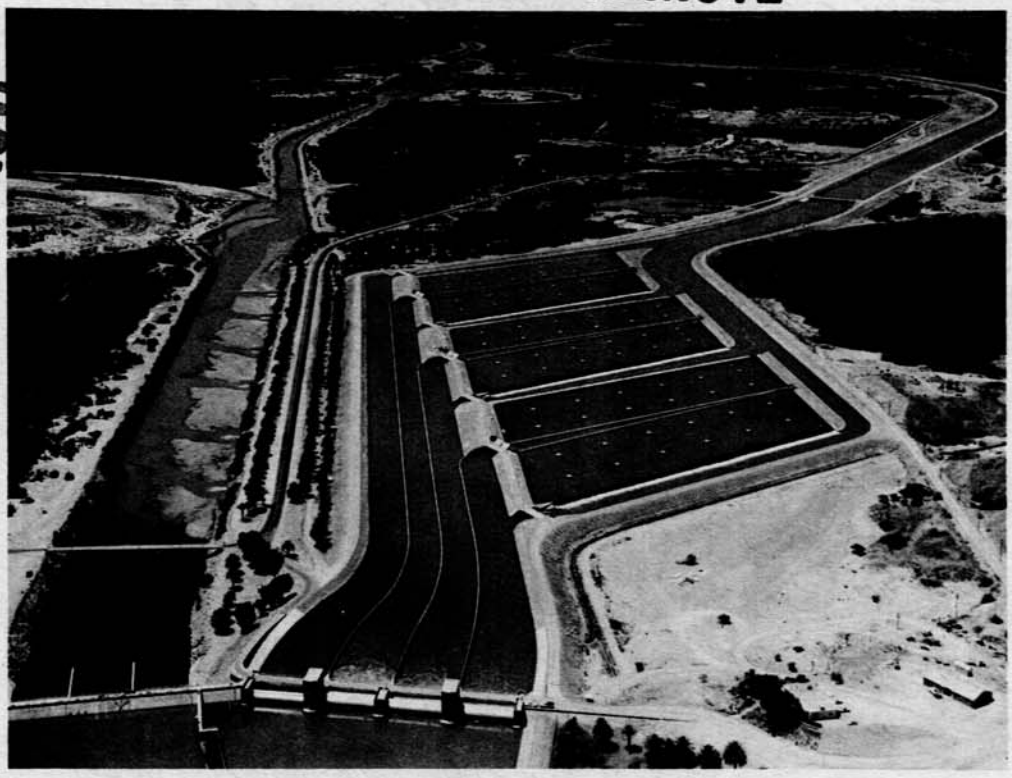
WATER OPERATION AND MAINTENANCE

BULLETIN NO. 82

DECEMBER 1972



IN THIS ISSUE:

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.

* * * * *

Division of Water Operation
and Maintenance
Engineering and Research Center
Denver, Colorado 80225

COVER PHOTOGRAPH:

Imperial Dam desilting basins on the California side downstream from the dam. Water passing through the desilting basin flows directly into the All-American Canal, Lower Colorado Region, Colorado River Front Work and Levee System, California-Arizona. Photo P212-300-6548

UNITED STATES DEPARTMENT OF THE INTERIOR
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WATER OPERATION AND MAINTENANCE
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INTRODUCTION

Using a uniquely designed epoxy pump and gun, the article starting on page 1, shows how repairs were successfully made on a concrete pedestal supporting a mechanical clarifier at the Imperial Dam and Desilting Works in California, with epoxy materials.

A shop-built hoist to lift silt and mud from a sump at the pumping plant on the Friant Kern Canal, California, can be found in an article on page 6.

An article on page 9 describes how compressed air is injected into Casitas Lake, California, by the Casitas Municipal Water District, to improve water quality.

A timely article by the National Safety Council beginning on page 12, specifies what to do when getting ready for winter driving.

The article on page 15 describes a new chemical, and when used on outside surfaces protects the building or monument from vandals.

"Aerosol Can Safety," and "Easy Vehicle Service Reminder," are the titles of two short articles to be found on page 16.

An article on page 17 gives an example of the importance of routine valve maintenance that could prevent costly and controversial results.

CONCRETE STRUCTURE REPAIRS WITH EPOXY

Use of epoxy to repair concrete structures has progressed in recent years to where varied applications are possible. The following article on epoxy repair was prepared for this publication by the Imperial Irrigation District, Imperial, California.

A concrete pedestal supporting a mechanical clarifier in the desilting basins recently failed. The clarifier was situated at the headworks of the All-American Canal on the diversion point at Imperial Dam. (See Cover Photo.)

The three desilting basins are equipped with 72 clarifiers to remove the silt settled from Colorado River water at Imperial Dam as it is diverted into the All-American Canal system.

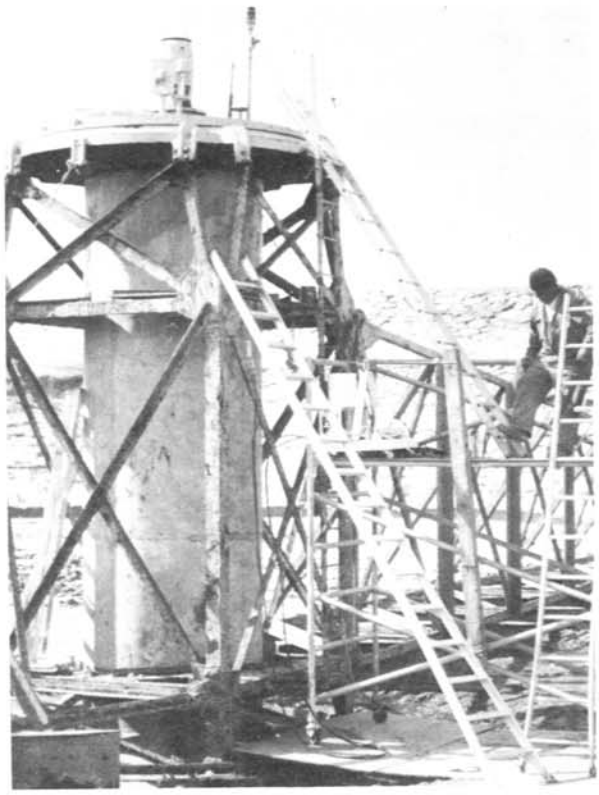

Figure 1 Photo P212-D-72384

These clarifiers are mounted on top of reinforced concrete pedestals, 18 feet high by 5-foot inside diameter, with 8-inch wall thickness. The clarifiers rotate at the rate of one revolution in 14 minutes to remove the silt deposited on the floor of the basin. This requires considerable torque on the concrete pedestal. After 25 years of service, torque has caused cracks in some of the concrete pedestals, with a severe failure recently on one clarifier resulting in an emergency shutdown. Figure 1 at left, shows a general view of Desilting Basin No. 3 and Clarifier No. 19, during the repair work. Please note epoxy pump on scaffold.

Several methods to accomplish repairs were considered. News of repairs of earthquake damaged buildings in Los Angeles area with injected epoxy sounded promising. Contact was made with the County of Los Angeles, Mechanical Department, which had successfully constructed an epoxy pump and gun

for mixing and injecting the two-part material into prepared cracks, with amazing results for sound concrete repair.

A similar pump and gun were fabricated by the Imperial Irrigation District Mechanical Shop. Mr. R. D. Reynolds, Operations Service Department, and shop personnel, were responsible for developing the equipment that was used in the repair work. The compact unit is a two-part container with each container piped to small gear pumps. An electric reduction motor is utilized to drive the gear pumps through sprockets to obtain the proper RPM to each gear pump for proper proportion of the two-part component. From the gear pumps the two components are transported through separate hoses to a mixing gun for thorough mixing prior to injection into section to be repaired. The pump is equipped with a button switch to activate the electric motor and pressure gage to determine epoxy pressure. Figure 2 below, shows a back view of the epoxy pump designed and built by the Imperial Irrigation District personnel. Figure 3 on page 3, shows a front view of the pump and hose connections and also showing the epoxy mixing gun with pipe nipple.

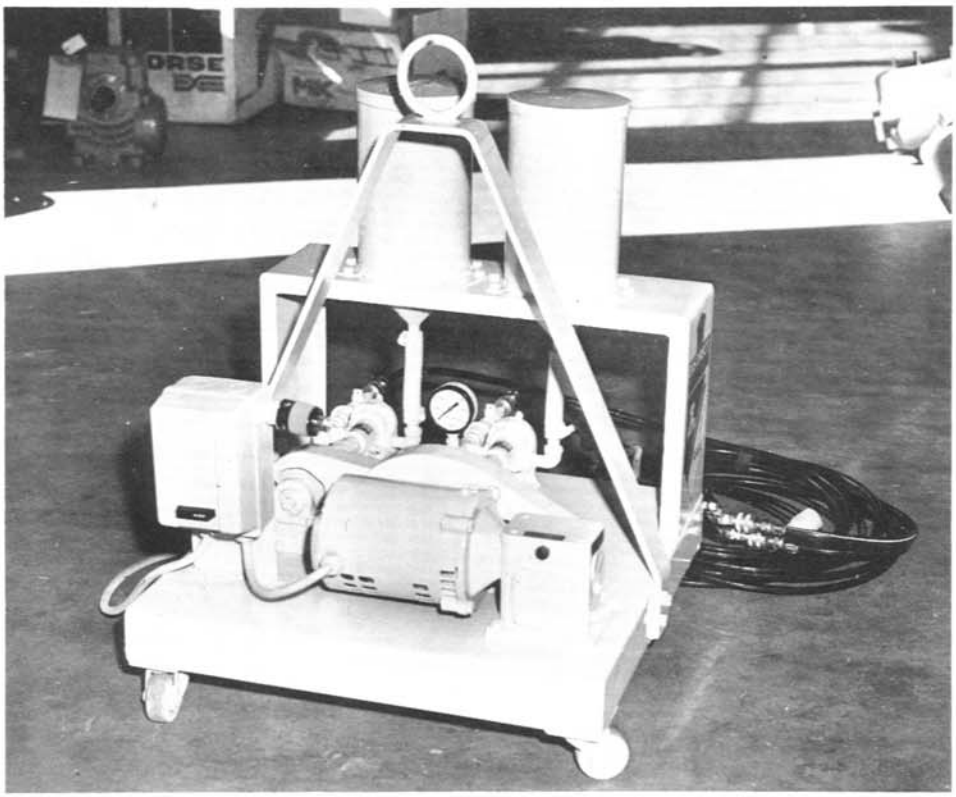

Figure 2 Photo P212-D-72402

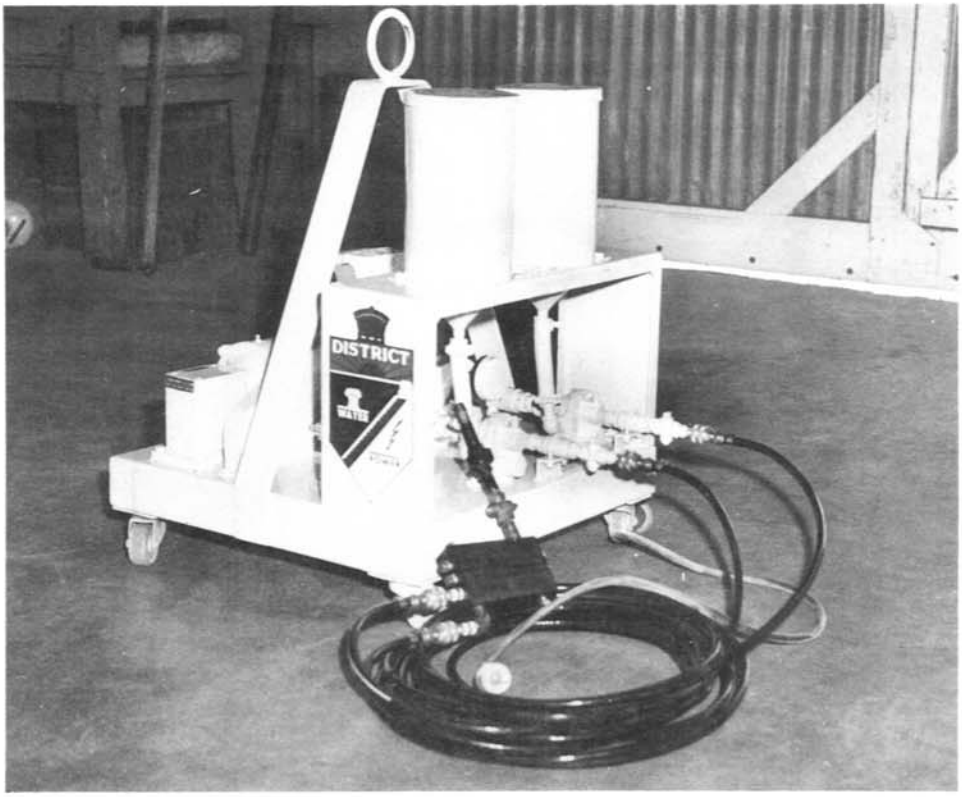

Figure 3 Photo P212-D-72401

The visual cracks to be repaired are routed out to a 1/4-inch depth groove, using a carborundum blade. A 1-inch-diameter core drill is used to drill a 1-inch minimum depth hole along the crack at approximately 18- to 24-inch spacing. A core drill is necessary to keep the internal crack open. Styrofoam is laid in the back or bottom of the hole. Figure 4 on page 4, shows a closeup view of the damaged concrete on the exterior of the reinforced concrete pedestal. Note that the conduit and reinforcement steel is exposed.

The routed cracks and drilled holes are filled with a paste epoxy and allowed to cure for 72 hours. The hole is then drilled and tapped to accommodate a 3/8-inch pipe nipple. The styrofoam plug is removed, thus creating a small cavity adjacent to the crack to be pressure filled.

The epoxy mixing gun with pipe nipple is secured to the tapped hole and concrete adhesive epoxy is then injected into the crack. See Figure 5 on page 5, showing cracks in concrete pedestal being pressure filled with epoxy using the epoxy injection gun. The operator activates the epoxy pump with pushbutton switch to bring pressure up to 200 psi and as pressure diminishes, the pump is reactivated and brings

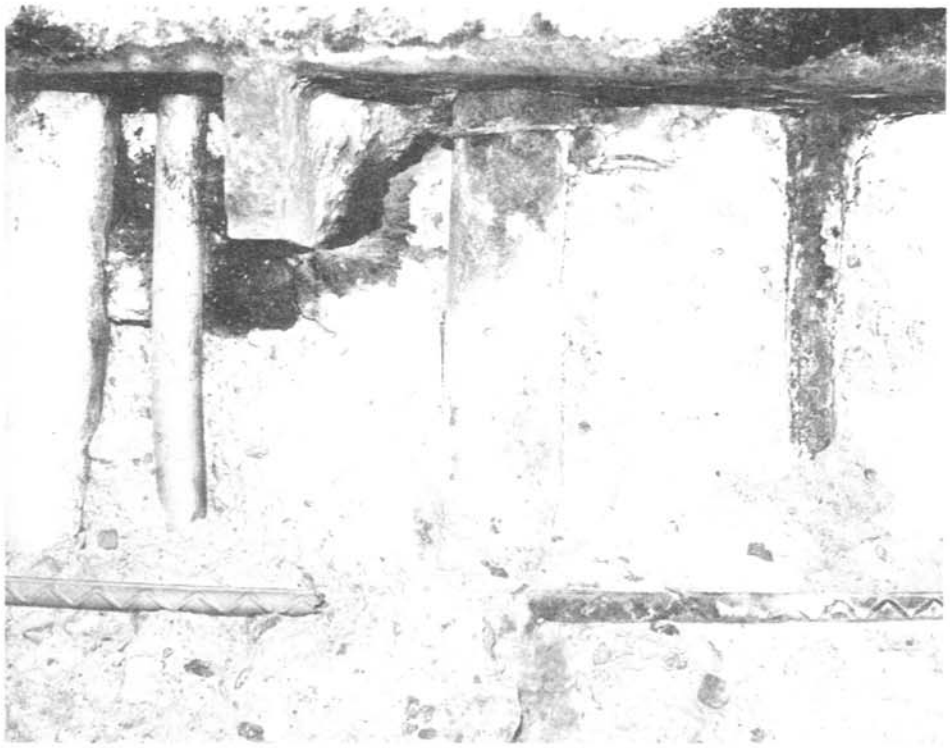

Figure 4 Photo P212-D-72400

the pressure back to 200 psi. This is repeated until the epoxy begins to weep from an adjacent hole or pressure does not diminish.

The pipe nipple and gun are removed from the filled hole and a cork is inserted to retain the epoxy until it solidifies. The cork is later removed and the hole filled with paste epoxy. The process is repeated until all prepared holes and cracks have been treated. Figure 6 on page 5, shows the repaired section with the epoxy-silicon and epoxy grout between pedestal and clarifier base.

Repairs were also made successfully to a concrete slab deck roof for Pilot Knob Hydro Electric Plant, near Yuma, Arizona. Previous repairs had been made without success in an attempt to seal rainwater from entering into operating area of powerplant below the deck roof.

The epoxy pump and gun were utilized to treat all visable cracks and from results of epoxy being spread throughout cracks, it now appears that the roof has been permanently sealed.

If additional information is desired regarding this epoxy pump and repairs, please write to the Regional Director, Lower Colorado Region, P. O. Box 427, Boulder City, Nevada 89005.

Figure 5 Photo P212-D-72399

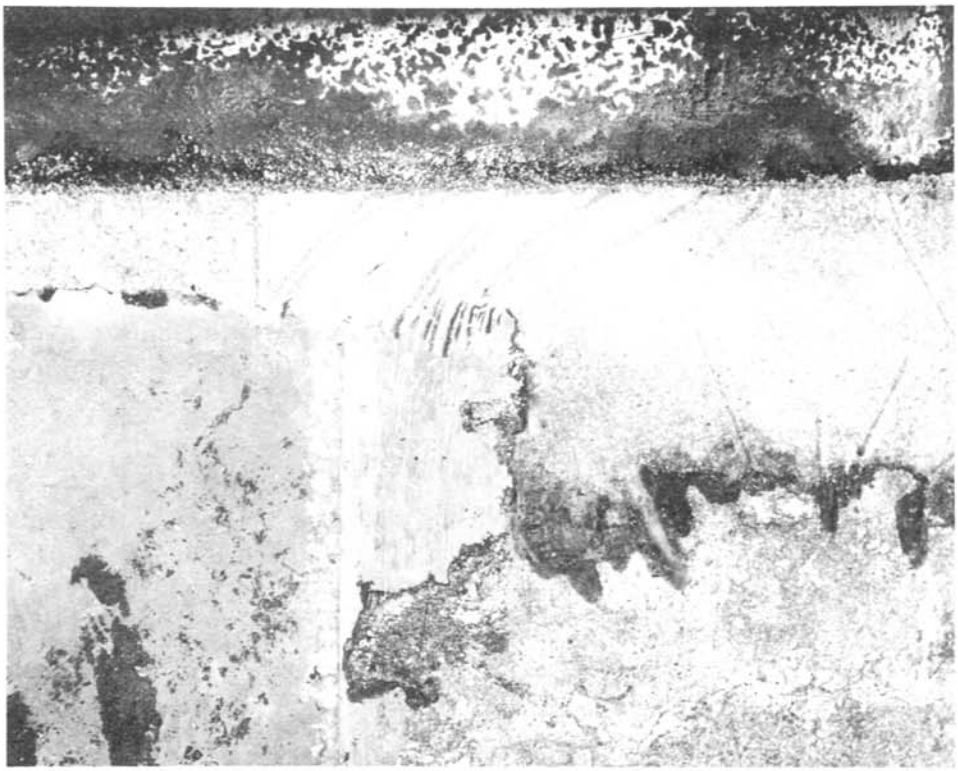

Figure 6 Photo P212-D-72398

SHOP-BUILT HOIST[1]

Through the combined efforts of the Tea Pot Dome Water District, Porterville, California, and a local machine shop a small hoist was designed and fabricated using scrap materials found in their respective maintenance yards.

The hoist is now being used by the district to lift silt and mud from the sump at the pumping plant located at Milepoint 99.35 on the Friant-Kern Canal. District maintenance personnel manually fill the 30-gallon barrel with the mud and silt, then the hoist is used to drag the barrel over to the sump access hole, where it then lifts the barrel out of the sump. The hoist is then swung around and the barrel is dumped into a dump truck.

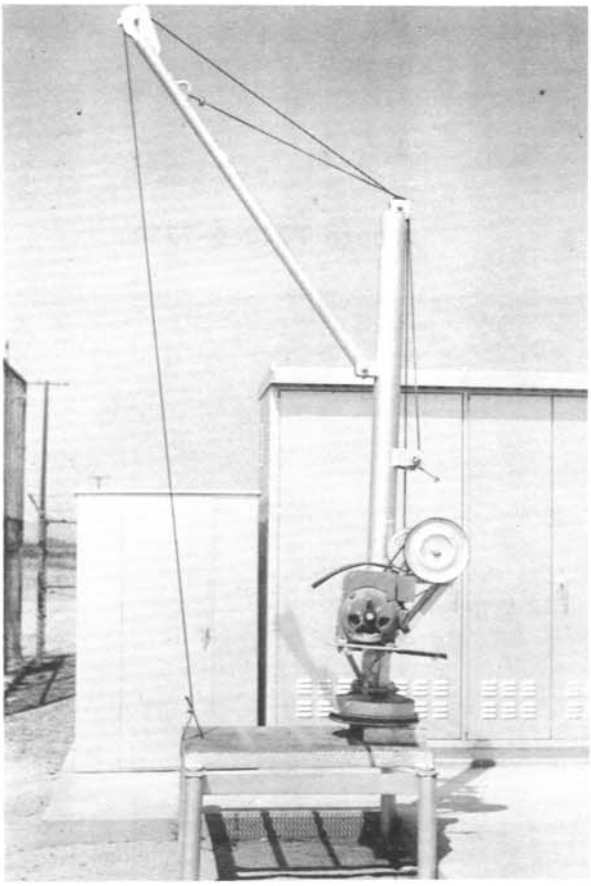

Figure 7 Photo P214-D-72385

Hoist unit consists of four 4-inch-diameter steel pipe supports mounted in concrete to form a 4- x 4-foot base on which is mounted a wire fabric covered 3-foot x 4-foot x 3-1/4-inch channel frame. Figure 7 at left shows the supporting framework for the entire unit.

Welded to the framework is a short piece of 4-inch-square bar to which is attached a heavy truck spindle and 18-inch-diameter brake drum. The truck spindle and drum provides a means by which the hoist can be swung around to unload the barrel into the dump truck. Figure 8 on the next page, shows a closeup view of the brake drum and spindle setup.

Attached to the brake drum by using the lug bolts is the 8-foot 2-inch x 6-inch diameter heavy wall pipe main support. This support carries the vertical loading and resists

[1] The article was prepared especially for this publication by the Fresno Field Division, Mid-Pacific Region, Central Valley Project, Fresno, California.

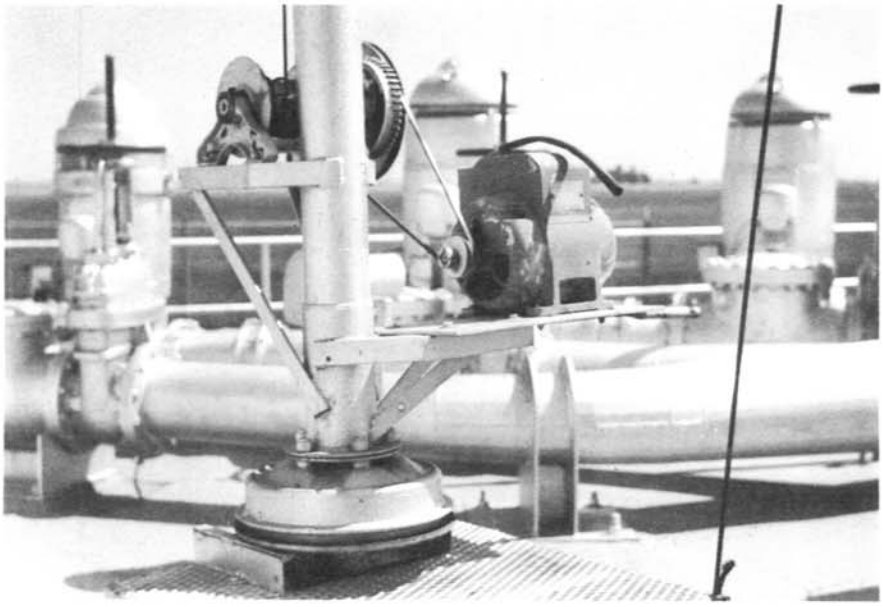

Figure 8 Photo P214-D-72386

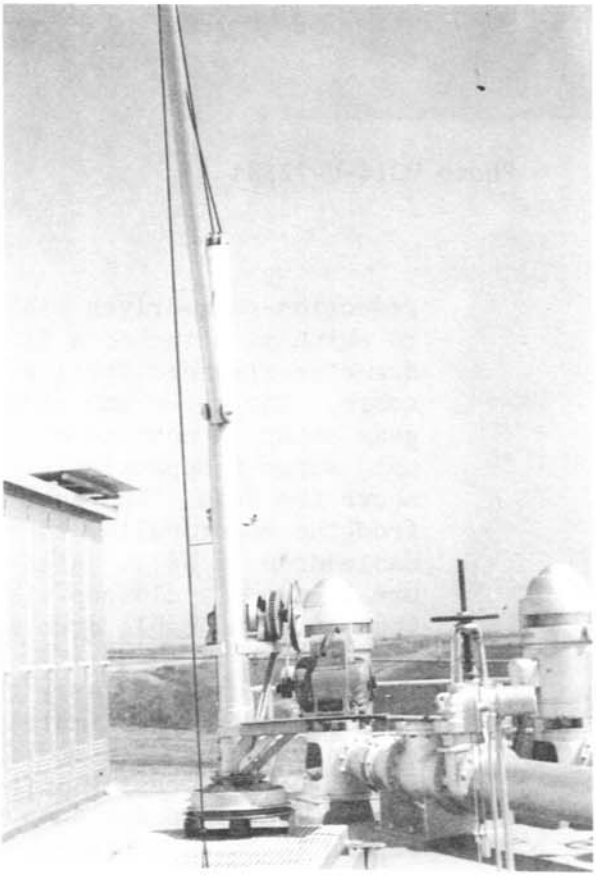

Figure 9 Photo P214-D-72387

the bending moments caused by the load of mud in the barrel. It also provides support for the motor and cable drum which raises and lowers the load. Figure 9 at left, shows a view of the main support.

The support arm is mounted on the main support 35 inches from the top of the main support and is made from 3-inch-diameter x 6-foot steel pipe. A 4-inch-diameter pulley is mounted on the upper end of the support arm to carry the 3/8-inch-diameter stranded steel wire cable that lifts the load. The angle of the support arm is adjusted by a small cable drum hoist located 54 inches from the top of the main support. Figure 10 on the next page shows the support arm and support arm adjusting hoist.

The load is lifted by a 3-horsepower, single-phase, 220-volt, 1,710-rpm motor attached to a

Figure 10 Photo P214-D-72388

Figure 11 Photo P214-D-72389

reduction-gear-driven cable drum to which is attached a 3/8-inch-diameter stranded steel wire cable. The motor and reduction gear setup is mounted on the main support approximately 2 feet above the base. The gear ratio from the motor pulley to the cable drum is 88:1. Also Figure 10 shows a closeup view of the motor and cable drum setup.

The barrel used to carry the mud and silt hold approximately 30 gallons and has been modified so that it can be easily lifted and emptied out into the dump truck. Figure 11 shows a closeup view of the barrel and the modification.

* * * * *

RESERVOIR DESTRATIFICATION IMPROVES WATER QUALITY[1]

Casitas Municipal Water District in California has made substantial progress with a new line of attack in meeting water quality problems. Operators are injecting compressed air into Casitas Lake to equalize temperature and dissolve oxygen content. The air is injected about 140 feet from the surface and creates currents, which seem to "stir" the water throughout the reservoir.

The results to the user are cooler water, reduced tastes and odors, reduced organic content, much better chemical quality, reduced costs for quality control, less use of chlorine, and reduced treatment costs to some industries.

A side benefit is the improved fishery in the lake. The District started experimenting with air injection 4 years ago to eliminate problems caused by high summer temperature of surface waters.

Prior to that time algae growth, spurred by warm surface water and high concentrations of nutrients at the surface, caused taste and odor problems. Users complained.

Treatment to control the algae consisted of copper sulphate and citric acid, applied to the shallower water at a cost of some $20,000 a year.

The theory of injecting air into a lake was not completely new. Others have done it on a smaller scale. It was the first time, however, that a body of water as large as Lake Casitas had been treated successfully.

Casitas Lake is a reservoir built by the U.S. Bureau of Reclamation about 10 miles from Ventura, California. When full it covers 2,700 acres, contains 250,000 acre-feet of water and at a maximum is 270 feet deep.

Water service is furnished to agriculture (mostly truck and citrus crops), and municipalities and industry. The latter has increased rapidly as the area has experienced a large influx of industrial development and residential subdivisions.

As municipal and industrial uses increase, water quality control becomes more and more important.

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[1] Written by Mr. R. G. Howard, Supervisor Water and Land Operations, Mid-Pacific Region, Sacramento, California and reprinted from the Reclamation Era of February 1972.

Algae growth that causes taste and odor problems is a constant problem in reservoirs, especially in warmer climates.

In summer the lakes stratify; that is, a layer of warmer water forms on top with colder water below. The natural dissolved oxygen is concentrated in the warmer surface waters.

Warm temperatures together with sunlight and high nutrient content encourage algae growth. When the algae begins to die, the resultant taste and odor are objectionable.

Others had discovered that air bubbling to the surface, after being piped to the bottom of the reservoir, creates currents and tend to equalize both water temperature and oxygen content. Accordingly, in 1968 the district started experimenting with air injection.

The operators had many problems. They had to learn about equipment, how to regulate depth and air pressures, and how much air to inject.

They learned by doing. They found, for instance, that air injected at the very bottom created more problems than it cured, by bringing manganese into solution from the bottom sediments.

Water containing appreciable quantities of manganese is undesirable for domestic use because it causes staining of porcelain and laundry.

The air injection system now being used consists of two 315-cubic-foot-per-minute electrically driven compressors. Both are operated continuously from March until October except when one is down for maintenance or servicing.

Air is carried through a 3-inch pipe supported on barrel floats to the deepest part of the lake. Here, four 1-inch hoses lead down to a diffuser system 140 feet below the surface. Air bubbling up from diffuser system makes the lake "boil" over a 2- or 3-acre area.

Contrary to what one might think, the effects of this "boil" of water are not confined to the one site. Imperceptible currents are set into motion that seem to reach and affect every part of the lake. Samples show that the summer surface temperatures are some two to three degrees below pre-treatment, and deeper temperatures are somewhat higher than before.

Dissolved oxygen is found to depths of 120 feet throughout the summer, as compared to only 25 feet prior to aeration.

Costwise, the air injection is less expensive than previous treatments of algae with copper sulphate. After a capital outlay of $19,000, operation and maintenance costs are projected at about $12,000 a year.

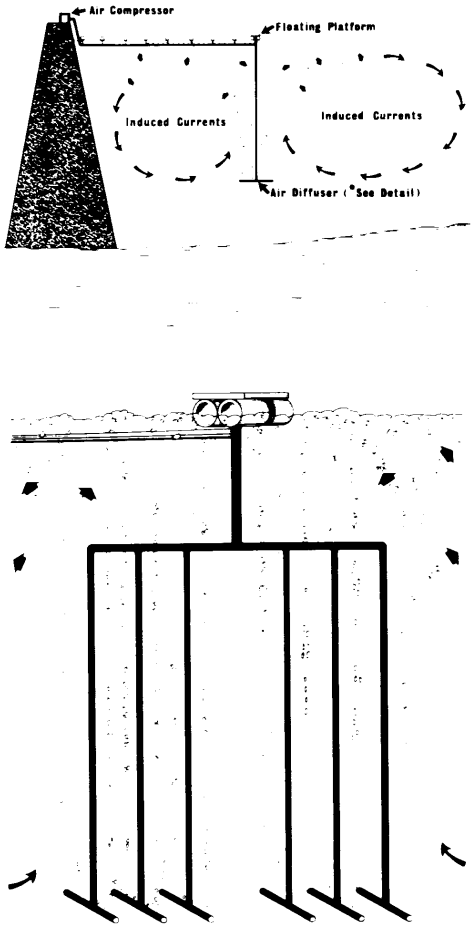
Surface treatment by copper sulphate, which cost approximately $20,000 per year prior to aeration was not necessary during the past year.

Due to improved quality of the water, much less chlorine is required for efficient treatment.

The benefits extend beyond cash costs to the district. One industry had spent about $250 a day for chemicals to remove oxygen from the water. Now, cost has been reduced considerably because water with a much lower dissolved oxygen content is selected for use.

Fishing has been improved. The lake is a favorite spot for campers and fresh water fishermen from the Los Angeles metropolitan area, and 100,000 catchable trout are planted in the lake each year. Since the air injection program began, these fish have thrived.

Trout have shown remarkable growth. Many trout planted as 1/4-pound fish now weigh 5 pounds or more.



Sketch

The Reservoir Aeration System consists of two 315-cubic-foot-per-minute compressors to supply air to the system through a 3-inch pipe suspended near the water surface from 55-gallon drums; see sketch at left. The air diffuser system is suspended from an 8- x 8-foot platform, plus additional drums not shown in the drawings. The diffuser is made up of 1-inch pipes, 140 feet in length, spaced at 25-foot intervals. The induced currents produced by rising air bubbles are sufficient to "mix" virtually all the water stored in the 240,000-acre-foot reservoir. Care must be used to avoid placing the diffuser too close to the reservoir bottom, possibly disturbing accumulated sediment. In this case, air was released about 70 feet above the bottom.

Whether this system developed by the Casitas District will solve similar problems elsewhere will have to be determined. Obviously, no two situations are exactly alike, nor can their solutions be exactly the same. The success of the Casitas District, however, points to a method that fully merits consideration by others with similar problems.

* * * * *

GETTING READY FOR WINTER DRIVING

(This article taken in part from a pamphlet printed by the National Safety Council, 1972.)

Driving accidents go up at a chilling pace in winter. That's because many motorists don't understand the winter driving picture. They fail to take into consideration the hazardous conditions created by winter weather--tricky traction and poor visibility.

Winter driving demands special defensive driving skills and adjustments--and just plain common sense. The winter scene won't be such a grim picture if you'll read and heed some solid advice from the committee on Winter Driving Hazards of the National Safety Council.

Readying the Car

Don't wait until winter is in full swing to get your car ready. As soon as the temperature starts to drop, drive in to see your serviceman and have him:

Check the Battery. - Fill and test. Get a charge if you need it. If you suspect it won't get you through another winter, get a new one.

Check the Tires. - Tread should be deep if you have regular tires. But now's the time to consider special winter tires. Snow tires are a big help, but studded tires (preferably on all four wheels) are even better, especially on icy roads.

Check the Brakes. - Have them adjusted if necessary. You need equal pull on all four wheels for straight-line stopping.

Check the Exhaust System. - Carbon monoxide from a leak in the exhaust system can be lethal. Have the muffler and entire system inspected.

Check the Windshield. - Defroster should work efficiently. Replace worn wiper blades and adjust tension. Put anti-freeze solution in the washer.

Seeing

Winter driving hazards can be avoided. But you've got to see them.

Peephole driving is inviting disaster. Before you pull out, clean off the entire windshield and all windows. A few extra minutes could save your life.

Road spatter can leave you driving blind. Use your windshield washer often. At night, stop occasionally to clean off headlights. In fog or heavy snowfall, keep lights on low beam.

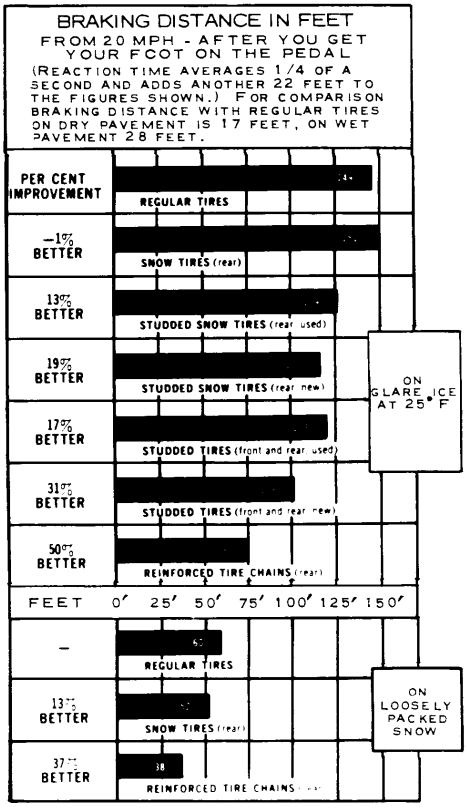
Run your heater and defroster a few minutes before you start out in a cold car. You'll prevent sudden fogging of your windshield.

Going

Snow can be pretty--and pretty awful, too. If you get stuck in snow, keep as cool as the weather.

Spinning your wheels will only dig you in deeper. First turn your wheels from side to side to push the snow away from the tires. Then, with a light foot on the gas, try to ease forward gently. High gear helps you from over-powering.

Easy rocking might help. But beware--you can damage an automobile transmission. Check your owner's manual for manufacturer's advice about rocking.



You might get the bite you need by putting rock salt, sand or a traction mat such as wire mesh or carpeting under both rear wheels. They're handy items to keep in your trunk if you face severe conditions. However, your best bet to get going in winter is with chains or studded tires. (NOTE: Some states and at least one Canadian province prohibit the use of studded tires. Most states limit their use to winter months. Check the law where you drive.)

Stopping

A safe stop on icy or snow-packed roads is a tricky maneuver, calling for skill and good judgment.

First of all, anticipate stops. Slow down gradually well ahead of intersections. Remember that the approaches to stops are apt to be polished and slick by stopping and starting traffic.

A skid is almost certain if you lock the brakes. Use hard rapid jabs on the brake pedal to keep your wheels rolling and to retain steering control.

Increase your following distance. You need extra time and lots of extra space to come to a safe stop on slippery roads.

Know your braking distances on wintry roads. The chart on the preceding page can help you judge a safe following distance.

Steering

Sudden steering movements can whip you into a skid almost as easily as improper braking.

Plan ahead for lane changes and move into them on a long, gradual tangent--and be sure to signal your intentions to traffic behind. Slow down for curves and turns. Take them with the smallest possible steering adjustment and apply slight power during the movement.

If you do go into a skid, there are two cardinal rules--don't oversteer and don't hit the brakes. Immediately steer in the direction that the rear of the car is sliding until you "feel" the recovery. Then straighten your wheels and keep rolling.

Watch out for unexpected ice patches on otherwise clear roads, especially in shady areas or on overpasses. Remember that ice is twice as slippery at 30° as it is at 0°. Wet ice warmed by the sun is far more treacherous than "cold" ice.

The Driver

The big factor in the winter driving picture is YOU....your attitudes, your adjustments and the common sense that you must apply to cope with the perils of winter roads.

Get the whole picture and you'll drive safely through the winter:

1. Get your car ready.
2. See all around you.
3. Know how to go in the snow.
4. Anticipate stops.
5. Steer with a firm, steady hand.

* * * * *

CHEMICAL SKIN PROTECTS BUILDINGS, MONUMENTS[1]

In the March, 1972, issue of The American City, we discover that once again technology seems to have found an answer to itself. This time an antidote for the already proven permanent markers and spray cans of iridescent paint which vandals seem to have claimed for their weapons. The anti-vandal chemical is called Hydron 300 and when applied to walls and concrete monuments forms an impervious barrier, preventing paint and inks from being absorbed into the material.

The chemical was recently tested on the George Washington Monument in Boston's Public Gardens. Hydron 300 was coated on a side of the monument and left to dry. The monument was then splattered with paint which was also left to dry. The experimenters then easily wiped away the paint with the help of ordinary paint remover. Had the monument not been treated, the cleanup job would have consisted of the usual scrubbing with detergent and steel wool, or the not-so-often used, but more effective, technique of sand-blasting.

The manufacturer states that the primary use of the chemical is to preserve masonary building surfaces. It is claimed to have an unusual "breathing" quality which inhibits the passage of moisture into the building material but also allows moisture trapped inside to escape to the air outside. Dirt rests on the outer skin and under normal conditions will be washed off by rain. Atmospheric pollutants including unburned hydrocarbons and sulphur dioxide will not penetrate the chemical barrier as the company claims the chemical skin is completely stable, non-corrosive, non-toxic and inhibits efflorescence.

* * * * *

The atmosphere is a very effective vehicle for water transport. A column of atmosphere contains, on the average, vapor equivalent to about one inch of liquid water--the thickness of the layer of water that would form over the entire earth if all atmospheric water were suddenly precipitated. Locally, however, storm air masses may contain as much as 3 inches of water or more. The air mass involved in a tropical storm may contain in the order of 3 to 7 cubic miles of water, and it may transport this water thousands of miles. Only part of the contained water vapor is actually precipitated. For example, it has been estimated that the total annual vapor transport across the conterminous (48) United States is equal to nearly 15,000 cubic miles of water, but only about 1/10 of this is precipitated.

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[1] Reprinted by permission of GRIST, September/October 1972 issue, a publication by the National Conference on State Parks, Washington, D. C.

AEROSOL CAN SAFETY

(Reprinted by perimission of GRIST, September/October 1972 issue, a publication by the National Conference on State Parks, Washington, D. C.)

With summer gone, the potential for accidents involving aerosol cans is still very dangerous.

To illustrate this point, here's the story of an accident which could have been avoided if the person involved had used common sense. A Park Service vehicle with a black-colored dashboard was parked while the driver went on an errand. Prior to leaving the vehicle, the driver placed an aerosol can on the dash, apparently so he would notice it when he returned. Fifteen minutes later, and fortunately after the driver had left on the errand, the aerosol can exploded--shattering the safety-plate windshield of the vehicle.

The damage to the truck was avoidable and fortunately no one was injured. The moral of the story is simple: Read the instructions on aerosol cans, specifically the section warning about storage above 120° F. The black dashboard on the NPS vehicle absorbed heat from the overhead sun and created an oven effect.

Most of us know how hot parked cars get from the sun. That's too hot for safe storage of aerosol cans. And, never puncture a can--it could explode in your face.

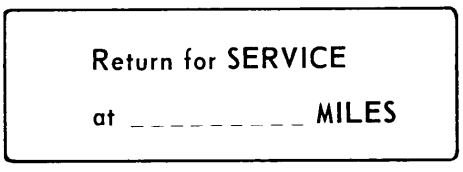
* * * * *

EASY VEHICLE SERVICE REMINDER

Is your project of work vehicle typical? If so, it is used by a variety of drivers and run many hundreds of miles without regular servicing.

To combat this situation, Gary Patzke, Assistant Park Superintendent, Devil's Lake State Park, Baraboo, Wisconsin, devised a simple sticker which can be placed on the dashboard of these vehicles reminding the driver of regular service.

The trick is both easy and inexpensive: Self-adhesive labels are stamped and the servicing mechanic places the appropriate mileage on the sticker which is then conspicuously placed in the cab of the vehicle.



The stickers can be purchased at office supply stores for about $1.50 per 250, and rubber stamps can be purchased for a comparable price. Happy Maintenance!

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VALVE MAINTENANCE[1]

Normal maintenance procedures seem to cover the more obvious equipment essential to the operation of a facility. Many times an overlooked auxiliary piece of equipment may play just as important a role in the project operation.

The need for scheduled maintenance and exercising of an outlet works needle valve, high pressure gate valve, spillway gate, pump discharge valve, etc., is quite evident to maintenance personnel. Perhaps not so evident are smaller valves that serve to guard a system serving a number of functions. These guard valves require closing only when a shutoff valve to a branch system fails to operate or needs to be removed from the system. The operation of these valves at such a time becomes of major importance.

A situation developed recently at a reservoir outlet works structure where an 8-inch gate valve could not be closed. With reservoir pressure on the system, it appeared advisable not to attempt a forced valve closure for fear of cracking the 125-pound valve casting. The other alternatives were:

1. Seal off the pipe inlet which would require divers.

2. Install stoplogs and unwater the outlet works.

3. Lower the reservoir.

All three methods would be very costly, with lowering the reservoir water surface adding a controversial element from fishing, hunting and environmental groups. Rather than initiating action in these directions, the valve was inspected to determine if it could be closed without fear of damaging the valve casting. Examination revealed that the valve stem and yoke threads were completely bound together with corrosion. The yoke was removed, with considerable difficulty, by intermittently heating. The threads on the stem and yoke were cleaned using cutting oil and steel wool, and fortunately little deterioration of the threads had occurred. After reassembling the yoke to the valve, lubricating the threads, and with the packing gland loose, an attempt was made to lower the valve stem. The concern at this time was that the valve disc could be corroded to the disc guides in which case the

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[1] Written by L. J. Yocom, General, Engr., Maintenance Branch, Division of Water Operation and Maintenance, U.S. Bureau of Reclamation, Engineering and Research Center, Denver, Colorado.

disc pin could shear making valve replacement necessary. Fortunately, the valve disc broke loose from the guides and closed satisfactorily.

The above situation would not have occurred if the proper valve maintenance had been accomplished. A good maintenance program should require annually that all valves be lubricated to protect the stem and yoke threads, and be exercised to ensure that the disc and packing box are not bound. If excessive leakage is occurring through the packing, the gland should be tightened, or if necessary, the packing replaced. It should be noted that most valve packing can be replaced with the valve in the fully open position while the valve is under pressure.

The purpose of the guard valve is to isolate a system for maintenance of equipment. It may not be needed only once in 10 years, but then must be in reliable condition.

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