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EC69-777 Management and Re-Use of Irrigation Runoff Water

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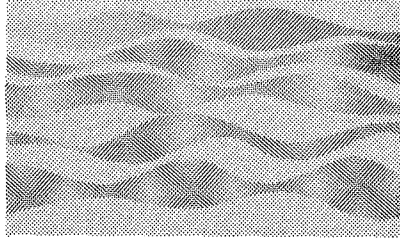
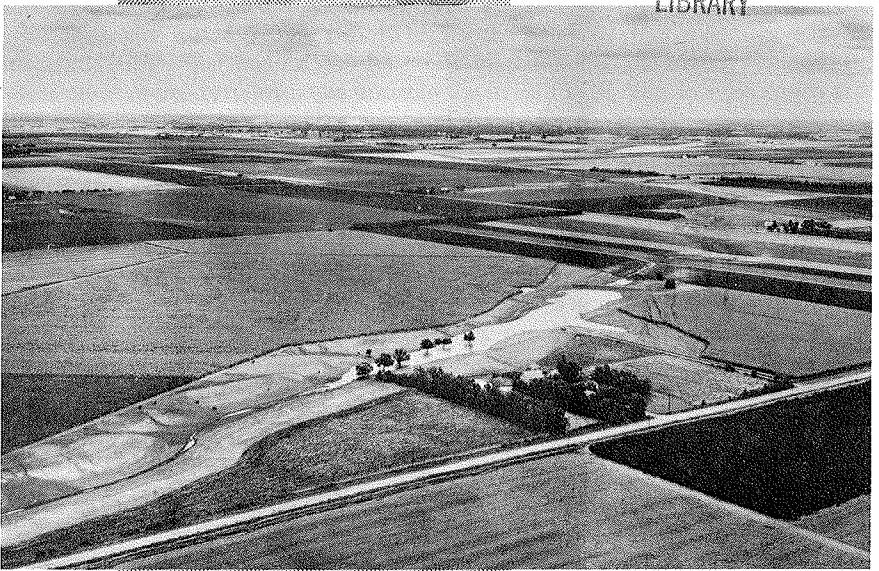
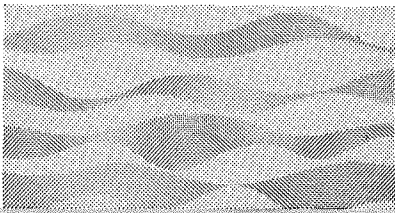
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MANAGEMENT and RE-USE of IRRIGATION RUNOFF WATER

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MANAGEMENT AND RE-USE OF IRRIGATION RUNOFF WATER

by

J. F. Decker and H. D. Wittmuss ^{1/}

Introduction

An irrigator has the potential of high water application efficiency, low labor requirement and top production potential if he installs a system to re-use irrigation runoff water. Other advantages such as efficient application of fertilizer in irrigation water also may be realized. Interruptions of farm operation on adjacent fields or neighbors' fields may also be eliminated by reusing the runoff water.

A re-use system collects irrigation runoff and returns it to the same or an adjacent field for irrigation. The component parts of a re-use system consist of drainageways or waterways to convey water to storage, a sump, dugout or pond for storing water, a pump, a power unit and a pipeline or ditch to convey water for redistribution.

Irrigation runoff losses, which average 25–30% of all water applied, can be saved by installing a re-use system. A given size well can irrigate 40% more acres with the same water if 30% runoff losses can be saved. If the same acreage is irrigated, substantial savings can be made in the amount of water pumped. In some cases re-use systems make possible the irrigation of remote areas which are impractical to irrigate from the main well.

Completely installed re-use systems including sump, pump, power unit and return pipe cost from \$1,000 to \$3,000. The total cost of pumping re-use water may be as low as \$4.00 per acre foot, which is generally less than the cost of pumping from the ground water or from a ditch system.

Re-use systems are economically feasible at present day prices on fields which collect runoff water from 100 or more acres and when the lift from the main irrigation well exceeds 100 feet. They can also be justified under other conditions if irrigation water is in short supply or runoff water causes an inconvenience to the operator or neighbors. Typical re-use systems are shown in Figures 1, 2 and 3.

Drainage or Waterways

Drainageways collect runoff water at the end of an irrigation row and carry it to a grass waterway or directly to the dugout for storage. Drainageways should be grassed and large enough to carry the maximum runoff from irrigation. A trash rack should be installed in the drainageway just before the re-use water enters the sump or dugout to keep trash from clogging the re-use pump.

Water Storage

Ponded water creates a hazard and liability problem to the owner. Liability can be reduced by installing warning signs and by fencing around the ponded area.

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H. D. Wittmuss, Associate Professor, Department of Agricultural Engineering.

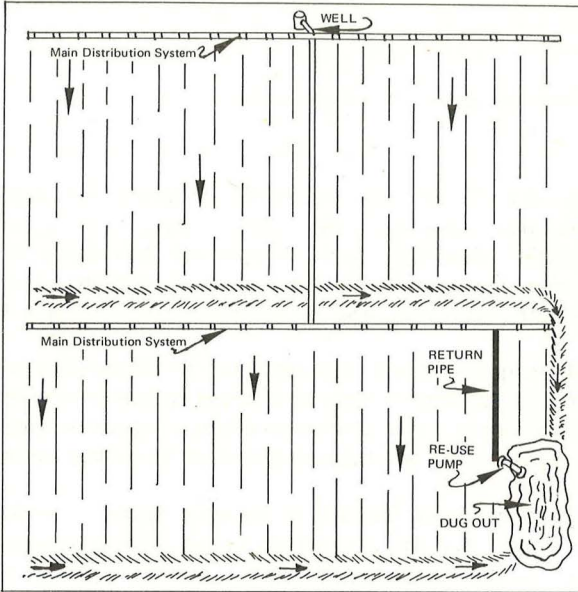


Figure 1. Water is collected in a dugout and returned to the main distribution system.

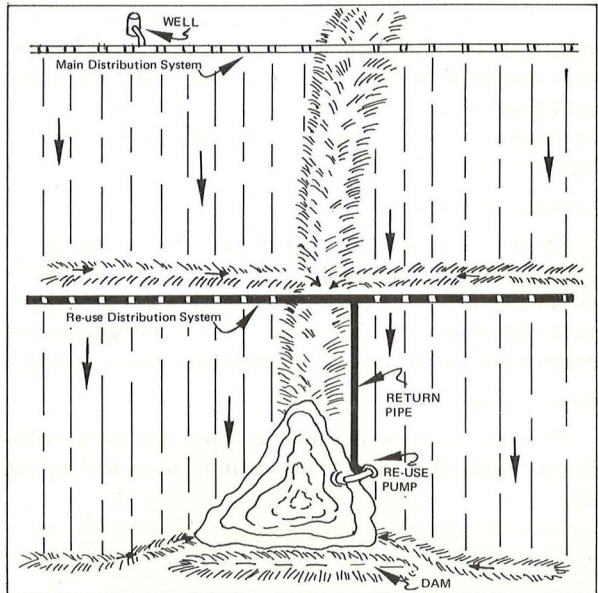


Figure 2. Water is collected in a farm pond and applied to another field by gravity.

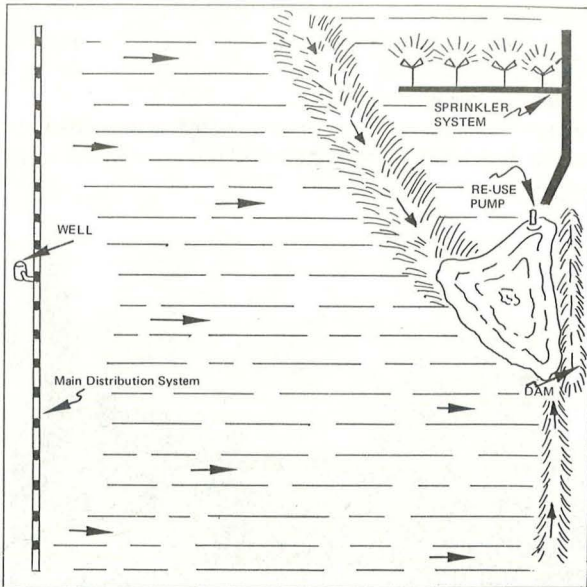


Figure 3. Water is collected in a farm pond and applied to another field through sprinklers.

Water can be stored in a pond behind a dam, a dugout or a small sump. All three are used and each has limits of adaptation.

A small sump is used where land has a high value, water cannot be retained in a dugout or water ponding is undesirable. The small sump is generally a vertical concrete or steel tube 48 inches in diameter installed to a depth 10 to 11 feet with a concrete bottom. The water is pumped from the sump and discharged into the main distribution system from a pump automatically controlled by a water level control switch.

Dugouts are most common and most easily adapted to storage and re-use of irrigation runoff water. Dugouts should be at least 8 feet and preferably 10 feet deep to discourage the growth of aquatic weeds. Side slopes should be constructed with 2-foot horizontal slopes for each one foot of vertical slope to prevent sluffing of the soil. A system should allow for an unused storage depth of 1 foot.

Dams are often used to concentrate runoff water from rainfall or irrigation for re-use but are limited by topography to definite location. Many times runoff water from one field can be collected in a farm pond and applied to another field, thus extending the use of irrigation water. Ponds vary in size from those required for small dugouts to those large enough to store all the runoff from a maximum storm that could be expected every 10 years.

Sediment build-up in storage facilities is a problem which may be prevented. Sumps and dugouts can be protected by building a dike around them to prevent the entrance of rainfall runoff which is often laden with sediment. A trash rack and inlet structure is needed where water enters the dugout or sump. Two layers

of hail screen separated two or more inches make a very effective trash rack. An inlet structure consisting of plastic sheet, concrete drop, pipe inlet, chute or other types diverts the water into storage without eroding away the entrance and filling the storage reservoir with sediment.

A pond which collects all the runoff water is designed with sufficient capacity to store both the anticipated sediment accumulations and water required for irrigation.

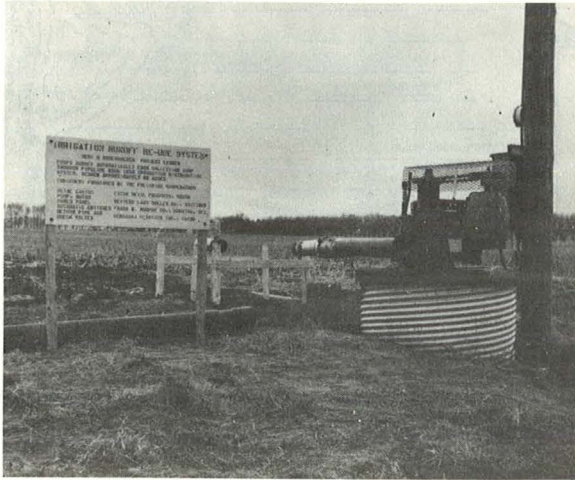


Figure 4. A small sump 4 feet in diameter 11 feet deep with a turbine pump.

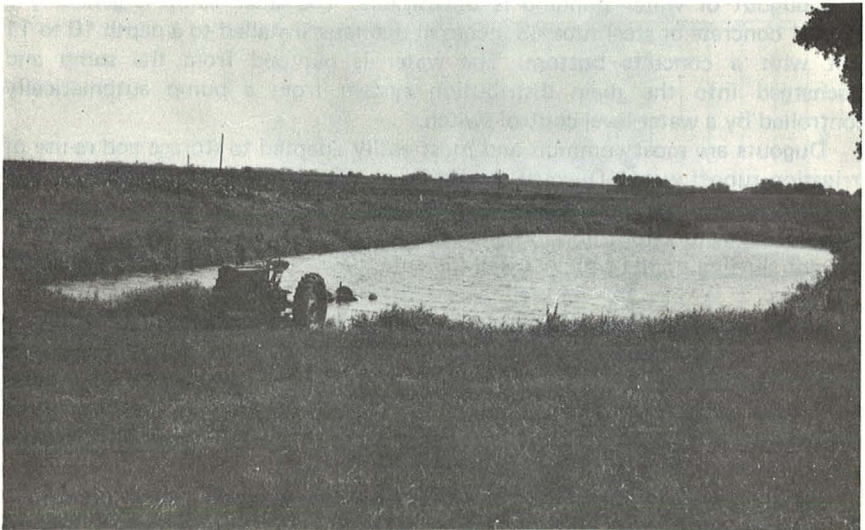


Figure 5. A dugout being pumped with tractor-mounted, submerged centrifugal pump. Dugout should be diked to keep rainfall runoff from running through dugout. A trash rack and inlet structure is needed where water enters dugout.

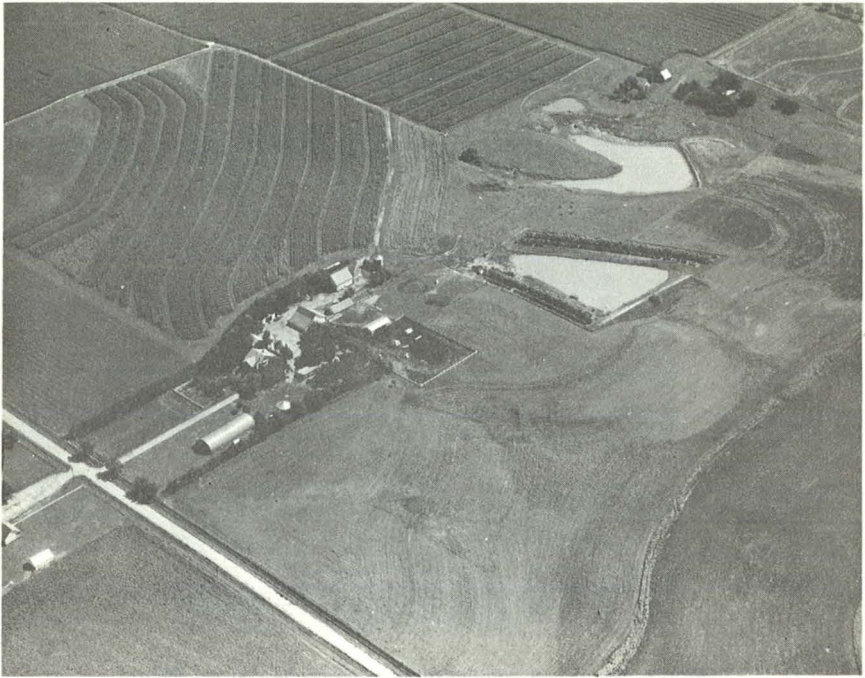


Figure 6. Farm ponds used to store runoff water for re-use.

Pumps

Single stage turbines, hand-primed centrifugals, self-primed centrifugals, submerged centrifugals and sump pumps can be used with re-use systems. Performance curves supplied by the manufacturer for each type of pump are used to select the right pump for the operating head and discharge conditions.

Turbine pumps (Figure 7) permanently installed are convenient and the most efficient type pump available. Turbine pumps can be driven by either a direct connected or V-belted electric motor (Figure 8) or by an internal combustion engine. V-belt connections allow more flexibility in pumping rate when changes are made in pulley sizes.

Hand-primed centrifugal pumps (Figure 9) are convenient and generally less costly than other pumps. The pump is commonly connected to a tractor power takeoff and mounted on a trailer. It is positioned on ground level and the suction line is lowered into the water. The pump must be hand-primed each time it is operated.

The self-priming centrifugal pump (Figure 10) can be started automatically without attendance. It can also be tractor-connected and trailer-mounted. Self-priming centrifugal pumps cost more than hand-primed centrifugal pumps.

The submerged centrifugal pump (Figure 11) is connected directly to a motor or engine and discharges at ground level. Tractor-mounted units are commonly used as portable units.

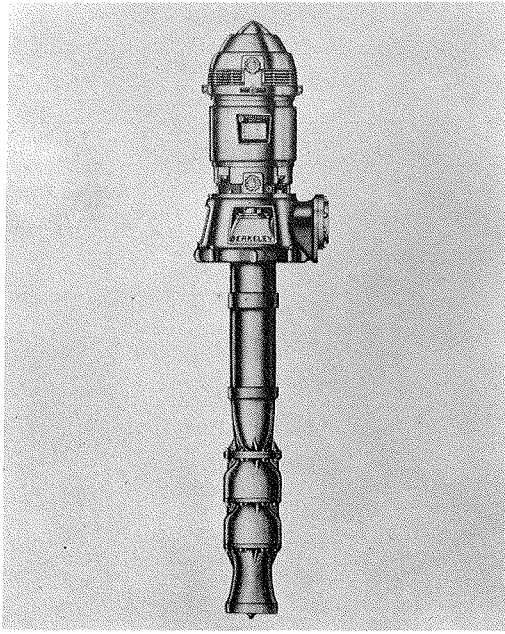


Figure 7. Deep well turbine directly connected to an electric motor. Pump speed cannot be varied to change discharge rate.

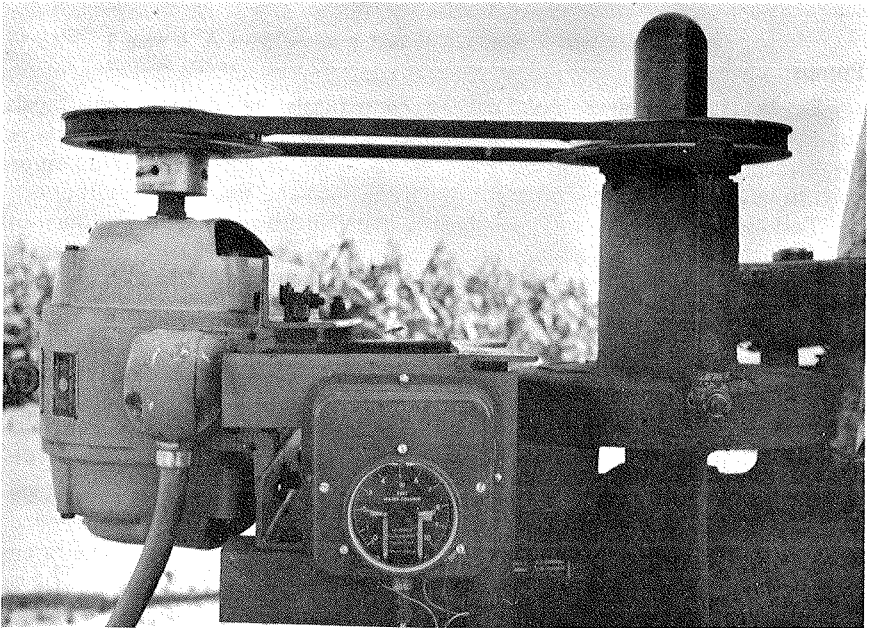


Figure 8. Deep well turbine V-belted to an electric motor. Pump speeds and capacities can be varied by changing pulleys. Protective screen shown in Figure 4 was removed from motor and pump drive before taking picture.

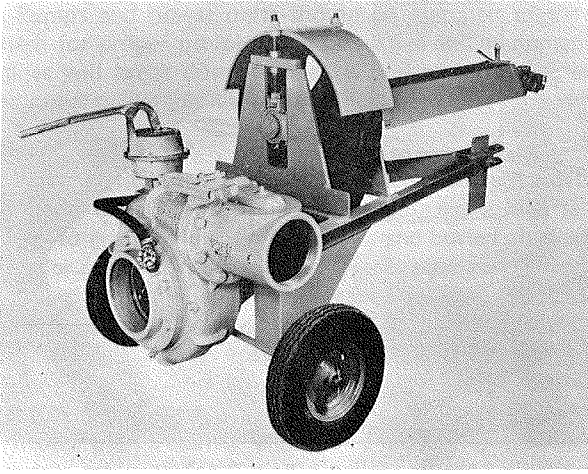


Figure 9. Hand-primed centrifugal pumps are convenient and low in cost.

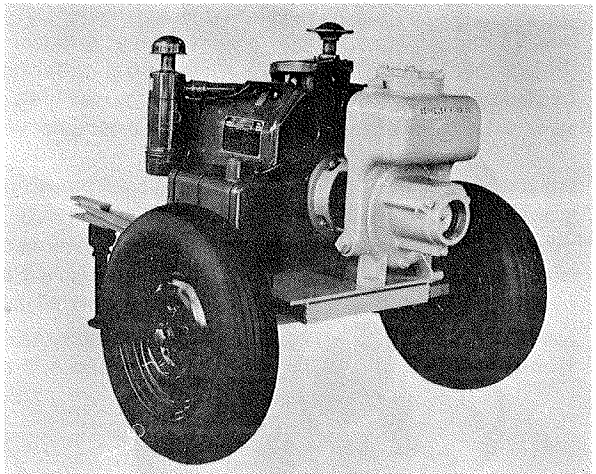


Figure 10. Self-priming centrifugal pumps are more convenient than hand-primed pumps.

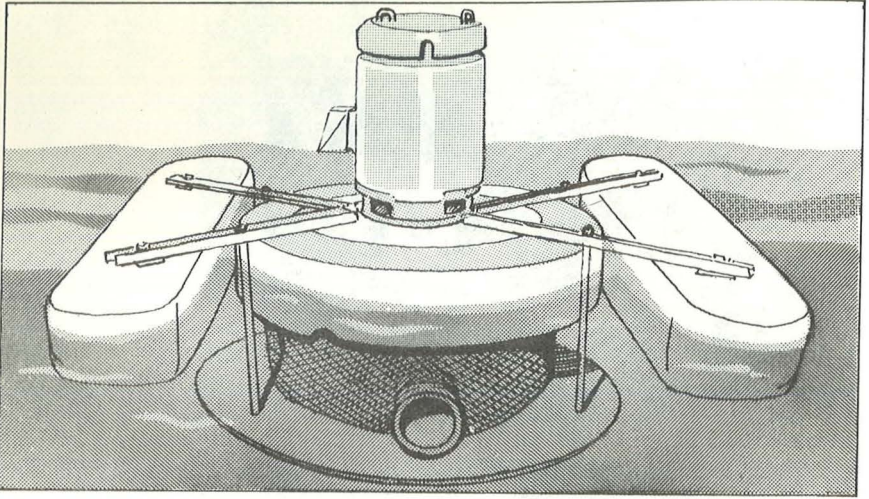


Figure 11. Submerged centrifugal pumps are very convenient.

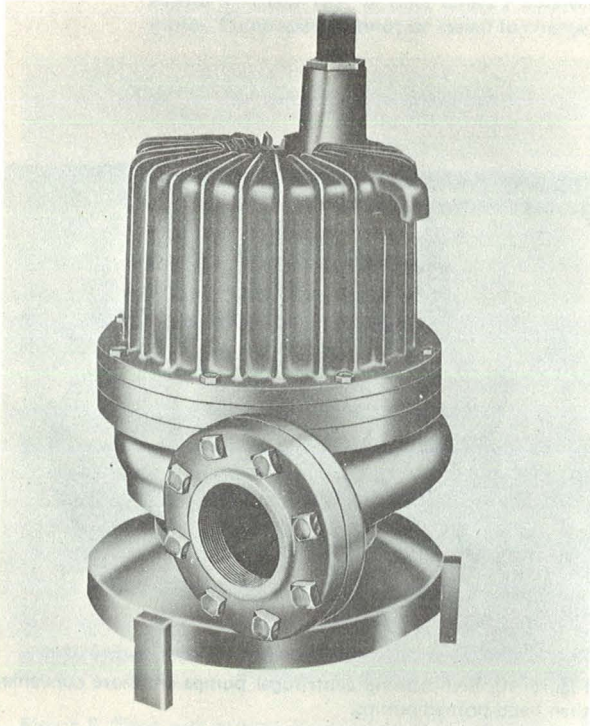


Figure 12. Sump pumps can be submerged in water during operation.

The sump pump and motor (Figure 12) can be submerged in the water for pumping and the pump is non-clogging. The pump can be operated automatically by a water level switch.

Pumps and power units should be matched to the design capacity of the system for proper performance of system and equipment. Undersized motors or engines will break down frequently and oversize engines may have high energy requirements and low operating efficiencies.

Conveyance Systems

Water can be carried in an open ditch, a surface pipeline or a buried pipeline. The open ditch is the cheapest system, has a high labor requirement and is limited to gravity flow. Portable pipe and buried pipelines have a high cost but a low labor requirement.

Aluminum, plastic or butyl rubber pipe are used for surface return systems. Six-inch pipe is the minimum size recommended when 400 gallons per minute are discharged through 1000 feet of pipe. Surface pipe is mobile and can be used in more than one location. However, surface pipe may restrict farm operations during irrigating seasons.

Steel, plastic-coated aluminum, concrete, cement asbestos, plastic and fiberglass are used for buried pipelines. Buried pipelines do not interfere with farming operations. Buried pipelines are more costly than other types but labor requirements are low.

Adaptation to Automatic Surface Irrigation

A re-use system is essential for development of automatic surface irrigation. It collects and automatically returns the runoff water to the general distribution system. Small re-use pumps, operating from a dugout on a complete set basis or from a small sump with an on-off water level control switch, each discharging into the main distribution system are very easily adapted to automation.

Design of Re-use System

An owner planning to install a re-use system should fill out Figure 13 and Part A of Table I. This information is needed to engineer a re-use system and fill out the design information data required in Part B of Table I. Many suppliers of irrigation equipment employ engineers who can design re-use systems for their customers.

The entire re-use system should be designed before construction starts so the storage capacity, pipe size, pump size and power unit size are matched. If any component is improperly matched, the re-use system may operate inefficiently or even fail. Good design is particularly important when a re-use system pumps water back into the main distribution system.

A properly designed re-use system will give years of trouble-free service, save water and save labor. Both the operator and community benefit when runoff water is kept under control.

FIGURE 13

MAP OF IRRIGATED AREA – FIELD WORKSHEET

Owner _____ Address _____ County _____

Legal description – Part _____ Section _____ T _____ R _____

Normal use – 1 quarter section map – 660' x 660' squares = 10 acres each

Table I

Design Date Form for Planning Re-Use Systems

A. Information to be furnished by owner

I. Identification

- a. Landowner _____
Address _____
County _____
- b. Land description: Part _____ Sec _____ T _____ R _____

II. Field description

- a. Acres irrigated _____
- b. Area draining into proposed storage
 - Field No. 1 acres _____ length of run, ft. _____ Slope, % _____
 - Field No. 2 acres _____ length of run, ft. _____ Slope, % _____
 - Field No. 3 acres _____ length of run, ft. _____ Slope, % _____
- c. Soil classification
 - Field No. 1 texture _____ basic intake _____
water holding capacity _____ in/ft
 - Field No. 2 texture _____ basic intake _____
water holding capacity _____ in/ft
 - Field No. 3 texture _____ basic intake _____
water holding capacity _____ in/ft

Information is available at County Extension office or
Soil Conservation Service office.

III. Source Water Supply

- a. Source _____
Flow rate, gpm _____ Discharge pressure, psi _____
- b. Distribution system: lateral and siphon tube _____
gated pipe, feet _____ buried pipe, feet _____

IV. Type of re-use system devised

- a. Small size storage (sump) – cycling
pump and water level control _____
- b. Medium size storage (dugout) – pump
designed for continuous operation _____
- c. Large size storage (pond)
 - 1. Pump designed for continuous
operation _____
 - 2. Pump designed to operate at the
start of each irrigation set
(1/4 time of irrigation) _____
 - 3. Pump designed to supply total water
needs each 4th or 5th day _____

- V. Method of control for re-use power unit
- Completely manual (internal combustion engine with safety devices) _____
 - Electric pushbutton control _____
 - Water level control _____

VI. Waterways in runoff system:

	Field 1	Field 2	Field 3
a. Field drains, feet	_____	_____	_____
b. Waterway to storage, feet	_____	_____	_____

VII. Re-use distribution system

	Main distribution system	Adjacent field
a. Graded ditch	_____ feet	_____ feet
b. Surface pipe system	_____ feet	_____ feet
c. Buried pipe	_____ feet	_____ feet
d. Sprinkler system	_____ ft main line	_____ ft main line

B. Design information

I. Water storage

- Small sump _____ diameter _____
depth _____ material _____
- Dugout
Storage capacity, acre inch _____ or cubic yards _____
- Pond
Storage capacity, acre inches _____
or cubic yards _____

II. Pump and power unit for re-use system

(Suggest minimum pump capacity 1/3 of source supply)

- Design pumping rate for re-use pump _____
- Head conditions
 - Lift - water surface to pump discharge, feet _____
 - Elevation - pump discharge to pipe discharge, feet _____
 - Friction loss in pipeline
Pipe diameter, in. _____ pipe length, ft. _____
Friction loss, ft. _____
pipe diameter, in. _____ pipe length, ft. _____
Friction loss, ft. _____
 - Pressure at source pump discharge, *feet _____
*Used when re-use water is discharged into main distribution system
 - Total head, feet _____
(5 = 1 + 2 + 3 + 4)

c. Pump design

Type pump _____ Model _____

Pumping rate gpm _____

Pump speed, rpm _____

Pump screen, type _____

Discharge pressure, psi _____

Pump efficiency under design conditions, % _____

d. Power unit

Electric motor, Model _____ HP _____ Speed _____

Voltage _____

Internal Combustion Engine,

Model _____ Bore x Stroke _____

Fuel _____