NORTH CENTRAL FOREST EXPERIMENT STATION

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SIMPLE RUNOFF CONTROL STRUCTURES STAND TEST OF TIME

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ABSTRACT.--Diversion terraces and detention basins constructed along the field-forest edge in the Driftless Area reduce farmland runoff and subsequent gullying in the forest below for many years. The structures are inexpensive and simple to build.

KEY WORDS: Erosion, detention basins, diversion terraces, water-spreading.

The forest gully is one of the most striking resource problems of the Driftless Area of Iowa, Minnesota, and Wisconsin. The gullies are of recent origin, having been eroded by surface runoff originating on ridgetop farmland and concentrating in natural drainage ways (Sartz 1961, 1977).

Curtis (1967) found that installing small detention basins prevented further gully development. The basins were positioned along the contour away from natural drainageways and runoff was diverted to them by simple diversion terraces constructed along the field-forest edge. The basins could be constructed as single units or as a series of small units positioned to overflow from one to the other. Encroachment on the farmland was avoided, and simple design minimized construction cost.

After Curtis demonstrated the feasibility of the treatment, a demonstration site was developed that included an alternative treatment of laying logs across the slope at the outlet to the diversion terrace (log-spreader) rather than constructing a detention basin. The idea was to spread the water within the forest zone to reduce its gullying potential at sites where a detention basin was not desirable.

METHODS

A 20-acre tract of ridgetop farmland on the Coulee Experimental Forest near LaCrosse, Wisconsin was selected as the demonstration site in 1972 (fig. 1). The site divided naturally into eight parcels of various sizes. Diversion terraces were constructed on all eight: in addition, detention basins were used on five and log-spreaders on the other three, completing the system. The parcels were laid out so that runoff could be diverted away from the natural drainage channels.

The basins were designed to hold a minimum of 0.5 inch of runoff from the contributing area per storm. Sartz (1970) indicated that as much as 1.6 inches of runoff may flow from tilled ridgetop soils per storm, but that more than 0.5 inch was exceptional. Grassed spillways were installed as a precaution to protect the dams in case of overflow. The diversions were installed on a 1-percent grade to minimize flow velocity while directing runoff toward the basin or log-spreader.

The basins were built with a small bulldozer by simply pushing soil downslope into a pile to form a dam and then pushing soil to the ends to block lateral flow. Only the location and approximate dimensions of the dam were marked in advance; therefore, the tractor operator was left to his discretion in forming the dam. A dumpy level and survey rod were used to check for low spots in the dam wall so that they could be corrected. Once or twice during construction the operator packed the soil in the dam by running the tractor the full length of the dam with one track on the dam and the other in the basin. The final height of the various dams ranged from 3- to 5-feet above the lowest point within the basin.

At one location two basins were constructed, one above the other, to meet the volume requirement. This increased the likelihood that overflow would

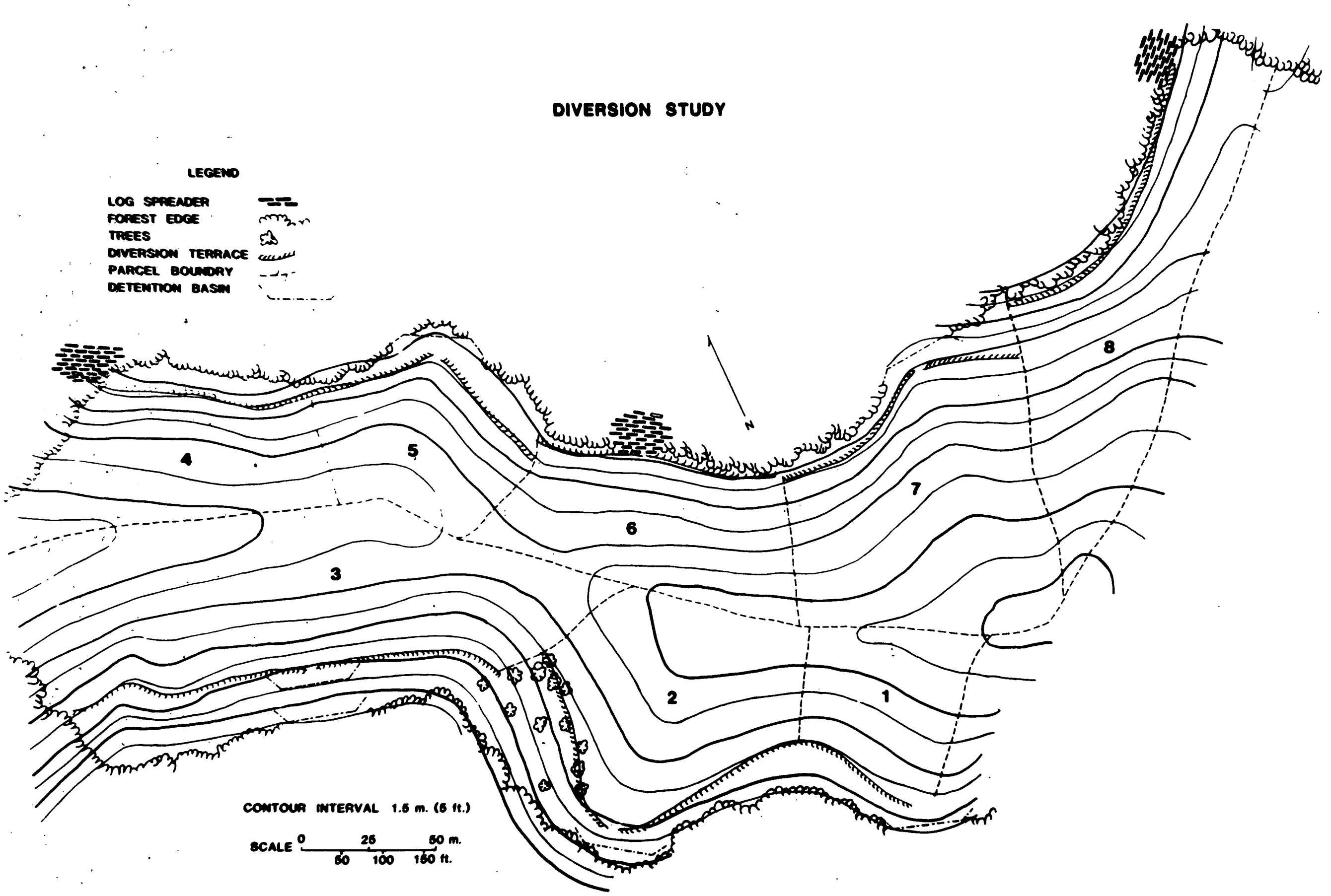

Figure 1.--*Contour map of diversion terraces and detention basin installation on the Coulee Experimental Forest in southwestern Wisconsin. Apparent drainage area for each unit (parcel) is indicated.*

occur from the upper basin, providing a good test of the durability of the grassed spillways.

The course of each diversion terrace was staked at a 1-percent grade before construction. The terraces were constructed the same as the dams but few exceeded 1.5 feet in height. All disturbed areas were seeded with a mixture of annual and perennial grasses except for spillways, which were sodded.

After each large storm, the dams were checked for washouts. And 5 years after construction, capacity of the basins were remeasured to check for sedimentation. Instrumentation was installed to find out how long it took the basins to recover (empty) after a storm.

The log-spreader systems were constructed by cutting some of the overstory trees within an area approximately 50 feet wide and 100 feet long running down slope from the terrace outflow. The trees were cut into lengths that could be moved by 2-3 people and laid across the slope in staggered fashion to spread the runoff. The number of logs per area was not recorded but they were positioned at 10- to 15-foot intervals down the slope. The success of this practice was determined by simply observing the extent of gullying that later developed.

Construction costs were minimized to make these practices as attractive to land owners as possible. This was done by using simple specifications and relying on the judgment of the crawler-tractor operator to make a reasonably secure structure with dimensions approximating the prescribed volume. Total tractor and operator costs were $390 in 1971. There were additional costs for seed ($40) to revegetate disturbed areas and 16 worker-hours for each log-spreader. Basins plus terraces averaged $55 (1983 dollars) per acre of cropland compared with log-spreader plus terrace systems at $143 per acre of cropland. The difference results from the labor costs required in cutting and positioning logs across the slope.

There were approximately 16 tilled acres above the diversion terraces. The farm practices used, as recommended by the local U.S. Soil Conservation Service agent, included contour strips in a corn/

corn/oats-alfalfa/alfalfa rotation. Cultivation above the diversions ended in 1978 and during the next couple of years conifer seedlings were planted on much of the area.

In addition to the new detention basins and terraces, the original set installed by Curtis (1967) in 1964 were monitored. They were installed as a series of three, one above the other, to collect runoff from one land parcel. The design was the same.

During November 1982 the site was revisited to inspect all diversion terraces, basins, and log-spreading sites for structure failure or signs of gullying.

RESULTS

All detention basins and diversion terraces were still intact and fully functional after 11 years. The basins lost an average of 14 cubic feet of storage volume per acre of contributing area per year, presumably due to erosion and sedimentation from the cropland (table 1). Trimble and Lund (1982) reported an average erosion rate of 65 cubic feet per acre per year for a similar location in the Driftless Area. Even at this higher rate, the loss of storage capacity over a 10-year period would be manageable. Detention basin design should include enough extra volume beyond that needed to handle 0.5 inch of runoff (1,815 cubic feet per acre of contributing area) to absorb the expected sediment.

Evaluation of the log-spreaders was difficult because actual flow was not measured, but it is reasonable to assume that they received about the same flow as the adjacent detention basins. A small gully did develop in the forest at one log-spreader site. It eroded to a maximum depth of 10 inches at the outlet of the diversion terrace and decreased in depth as it progressed downslope 30- to 40-feet. This gully cut its path underneath the logs, and its course seemed to be little affected by them. The gully was still apparent and somewhat active in 1982, but it had formed shortly after the study was begun. After 18 years the logs installed by Curtis (1967) had decayed beyond recognition. Although he reported that the log-spreader was somewhat effective, this follow-up indicates that it is not a dependable option.

The basins essentially emptied within 24 hours of each storm. This reasonable recovery time was due to permeable underlying rock strata characteristic of the region. A loessal silt loam on the Coulee Experimental Forest covers a thin clay residium weathered from a fractured dolomite cap overlying sandstone. The soil-rock system is permeable (Sartz 1969) and therefore suitable for the runoff detention concept.

Table 1.--*Change in basin volume during first 5 years*

(In cu ft/acre of cropland)

Parcel	Basin volume 1972	Basin volume 1977	Average annual volume change
2	4,214	4,265	+ 8
3	2,390	2,339	− 13
5	2,809	2,563	− 49
7	2,093	2,084	− 2
Mean			14

IMPLICATIONS

Construction of simple detention basins and diversion terraces offers a desirable supplement to other soil conservation practices recommended for sloping farmland. Log-spreaders are more expensive and apparently less effective in preventing gullying.

Installation costs are minimal because no elaborate engineering is needed if much is left to the discretion of the tractor operator. In fact, land owners can be encouraged to do their own construction. The low cost will encourage implementation, particularly when government cost-share funds are made available.

The contributing area for a detention basin should not be greater than 5 acres. Detention basins should handle at least 0.5 inch of runoff from the contributing area. Basin volume should be adjusted in other regions to meet local conditions but should not exceed 10,000 cubic feet. Larger volumes may pose unacceptable risks if failure occurs.

If these rules are followed, the basins and terraces should last more than 10 years without maintenance.

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