spreading by means of diversions is designed to be more or less self-operating as a rule, but no system can be expected to continue to operate without maintenance. The cost of maintenance will be much less if the system is observed closely and repairs and adjustments are made promptly. Rodents, for example, may burrow through dikes and cause destruction of the whole system unless repairs are made.

Unrepaired, a minor detail may become a major operation. Silting may necessitate adjustments such as shifts in location of spreader dikes. The main diversion is the key to the whole system and may be destroyed or made useless by lack of proper maintenance.

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SPACING WATER HOLES TO SAVE GRASS

B. W. ALLRED, HOWARD MATSON

THE RANCH that has poorly spaced and too few water holes for its cattle faces the danger of ruinous overgrazing around the water holes while little use is made of the forage that lies just beyond.

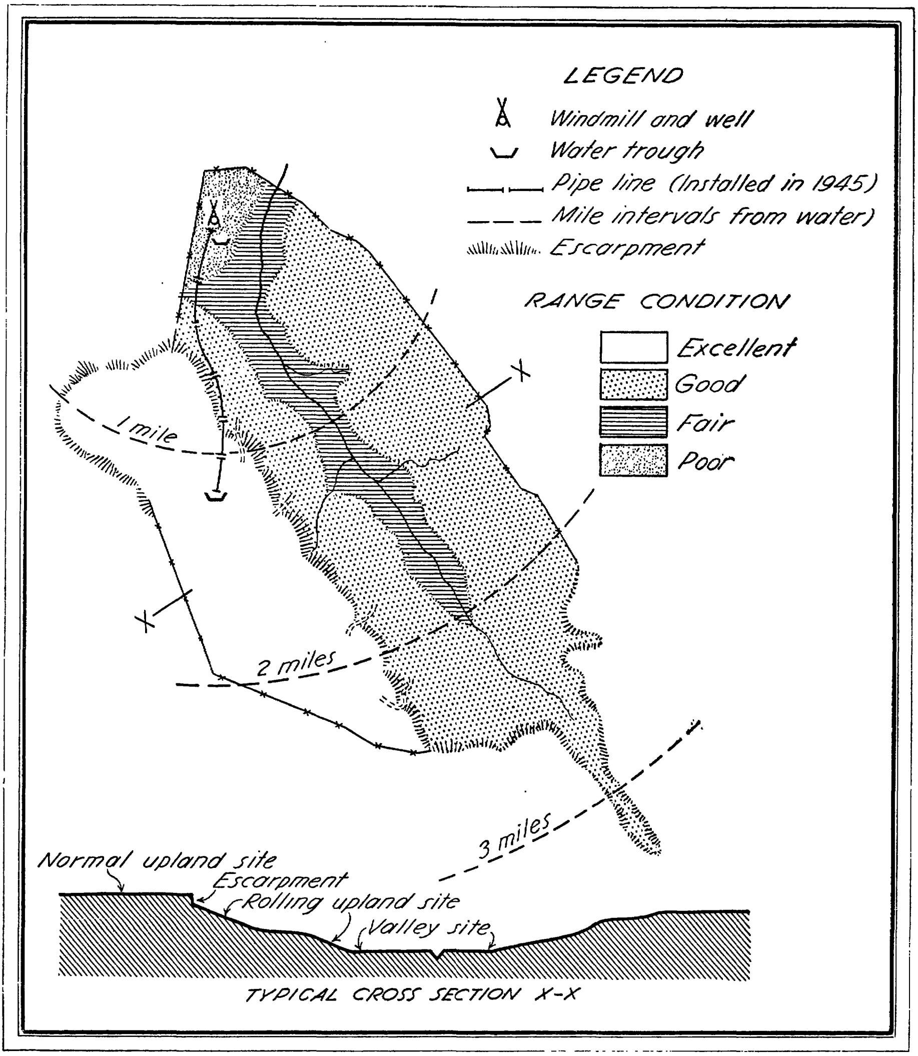
As the grass is tramped and grazed out, wind and water erosion takes a foothold and spreads rapidly. The eroding soil gradually loses its ability to absorb the water needed for good vegetation. The only remedy for this situation is to have plenty of well-distributed stock-watering places that will cause the livestock to spread out over the range and prevent the concentration of grazing in small areas.

To illustrate: East of Colorado Springs, ranges in poor condition near overused water holes absorbed only a third as much heavy rainfall as good grassland that was a long distance from water.

Another example: A rancher near Mangum, Okla., planned a soil conservation program on his 4,700 acres and developed a spring and 9 stock ponds to furnish fresh water at convenient locations for his cattle. Now there is no sign of erosion or the destruction of forage grasses because of grazing concentrated around water holes. His lowland range is covered with western wheatgrass, Texas bluegrass, and Canada wild-rye, and the upland range has a vigorous stand of little bluestem, sand bluestem, and side-oats grama. Beneath the grass is a cushion of litter that breaks the fall of the rain and lets it sink quickly into the soil. The improved method of watering and other conservation practices have increased livestock production on the ranch 25 percent.

Springs, wells, and ponds are the most common types of stock-water developments. A dependable supply of good water at the lowest cost for installation and upkeep is usually the goal. Wet-weather springs, intermittent streams, and shallow ponds are used frequently as extra sources of water.

The correct installation of watering facilities is based on the number of animals to be grazed for a given number of days during a particular season, lay of the land, quality of water, con-



The improper placement of watering facilities led to the uneven use of forage on a 1,690-acre ranch near Marfa, Tex. The cattle grazed too much around the windmill and trough, and the forage there fell off 75 percent. The areas near the stream (indicated by the heavy shading) were next most heavily grazed. The animals were not forced to go for water to the upland area, where the forage was excellent.

dition of forage, spacing, ease of approach, and cost.

The rancher should plan for about 10 to 12 gallons of water daily per head for cattle, horses, and mules. Dairy cows and work horses need 25 to 30 percent more. Sheep and goats need 0.8 to 1 gallon.

The size and shape of pastures influence the location of water supplies. For example, livestock in the Southwest tend to graze into the wind; hence the windward side of a pasture is often tramped out. Some ranchmen change their fences to give the animals a wider pasture and place the water supply on the leeward side to bring about a more even use of the forage.

In many places springs can be developed easily into dependable sources, particularly when they are at a convenient location. A hillside spring that has a flow sufficient to meet requirements and from which the water can be delivered by gravity to a trough is ideal. But when springs occur as seeps extending over wide areas at the foot of slopes or in draws or depressions, it is wise to find out first the cost and practicability of developing them.

Wells and Ponds

If a dependable supply of ground water can be found at not too great a depth, a well has some advantages over a spring or pond. Usually there is greater likelihood of locating a well at a desired point and less danger of a water shortage during long droughts. Whether a well should be dug, driven, or drilled depends upon the nature of the water-bearing sand, its depth below ground surface, the character of the material between the surface and the water-bearing sand, and the kind of equipment at hand. Drilling, developing, and equipping wells can be complex—a job for competent drillers.

In areas where it is practical to develop water supplies from wells or ponds at only a few widely scattered locations, it is sometimes necessary to pipe water long distances to watering troughs or storage reservoirs to distribute it enough to insure the use of the forage over the entire range.

In the areas without year-round streams, springs, or good ground water close enough to the surface for economical well development, ponds are the main source of water for livestock. Even if such water is present, ponds sometimes can be developed more economically than other sources and can be used for other purposes, such as irrigation, orchard spraying, fish production, recreation, or extra water supplies.

For the greatest benefit and long life of ponds, it is essential that the drainage area be mainly grassland or woods to prevent rapid sedimentation of the pond; that soil conditions be suitable for pond construction; that any necessary dam construction be high enough, or the pond deep enough, to provide proper depth of water; that a suitable spillway site be available; and that the storage capacity be properly related to the size of the drainage area.

To reduce sedimentation, a band of dense vegetation is useful in desilting the water before it flows into the pond. The pond, including the dam, spillway, and desilting area, should be fenced against livestock to reduce pollution and the spread of disease, and to protect the vegetation on the banks of the pond. The stock get their clear, fresh water from a trough or tank to which it is piped through the dam. Wide platforms of concrete, masonry, or stone prevent the formation of mudholes around the trough or tank.

Economical use of a pond depends upon careful maintenance of installations. Grassed spillways and the various types of riprap usually need repairing after floods. Rank vegetation in spillways can be mowed to avert blocking during floods. Mechanical devices, such as troughs, pipelines, and float valves, require regular inspection.

All wells should be protected against surface pollution. Watering troughs or tanks are necessary at wells. In range areas where windmills are used most commonly for pumping, storage tanks or reservoirs that hold enough water to last for several days are needed for protection against a shortage in calm periods. Another protective measure is to equip the well with an auxiliary engine or motor.

Before extensive developments are begun, it is wise to learn the quality of the water available. In some localities neither surface water nor ground water is good for animals because of muddiness, salt solutions, or other impurities.

Properly spaced water supplies keep livestock from walking off their gains in weight. Spacings of a quarter mile are most convenient for animals but returns on the investment often will not justify such extensive water developments. At any rate, watering places should not be separated by more than 5 miles on level or gently rolling ranges and by not more than a mile where there are thickets, down timber, steep canyons, badlands, and mountains that impede travel. Sheep should travel no more than 3 or 4 miles for water in cool weather—half that distance in warm weather. Animals with young need water at closer intervals than do dry animals. Needless concentrations along one route can be avoided by providing several approaches to watering places.

Installation costs vary according to needs and conditions. Some authorities contend that $5 per animal unit is a reasonable expenditure, while others believe that the expense of water development is not justified at all on ranges where the potential grazing capacity is less than five or six animal units per section yearlong. On the other hand, the cost of quarter-mile spacing may be justified in high-rainfall belts and on highly improved tame pastures, and, of course, purebred stock may justify greater outlays than grades.

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GRASS AND WATER AND TREES

CHAS. A. CONNAUGHTON

NEARLY EVERY acre of range has other uses and values besides forage production—to protect watersheds, produce timber, give wildlife a home, and provide places for recreation.

These are the "other" values of the range. Each is important; on some ranges, indeed, the demands of one or more may dominate or even exclude grazing. If grazing is properly managed, however, the various uses are usually compatible with the use of forage by livestock.

A description of how grazing can be coordinated with watershed and timber management is given here to provide a basis for a fuller understanding of the concept of management for multiple use.

In theory it is not particularly hard to coordinate grazing and watershed use on range land. In the main, it requires simply that methods and systems of grazing be practiced that will insure maximum production of forage so that grazing capacity is maintained and a cover of vegetation is provided to stabilize soil and help regulate runoff. Favorable watershed conditions are thereby insured.

There are exceptions to this general premise: On some steep slopes the loose