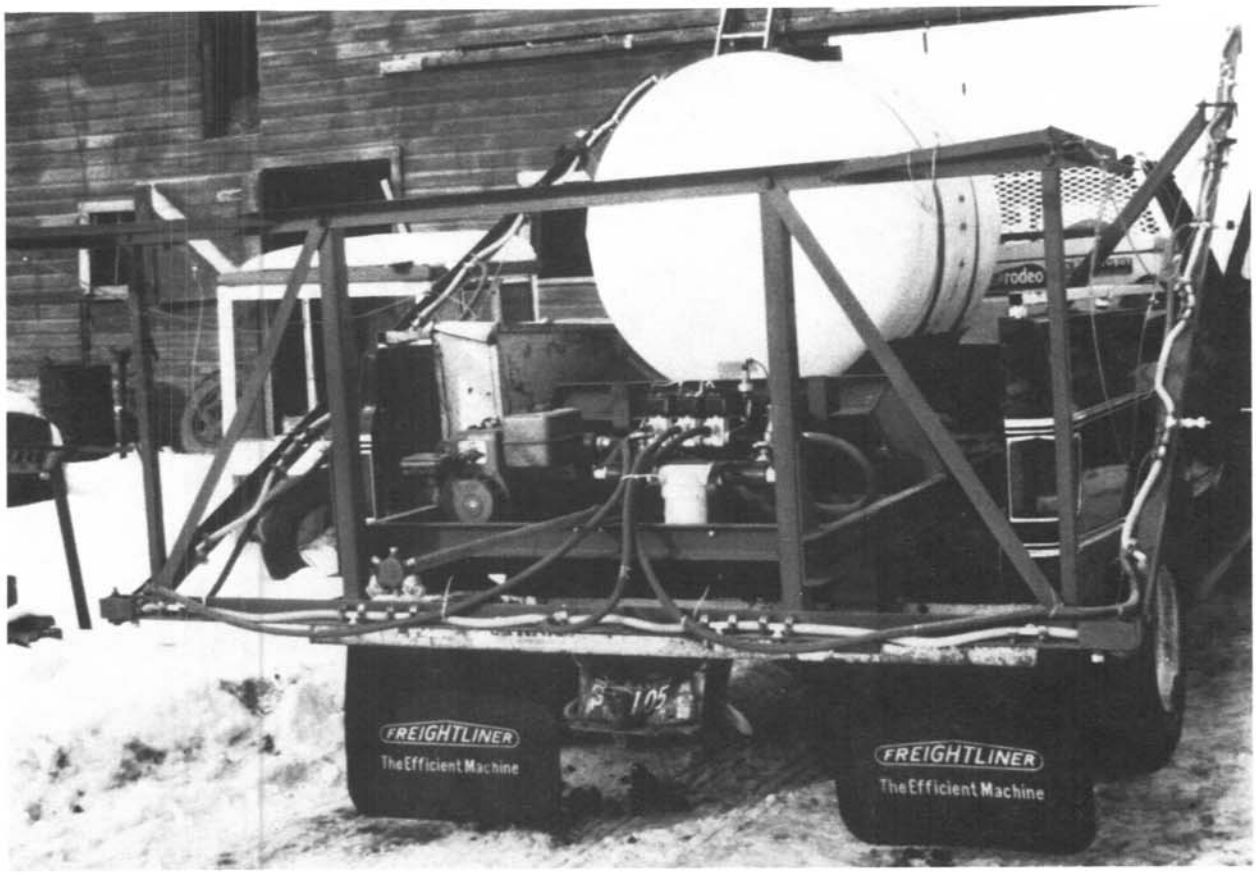

Figure 11.–A custom-designed, slide-in pickup sprayer built by Jody Novak.

Novak's chance to build one came in the form of a project in a shop class at Cloud County Community College taught by Harold Severance. The project won Novak one of the 1983 Lincoln Arc Welding Awards in nationwide competition.

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[4] Reprinted by special permission of the Editor, Kansas Farmer, from March 17, 1984 issue.

The slide-in sprayer serves a useful purpose on the Novak's farm. "We couldn't buy a sprayer like that. We have a 9-1/2-in (242-mm) high gooseneck hitch ball in the back of our pickup and the problem is that we couldn't find a tank that would clear the hitch ball and slide into the truck far enough," Novak explains.

"To get around that problem, we built this channel iron frame up and over the hitch ball so we could clear it with the tank. Then we put a little hitching strap on that hooks around the narrow part of the hitch ball. The strap helps hold the sprayer in without needing chains or other fasteners."

Their pickup also has a winch in it for hauling big round bales. The sprayer just clears the winch so they can work around it.

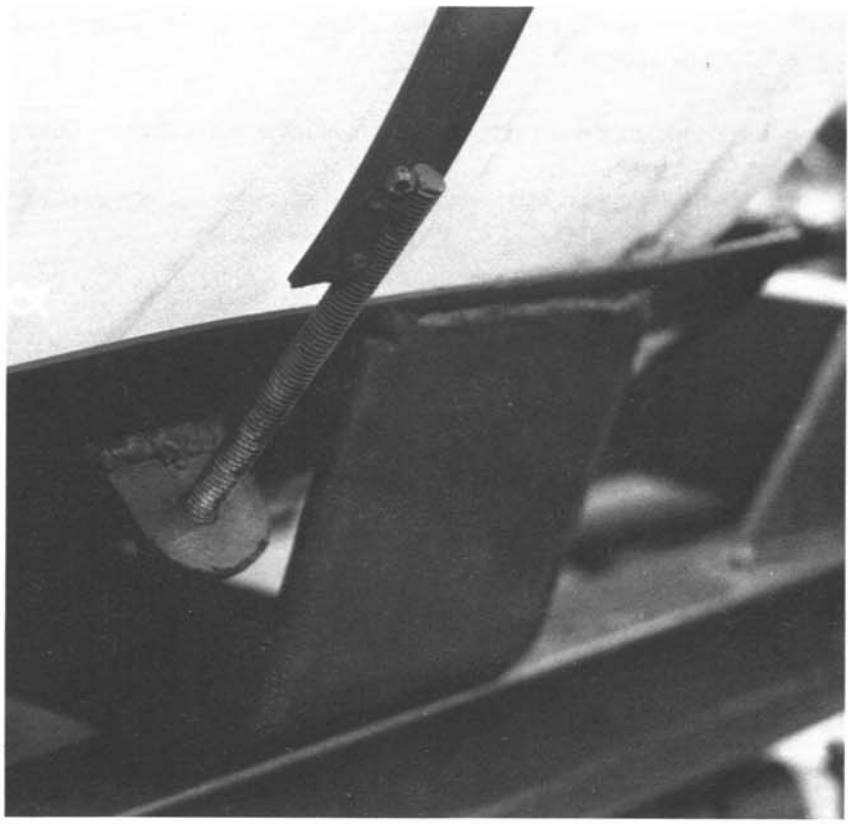

Figure 12.–Tank saddle.

In building the tank saddle, a 32-in by 40-in (812.8-mm by 1016-mm) flat iron was rolled to simulate the curvature of the tank. Each flat iron was bent to about a 100-degree included angle. They were then centered in the proper position, tacked, and then welded to the bottom side of the rolled flat iron. The saddle was then placed on two I-beam rails, centered, and welded in place. On each end of the rolled flat iron, a tab 3 in wide by 1-1/4 in high (75 mm wide by 30 mm high) was turned up to keep the tank from sliding. See figure 12.

The sprayer costs around $600 to make. Of that, $300 was for electrical parts. Operation of the unit is done from inside the cab with electrical controls run on magnetic solenoids. This is a safety feature in that it keeps spray drift off the operator. See figure 13.

Figure 13.–Remote electrical controls allow Novak to turn the nozzles on and off from the seat of his pickup cab.

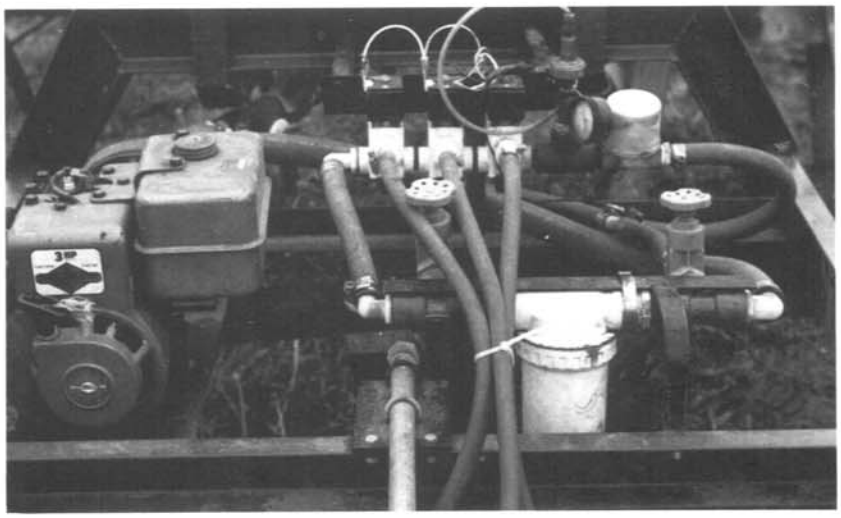

Figure 14.–Installation of electric valves.

The hangers for the electric valves used a 2-ft (0.6-m) piece of flat iron and two pieces of 1-in (25-mm) square tubing, each 1 ft (0.3 m) in length. The two square tubes were welded onto the flat iron 10 in (254 mm) apart. On the other end of the tubing, two pads with 1/4-in (6-mm) holes were welded. A plate to which the valves were bolted was attached to these pads. The 1-in by 13-in (25-mm to 330-mm) flat iron was bent and drilled to make a support and fastened to the main frame to keep the valves from vibrating. See figure 14.

Novak put a 200-gal (757-L) tank on the spray rig, but he now wishes he'd made the tank bigger. "I'd put a different style of tank on it if I did it over. I'd want a bigger tank, a 300 to 400-gal (1135.6 to 1514.2-L) tank. A lot of the herbicides we spray now are high volume materials. I use the 20-gal (75.7-L) per-acre rate a lot, and now I can only spray 10 acres (4 ha) at a shot."

He would also want a flat, lower-profile tank and longer, heavier booms. "The booms I have on it swing a little too much," especially at speeds over 8 mi (12.9 km) per hour, he explains. The current width is 30 ft (9.14 m) of broadcast area, with 12 nozzles on 30-in (762-mm) centers.

The booms can be removed and a boomless jet installed for spraying fence rows or around trees. The booms were bolted together rather than welded. That way, if a boom is hooked or the boom frame is bent, each part can be individually straightened or replaced as necessary. On the ends of the center boom, a joint was made so that the booms could be folded up. The joint was selected because it would be able to flex up and down vertically and must also flex on the horizontal, figure 15.

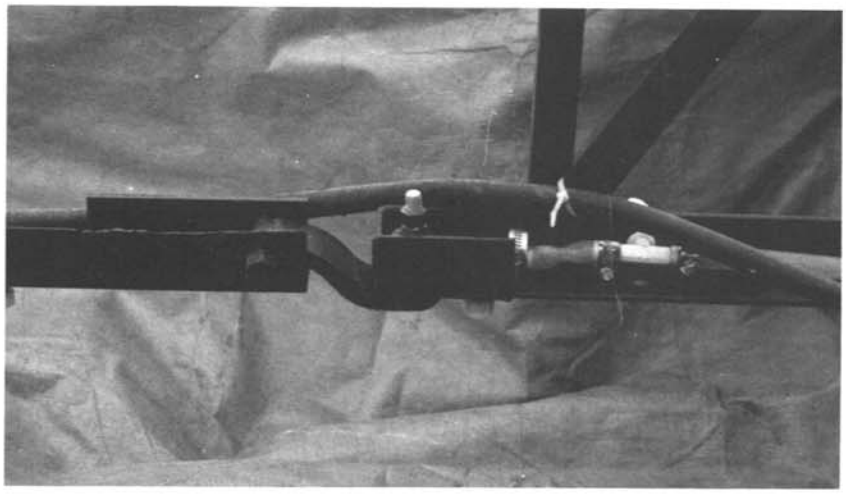

Figure 15.–Joint on center boom.

The whole project was constructed heavier than commercially available pull-type units of similar size. This will allow the sprayer to last longer and need fewer repairs, Novak believes.

The only special welding was in the use of 7018 electrodes on the corners to beef them up. Other welding was done with 6011 electrodes.

The sprayer has worked out well, both for spraying pasture and wheat fields. Novak says, "For spraying mustard in wheat, it works out real nice. We're getting better speed accuracy with the pickup than I thought we would."

* * * * *

SOME SIMPLE TESTS FOR AGRICULTURAL CHEMICALS[5]

Tank mixes of pesticides can be highly effective for controlling certain weeds, insects, and plant pests. They can also be a hazard and a problem if the chemicals aren't compatible with each other, says Dr. Gary Jensen, Extension Entomologist at Montana State University.

Jensen recommends following label directions exactly, if possible, for tank mixtures of pesticides.

He also described the following simple test that can be used to determine how the chemicals mix and to avoid such possible problems as clogged sprayer lines and nozzles, and poor results:

1. Add the pesticide or premix to 1 pint (0.473 L) of water or fluid in a quart jar

2. Add 1/2 teaspoon of an adjuvant to 1 pint (0.473 L) of liquid in a second quart jar, and then add the pesticide in the proportion to rates for field use

3. Close both jars, and mix the contents by inverting each 10 times

4. Inspect the mixtures immediately and again after they have stood for 30 minutes

The mixture should not be used if the contents do not mix uniformly.

The combination may be used if the mixture that does not contain the adjuvant remains uniform for 30 minutes. An adjuvant must be used if the solution with the adjuvant stays mixed, but the one without it does not.

If either mixture separates after 30 minutes, but remixes readily with 10 inversions of the jar, the mixture can be used with good agitation in the tank.

If clumps of solids, sludge, or nondispersible oil form, the mixture should not be used.

A simple test of liquid insecticides can be determined if they were frozen and should be discarded.

Two tablespoons of liquid concentrate should be added to a small jar that is about three-fourths full of water; the mixture shaken thoroughly, and allowed to sit for an hour. If the mixture remains uniformly milky, the insecticide probably still is good. If it separates to show a layered effect, it should be disposed of safely.

It is almost impossible to use liquid insecticides that were frozen, powders that become damp, and pesticides which have been stored for years at the recommended rates, says Jensen.

Most wettable powders probably still are good if they were stored in a closed container and kept dry. Lumps or caking indicate they should not be used.

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[5] Reprinted by permission of the Editor, Washington Farmer-Stockman, from March 15, 1984 issue.

Granules and dusts less than 3 years old probably are usable if they were kept sealed and dry. Jensen recommends buying only enough pesticide for one season, and dating packages when purchased to help to ensure they will be good when used.

Like other pesticides, insecticides require safe disposal. Small amounts can be wrapped and placed in garbage that will go into a landfill dump. The chemicals should be buried only where it is not possible for them to get into ground or surface water.

* * * * *

CHEMICAL TRAILER[6]

Figure 16.–Trailer has holders for two tanks and a storage bin for dry chemicals.

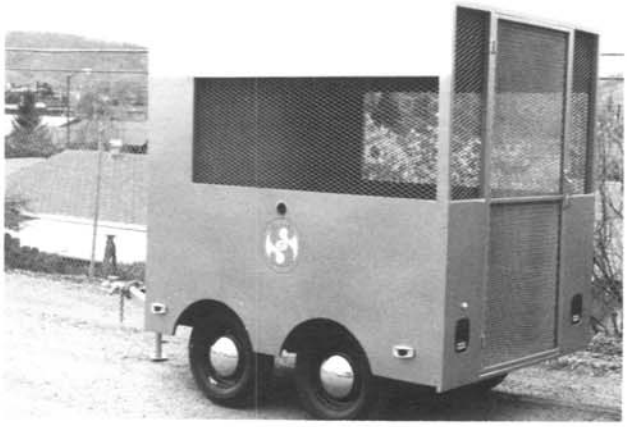

Figure 17.–Safety light hookup and common trailer hitch.

Transporting chemicals safely is a concern for all. The Solano Irrigation District constructed a trailer to meet its needs. The trailer is approximately 7 ft long, 6 ft 3 in high, and 5 ft 6 in wide (2.1 m long, 1.9 m high, and 1.7 m wide), figure 16. It has holders for two tanks and a storage bin for dry chemicals.

Level supports that can be raised when traveling have been installed on the front and back. These legs can be locked at various elevations as required. Safety light hookup and common trailer hitch have also been installed, figure 17.

The trailer was built at a cost of $1,500, including labor and materials.

[6] Article submitted by Gordon Johnston, O&M Specialist, Sacramento, California.

BAT CONTROL IN GALLERIES OF DAMS[7]

Bats sometimes use the galleries of dams for roosting purposes. The roosting problem is more prevalent in areas of the southwestern United States. Roosting bats create unsanitary conditions and unsightly messes. More importantly, some bats may be rabid and can transmit rabies through their bite.

Basically, there are three bat control methods. The methods are exclusion, repelling, and killing. Exclusion is the best method when it is practical and economical. Exclusion programs should be initiated either in late fall after the bats have departed for hibernation areas, or in late winter, or early spring before the bats return. Large openings into dam galleries can be closed off with hardware cloth or bird netting. Smaller openings can be boarded up or sealed off with flashing or other suitable material.

Bats are effectively repelled by napthalene flakes or balls (moth balls). The napthalene flakes or balls can be suspended in old socks, cheesecloth, or other suitable suspension materials in bat roosting areas. This method should not be used in confined areas where people are working for extended periods of time and would be exposed to the napthalene odor.

Killing roosting bats is another option. Chempar Products Division of Lipha Chemicals, Inc., distributes Rozal Tracking Powder. The active ingredient is chlorophacinone-liphacinone, an anticoagulant. This tracking powder is available under SLN (special local need) registration in a number of Western States. Tracking powder is dusted on roosting areas and entrance holes where bats are likely to come into contact with it. The powder adheres to the bats' feet or fur. They lick it off, and death usually occurs after 4 or 5 days of exposure. Dead bats should be collected and burned or buried deeper than 3 ft (0.9 m). Unused powder should be gathered up and disposed of properly. Rozal Tracking Powder is a restricted-use pesticide and is intended for application only by certified applicators or persons under their direct supervision.

* * * * *

[7] Written by Gary Hansen, Pest Management Specialist, Bureau of Reclamation, E&R Center, Denver, Colorado.

PUMP UNIT BEARINGS[8]

Fewer bearing failures have been experienced by the Lake Chelan Reclamation District since they replaced the glass bulb-type oil sight gages on the horizontal pump unit bearing reservoirs with galvanized pipe nipples. The pipe nipples extend higher in elevation than the top of the pump bearing reservoirs, and the bearings can now be submerged in oil during the nonirrigation season. This has prevented rust from forming on the upper half of the bearings. See figure 18.

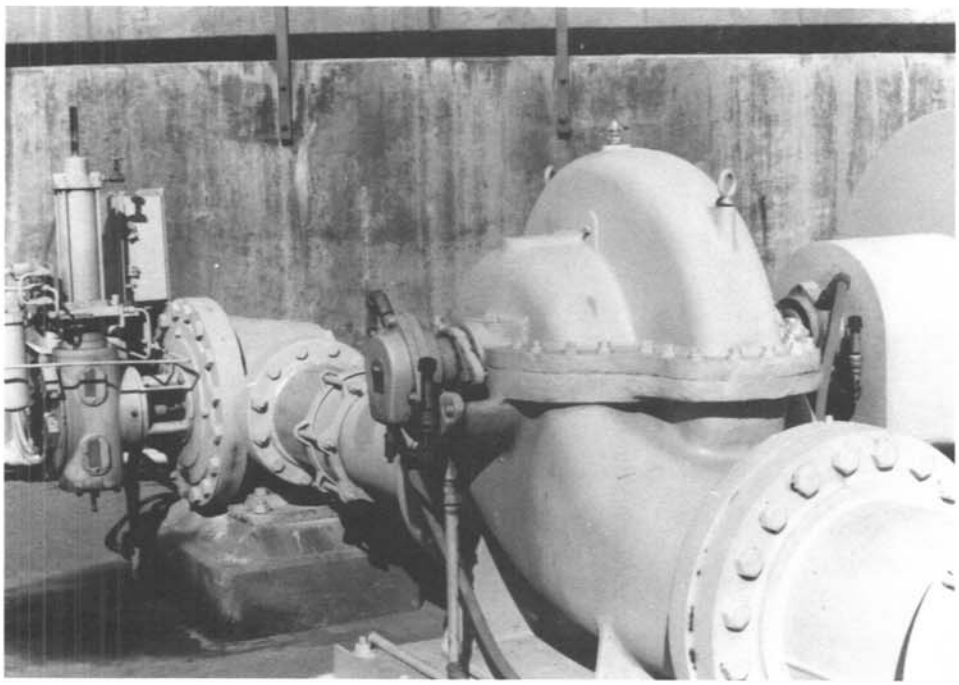

Figure 18.–Pump unit bearings.

[8] Excerpted from Review of Operation and Maintenance Examination Report by Virgil D. Temple and Keith Campbell, dated February 3, 1984, Bureau of Reclamation, Boise, Idaho.

TRANSFORMER MAINTENANCE[9]

In a recent examination of the Brewster Pumping Plant, operated by the Brewster Flat Irrigation District, an excellent preventive maintenance procedure was noted.

An oil sample is taken from the transformer every other year and tested in order to establish trends and note any unusual odor. The oil is also tested for dissolved combustible gases. The transformer is repainted regularly in areas where the primer shows through. See figure 19.

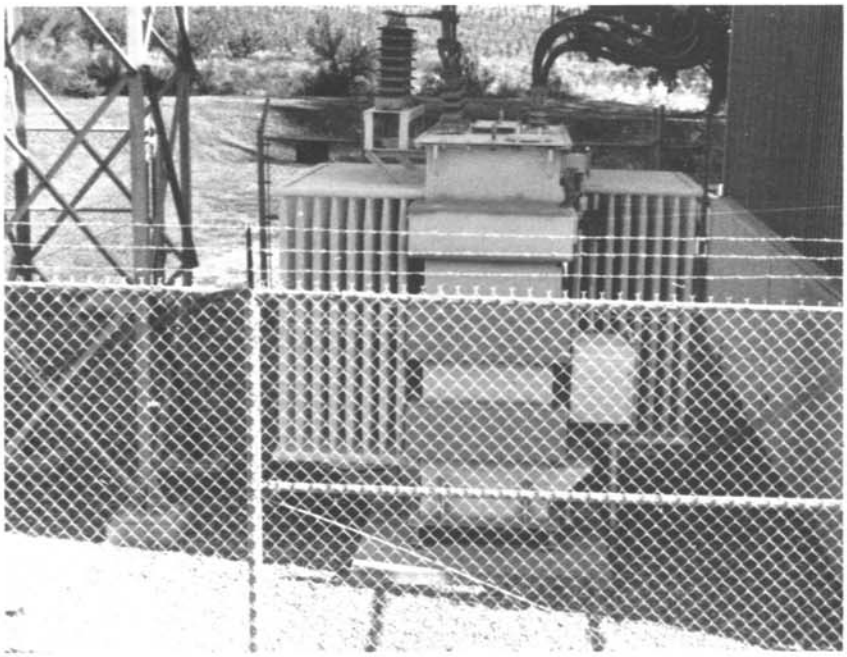

Figure 19.–Preventive maintenance on transformer.

[9] Excerpted from Review of Operation and Maintenance Examination Report by Virgil D. Temple and Keith Campbell, dated December 28, 1983, Bureau of Reclamation, Boise, Idaho.

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.

A free pamphlet is available from the Bureau entitled "Publications for Sale." It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-922, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.