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Water erosion control - 3

J P. Fallon
Department of Agriculture

WATER EROSION CONTROL—3

Designing Contour Bank Systems

By J. P. FALLON, B.Sc. (Agric.), Adviser, Soil Conservation Service

"CONTOUR BANK" is the name applied to a ridge or bank of earth built across sloping ground between points of equal or nearly equal height. The basic function of a contour bank is interception of run-off water. This water is then either absorbed or conducted slowly from the land, depending on the condition of the soil and intensity of run-off. It should be kept in mind, that in soil conservation work contour banks are not a substitute for, but supplementary to, suitable plant cover and careful land management.

To rely on contour banks without giving attention to improved pastures, cropping and grazing methods would be as great an error as to attempt to use only pastures and land use methods for erosion control in places where alone they cannot be effective. The previous article in this series tells of the special place that contour banks hold in the general soil conservation programme. It also indicates conditions under which banks are likely to be required to support good land management practices. This article deals with some of the more important aspects of the designing of contour bank systems.

Designing contour layouts involves much more than the ability to use a surveying instrument. However, a high degree of technical knowledge is perhaps not so important as the faculty of good judgment combined with an

This is the fourth article of a series which commenced in the January-February issue of the Journal—a series which outlines the principles of soil conservation and their main applications in Western Australia. It is hoped that the articles will help to impress upon farmers the need to conserve the soil and prevent erosion, and will point the way to the practical application of suitable soil conservation techniques.

The Soil Conservation Service exists to co-operate with farmers to this end. If you would like an officer of the Service to visit your property to discuss your soil conservation problems, write without delay to the Commissioner of Soil Conservation, Department of Agriculture, Perth.

agricultural background and a good understanding of the various erosion control measures. Generally speaking, unless farmers are prepared to buy or construct a surveying instrument of suitable accuracy, and are prepared to use it with unremitting care and attention to detail when surveying contour banks, they would be well advised to call on experienced help with their layout and surveying problems.

An article dealing with some of the types of simple levelling devices suitable for the layout of contour banks together with a description of how to construct and use them will appear in a later issue of this journal.

In the preliminary planning of any conservation programme for a farm, the entire property should be considered as a unit. This ensures that a layout for any one paddock may at any time be fitted into a comprehensive system without the necessity of greatly altering previously constructed bank layouts. Contour bank systems are planned according to the drainage pattern of the land, and the areas that can be effectively handled through any waterway, natural drainage depression or system of outlets. Such factors as ridges, roads, large gullies or property limits may determine the boundaries between the contour bank systems.

Frequently, adjacent farms on a watershed may be on the same drainage system. In this case, a contour bank system common to both farms may be used if agreement on details of layout, construction and maintenance can be arrived at between the farmers.

WATERWAYS

The first consideration in planning a contour bank layout must be the selection of safe outlets to handle the water which may be discharged from the banks. Under Western Australian conditions four main types of waterway are used.

(1) Specially prepared areas of level cross section and gentle grade (usually along a boundary fence or along a depression) which are put down to pasture. These areas should be fenced off if this is at all possible.

(2) Natural drainage depressions which may or may not be slightly gullied and which generally require the support of mechanical measures to prevent scouring.

(3) Gullies which must be treated and stabilised with special structures before being used as outlets.

(4) Large natural creeks.

In some cases it might even be necessary to use all four types of outlet in the one paddock. Because the waterways into which banks discharge are so vital to the success of the whole contour layout every effort should be made to make them safe. It is essential that the cover of pasture on these sites should be the very best possible for the area.

The next article in this series will deal with the problems of waterway selection and construction.

LOCATION OF CONTOUR BANKS

Individual contour banks should be located so as to provide adequate control of surface runoff, consistent with keeping normal farming operations as easy as possible and bank maintenance

work to a minimum. Some general guiding principles may be followed to obtain these ends.

Contour bank layouts are normally started near the top of the slope to be treated. The top bank should be placed so that the area it is serving is no greater than the areas served by the lower banks. The top bank is perhaps the most important one in the layout for, if it is overtaxed by runoff from too great an area, the whole system is likely to be severely damaged. A trial line should be surveyed and then adjusted up or down hill as needed.

Fig. 1.—Contour banks and associated earthworks on a paddock in the Northam district. Note the use of a diversion drain with pasture furrows above it, on areas where contour banks could not be used. Absorption banks are also shown. Two distinct types of waterway are used in this paddock.

Note also the contour banks continued through the boundary fence at the top of the photograph—an instance of co-operation between neighbouring farmers in the treatment of a watershed.

Having located the top line, the other lines are surveyed at the required intervals. Frequently, an obstacle in a paddock (i.e. a large rock outcrop or patch of timber) necessitates starting a layout at that point. If this is the case, the other banks may then be laid out at the required intervals above and below, but care must be taken that the top bank is placed sufficiently close to the head of the slope. Contour banks should be kept as short as possible. Short banks are safer than long ones as they require less channel capacity and are therefore easier to construct and require less maintenance.

In order to decrease the length of bank draining in one direction a point roughly midway between two outlets may be selected and the banks graded from this crest to the outlets. Ridges are the ideal site for splitting the drainage in this way as they ensure flow in both directions towards lower spots where the waterways should be located.

In planning the layout, provision must be made for access of vehicles and machinery to all parts of the paddocks. These farm roads should be located on the contour immediately below contour banks or along the ridges where the drainage divides. In no case should a waterway be used as a roadway.

In many paddocks, it will be found that the selected waterways have insufficient elevation to take discharge from where the highest banks in the paddock would be located. In this case one of the following methods may be used to treat these areas above the top bank.

A. Where the slope above is very steep, and not well suited to cropping, particularly if it is broken by rock outcrops, the highest bank that will discharge into the waterway might be constructed as a diversion drain (i.e., bank of greater capacity and higher gradient) and pasture furrows laid out above it on the true contour. (See photo fig. 1).

B. An alternative to pasture furrows on land that is suitable for occasional cropping is the use of contour absorption banks. (Fig. 1 also). These are very large capacity banks and being on a true contour require no prepared outlet. They are constructed so as to pond water behind a very high bank and when full to overflow around the ends before overtopping the bank. This type of bank may be laid out at the same intervals as the normal drainage type contour banks. Blocks in the channel should be constructed to prevent any excessive accumulation of water at one point should the bank be constructed slightly off contour. The effective height of this type of bank will the the height of the blocks at the ends of the bank. These are usually one half to three quarters the height of the bank itself. If built any higher than this the bank wall is likely to be endangered.

C. In situations where no natural outlet is available and contour banks are required, it might not be feasible to build long lengths of absorption type banks. Normal drainage type contour banks may be used without a waterway if the area on to which they discharge is protected by short lengths of absorption banks and spreader furrows. This type of outlet would preferably be along a fence or in a situation which could conveniently be left out of cultivation. The aim of this treatment is complete absorption of any water that may be discharged from the banks. Failing this, any unabsorbed runoff is slowed down to non-erosive speed and finds its way to the main outlet or waterway in the paddock.

SPACINGS OF CONTOUR BANKS

The spacing or vertical drop between the banks depends upon land slope, rainfall, vegetation and the nature of the soil, all of which effect the amount of run-off. It also depends on the size of of the banks to be constructed and the gradient of their channels which limits the amount of water the channels can carry.

The degree of erosion hazard in any particular district determines the extent of the soil conservation measures necessary to effectively control run-off in that district. Broadly the farming areas in this State which have suffered most from soil erosion by water may be divided into two categories, according to the degree to which pasture improvement can be relied on to lessen the risk of erosion.

A. Areas where it is possible to develop improved pastures and longer rotations

Fig. 2.—Aerial photograph showing the layout of a contour bank system in the Northam district. Pasture furrows are used on the rocky slopes (top left). A natural creek and its tributaries have been used on the waterways in this paddock.

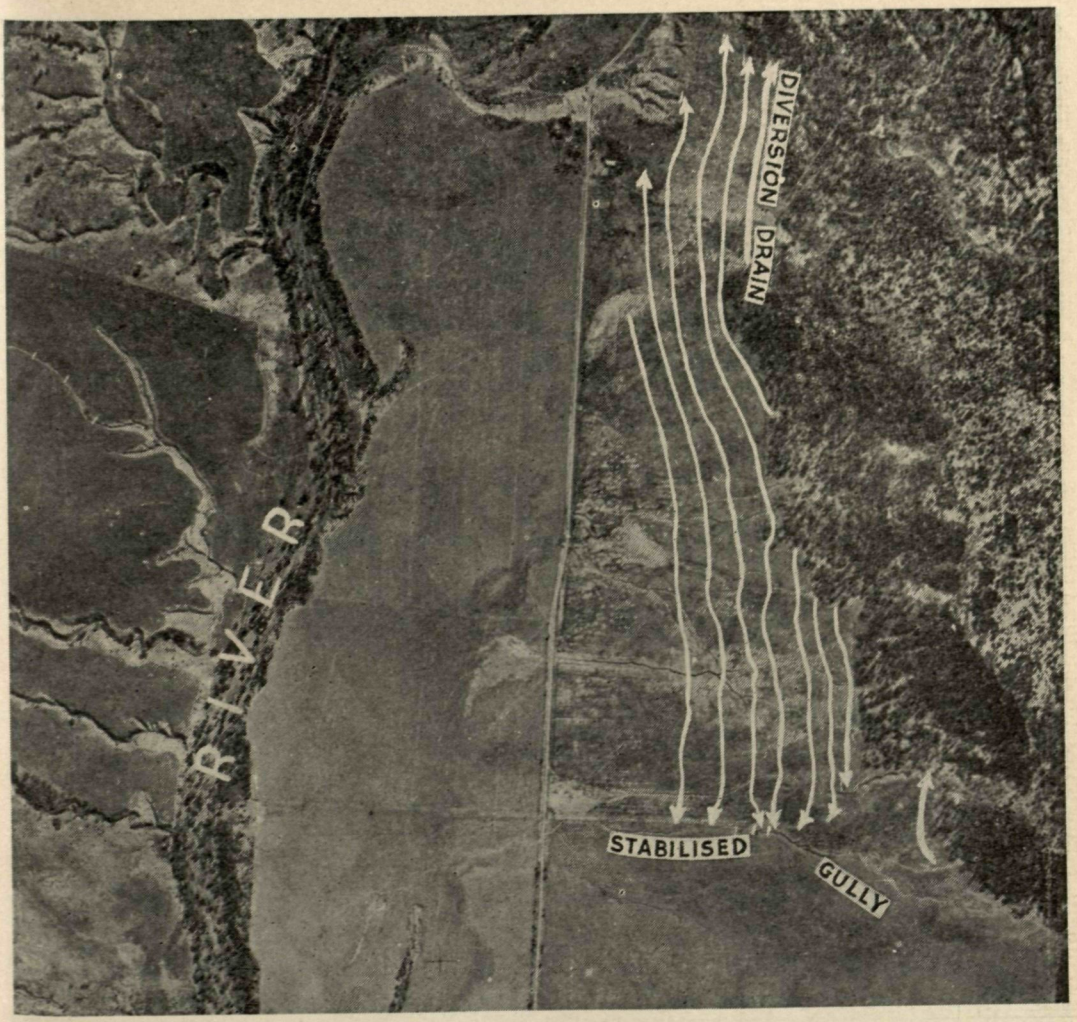

Fig. 3.—A contour banked paddock in the Mingenew district. Prior to treatment, this paddock could not be cultivated owing to the large number of deep gullies, some of which may still be seen crossing the white lines on the right of the photograph. The contour banks are graded from the centre of the paddock towards waterways at the top and bottom of the picture. Note severe erosion on left where gullies from 30 to 100 feet deep have been washed out. Had conservation methods been applied in years gone by, this land could probably have been saved. Today it is irreparably damaged.

using either subterranean clover, trefoils or minor clovers as the basic pasture species.

B. Areas where up to the present, improved legume pastures are not a practical possibility.

For those districts coming under the first division, the spacing of banks has been on a vertical interval of ten feet, (Obstacles sometimes necessitate a slight departure from this ten foot interval). This means that a bank is ten feet lower than the bank above it. On a ten per cent slope, banks would be 100 feet (1½ chains) apart and on a five per cent slope they would be 200 feet (three chains) apart. A slope is five per cent if there is a fall of five feet in one hundred feet along the ground straight downhill. If banks are put in

on more gentle slopes (i.e. less than 3% this vertical interval should be decreased so that the area between banks will not be excessive.

On the areas where it is not yet possible to establish and maintain improved legume pastures, a spacing of 2-3 chains, according to the steepness of the slope, should be used. Where it is thought necessary to put banks on very steep slopes the 2 chain spacing should be reduced to 1½ chains, as banks built on steep slopes have less channel capacity than those constructed on more moderate slopes.

The vertical interval spacing of ten feet as extensively used by the Soil Conservation Service in this State has been found successful under our farming conditions. The selection of this interval has been in the light of the experience of the Soil Conservation Services of the U.S.A. and the Eastern States of Australia modified to suit Western Australian climate, land slopes and soils. Wider spacings have been tried and found to be unsatisfactory. In view of the type of agriculture practised and the size of farm machinery used in Western Australia the spacings advocated would seem to be a fair compromise between soil conservation ideals and general practicability.

GRADES OF CONTOUR BANKS

This heading is technically a contradiction in terms. In the strict meaning of the words, a bank is not a contour bank unless it is perfectly level along its entire length. However, as explained in a previous article in the Journal, contour bank is the general name given

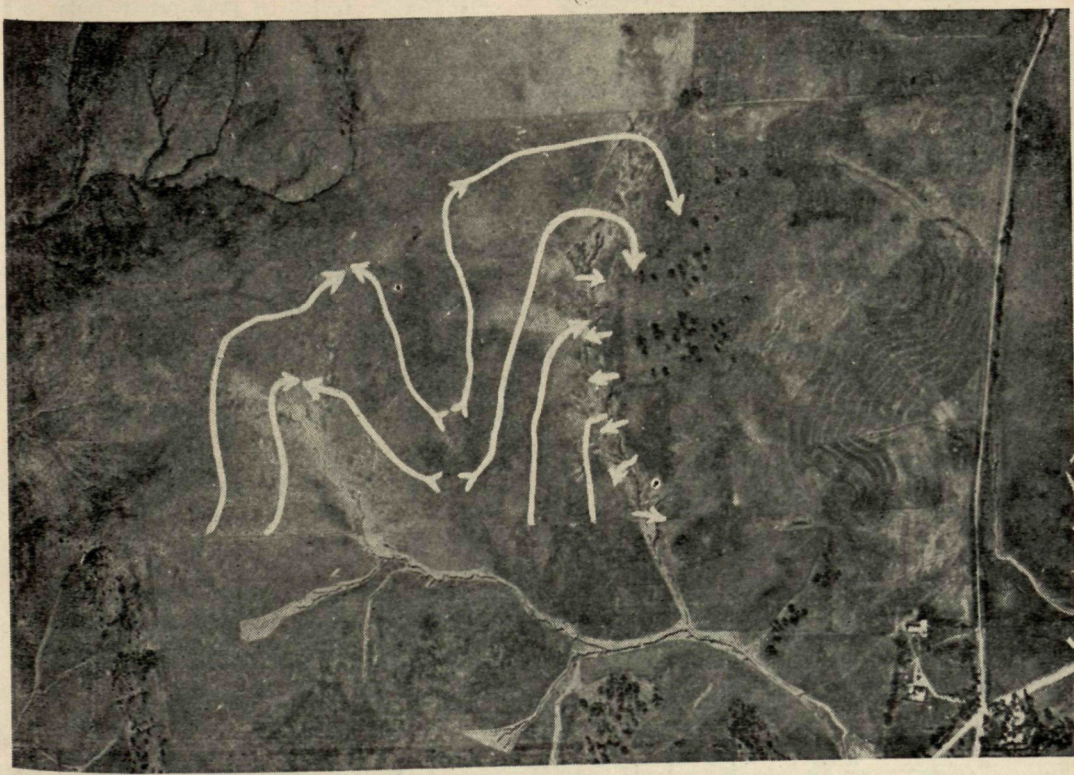

Fig. 4.—A system of contour banks in the Mingenew district. Treated gullies have been used as waterways in this paddock. Note severe gullying in other parts of the property (bottom right shows the worst example). Pasture furrows may be seen in paddock alongside the road at the left of the photograph.

to banks whether they are absorption type contour banks (i.e. on a true contour) or drainage type contour banks (i.e. banks with a slight grade to an outlet). For drainage type contour banks, the grade must be sufficient for the channel to carry the water, yet gentle enough to avoid scouring and promote some absorption. A variable gradient increasing with the length of the bank is generally used. The total length of a proposed bank is usually estimated and a variable grade established that increases towards the outlet by regular amounts. The grade is normally increased every 300-500 feet. It is advisable to fit the change of grade to such critical points as gully crossings or low spots if this can be done conveniently. Points where banks cross gullies or depressions are generally weaknesses in the bank. If the increase of grade can be made conveniently at these points, the tendency for banks to overtop and break will be partly eliminated.

Gradients used on normal drainage type contour banks in W.A. range from 0.2% - 0.5% (i.e. 2½in. per 100ft. to 6in. per 100ft.). For example, a bank 1600ft. long may be given a grade of 0.2% for the first 400ft. 0.3% from 400ft. to 800ft., 0.4% from 800ft. to 1200ft. and 0.5% from 1200ft. to its outlet at 1600ft.

Gradients on diversion drains are generally a little steeper depending on the type of bank to be constructed, but they should never exceed 1%. If diversions are built with heavy earth moving plant (e.g. bulldozers) normal grades should be used. The reason for this is that large banks like bulldozer-built diversion drains have large capacities and allow a greater depth of water in the channel. As the depth of water in a graded channel increases, so also does its velocity and hence its cutting action. To prevent this the normal grades for ordinary drainage type contour banks are used.

TABULATION OF GRADIENTS FOR CONTOUR BANKS

Grade in %	Grade in inches
0.1%	1.2 in. per 100 feet
0.2%	2.4 in. per 100 feet
0.3%	3.6 in. per 100 feet
0.4%	4.8 in. per 100 feet
0.5%	6 in. per 100 feet
0.6%	7.2 in. per 100 feet
0.7%	8.4 in. per 100 feet
0.8%	9.6 in per 100 feet
0.9%	10.8 in. per 100 feet
1.0%	12 in. per 100 feet

LENGTH OF BANKS

Bank channels should not usually carry water for more than 1600-1800 feet (24-27 chains) in any one direction. However, in practice it is often extremely difficult to keep banks down to these limits. By grading banks to run both ways from a suitable point, the distance between waterways can be safely doubled. If banks of excessive length must be used, the end sections (i.e., last 1,000 feet) should be built up and the channels enlarged to give greater capacities.