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Diversion Dikes and Channels for Saving Soil

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Fig. 1.—This diversion channel and dike intercept 20 acres of runoff from a neighbor's land across the road and also the road water. There was a large gully to the left of the tree, and the head water is now taken from the gully by the diversion dike and channel. Below the diversion channel, the old gully is crossed by terrace and completely erased.

Much can be done toward the economical management of runoff water by the proper use of diversion dikes and channels. Diversions, however, do not lend themselves as readily as terraces to the standardization of grade, spacing, shape, and size. Each diversion must be designed specifically for the situation and purpose for which it is to be used, because of the wide variation of conditions involved. Success also depends on the experience and judgment of the individual designing and constructing the diversion, as well as on the willingness of the farm owner to give timely attention to maintenance.

While this is true also in terracing, close attention to construction standards will eliminate from terraces many of the hazards to which diversion channels are subject due to the fact that the diversion often is used near the property line to handle runoff from a neighbor's land under conditions that are quite beyond the control of the man who builds and maintains the diversion channel. On the other hand, it is in just this sort of situation that a diversion channel usually is necessary to remove the hazards before a terrace system can be used successfully.

Diversion Channels in a Water Management System

Diversion channels or dikes are constructed of earth, and may be built with teams and scraper, or terracing equipment of any kind. They are shaped much the same as a terrace, and a small diversion except for grade and location may be identical with a terrace. The cost is usually small compared to material and labor cost for control of certain drains or waterways by individual mechanical structures. Oftentimes a channel or dike with terraces below can be made to do the work of several gully control structures, resulting in a much more comprehensive plan of water disposal and conservation than is possible with gully control structures alone.

Occasionally diversion channels are used at the foot of well sodded, timbered, rocky, or otherwise untillable hillsides to prevent runoff water from washing across the bottom—causing it to be either wet or eroded. Unless special precautions are taken to prevent the formation of shoals, however, diversions should not be used below raw gullies even though the hill is otherwise well sodded.

Use Terraces Instead of Diversions

If land is to be farmed above a proposed diversion channel and this land belongs to the same landowner, the diversion should not be constructed. The hill above should be terraced instead of using a diversion, and under these conditions the terraces will do all the diversion would have done plus a great deal more in protecting the hill from sheet wash and also conserving moisture. If the terraces are not constructed, the great amount of silt washing from a cultivated field will fill the diversion channel at the foot of the slope. The construction of an unusually large diversion plus excessive maintenance will be required, making the diversion very impractical and subject to failure. For effective control, the diversion would not compare with a good terrace system started at the top of the hill and continued to the point proposed for the diversion.

Intercepting the Runoff From the Neighbor's Farm

If the neighbor has a tillable field which drains onto the field in question cutting it into several washes and taking a heavy toll in sheet wash, and the neighbor is not interested in terracing, one has an added problem. The fence line will aid the diversion placed just below it, but this is seldom enough protection for the diversion under these conditions. However, rather than to have the field cut into several small fields or to construct several sets of individual concrete or rock dams, most farmers are willing to take extra precautions with diversions and intercept all of the neighbor's water in a diversion channel, carry it all to one large drain or across all drains to the side of the field and place it in one outlet. The field below can then all be terraced into the same outlet and all gullies closed. It was at one time thought impossible to terrace such a field. Silting basins are a necessary part of the diversion under these conditions.

Silt Basins in Diversion Channels

The diversion channel will intercept a rush of water from the slope above, oftentimes taking care of concentrated flows from small drains as well as sheet water. When the rapidly moving water is forced to slow down and change its course, the larger part of any silt load it is carrying will be dropped and eventually fill the channel. The fill is usually in the farm of shoals which must be cleaned out. This silt can be scraped out and spread over part of the adjoining field or part of it left on the diversion dike. The owner of the unterraced land above the property line can keep the deed and pay the taxes, but the man with the diversion channel and silting basin will be getting the better part of his farm unless he becomes aware of his losses and does something about it. However the silt may be a liability to the man with the diversion because of the added maintenance it requires.

Diversion channels are not recommended where cultivated fields, or open, active gullies drain into them, unless ample stilling or silting basins (shallow ponds) are constructed where concentrations join the diversion channel. This allows the formation of shoals in the same manner, but places them back from the channel of the diversion. Usually cleaning once in several years is all the maintenance required. A sod strip above the diversion is recommended to reduce silting from sheet water above, but

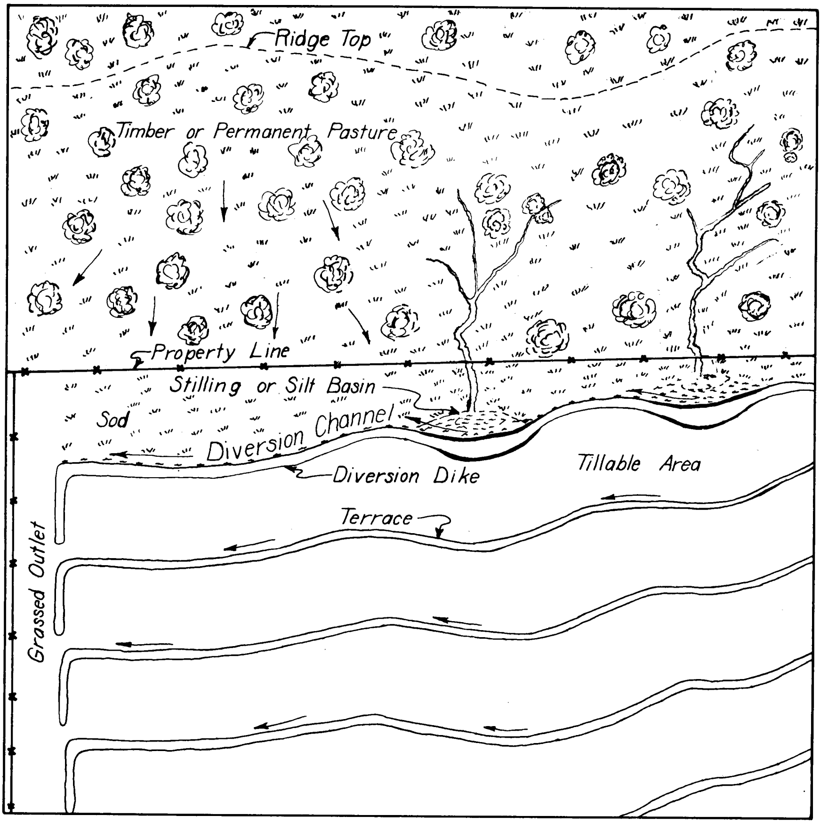

Fig. 2.—Diagram of a terraced slope on which the runoff water from higher ground across the property line is held back by diversion dike and channel.

a sod strip will not be ample protection for the channel, particularly where concentrations occur before reaching the channel.

Grade Given a Diversion Channel

The most common grades given diversion channels are 5 and 6 inches fall per 100 feet. Such a grade allows more velocity in the channel than is ever acquired in a terrace channel, because of the greater grade given and greater depth of flow. This higher velocity is usually necessary because of the rush of water hitting the channel and the necessity for carrying this water on its new course as rapidly as possible without allowing serious channel cutting or scouring. Unless the soil is extremely rocky or gravelly, diversion channels given a 6 inch grade and carrying an appreciable depth of flow will scour out some until they become sodded. This scouring never becomes serious in small drainage areas if any attention is given to proper maintenance of the channel.

Sometimes diversion channels fill at points where concentrated flow hits them and they scour between such points. This is particularly true if the grade is stepped up to try and prevent the formation of shoals. In such cases the regular 5 or 6 inch grade is recommended and at the point where the small drain is intercepted, the diversion should drop downhill sufficiently to lower the elevation of the channel 6 to 8 inches, and the dike should be made higher at that point, to avoid overtopping and also to minimize the damming effect of a shoal. This added drop of 6 to 8 inches functions in three ways: (1) It allows the shoal to be deposited on a lower elevation than the channel immediately up-grade; (2) It gives the added fall where it is most needed to spread out the fan as much as possible; and (3) It minimizes scouring of the channel because the two flows of water merge almost at right angles and the slowing effect decreases the scouring. A small silting basin is desirable under these conditions also.

Diversion channels carrying small quantities of sheet water from timber or permanent pastures (if one is sure the pasture will be permanent) may be given as little as 4 inches fall per 100 feet. A 5-inch grade may be used under these conditions also, if small drains enter only at the upper end of the diversion channel and not somewhere along its course. If conditions will permit the slighter grades, the scouring tendency is avoided. A larger channel is always necessary with the slighter grade as shown in Table 2 because of the extra cross section needed with the lower velocity. Since silt does not move or spread well in channels of slight grade, a strip of sod should be established above the channel to hold back the silt from sheet water, thus preventing it from reaching the channel.

Diversion channels carrying water 3 or 4 feet deep have much more tendency to scour than where flows of 18 or 24 inches are carried; consequently a 4-inch grade is often recommended for these channels, although a somewhat higher dike or berm and wider channel are required.

A grade of 8 inches per 100 feet is also used in extremely gravelly or stony soils where shoals of gravel may be built up and a higher velocity can be tolerated because of the lack of scouring.

It can be seen that judgment must be exercised to use the type of diversion best suited to the local problem involved. When this is done, however, remarkable success in the management of runoff water is accomplished.

Use of Tables

Table 2 gives the different sizes of diversion channels with 4, 6, and 8 inch grades that will be required to carry different quantities of water. For example, suppose we design a diversion channel to carry 30 acres of runoff water from a hilly timber area. Table 1 tells us the channel must carry 50 cubic feet of water per second to carry the hardest rain that can be expected on the average of once in 25 years. (The reason for the 25-year design is that there is no satisfactory emergency outlet or bypass for the diversion.) If it overtops seriously, the cultivated field below will be damaged. When considerable damage to the field below is likely from overtopping, a 50-year design is suggested.

Consulting Table 2 on diversion channels we see that a channel with 6 inch grade, 2 feet deep and 5 feet wide at the bottom will carry 53 cubic feet per second. A channel 18 inches deep and 12 feet wide at the bottom will carry 54 cubic feet per second also. We would probably choose the former channel if it was placed across a rather steep slope. A 12-foot channel on such a slope would be very difficult to construct while the 5 foot channel 2 feet deep would be very satisfactory.

It should also be noticed that if this channel carried sheet water with no larger drains entering it, the size of the channel could be gradually reduced toward the upper end.

Table 1. -- To be used in determining the rate of runoff to be carried by the diversion dike and channel.

Runoff in Cubic Feet Per Second - 50 Yr. Frequency

Type of Watershed	Acres													
	3	5	7½	10	15	20	30	40	50	75	100	125	150	200
	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.
Rolling Timber	7	11	15	20	28	35	49	60	70	95	118	142	165	205
Hilly Timber	8	13	18	24	34	43	60	75	90	125	160	193	225	285
Rolling Pasture	13	21	30	39	54	68	92	114	135	186	237	285	330	410
Hilly Pasture	16	25	37	47	67	85	118	148	180	250	320	385	450	565
Cultivated (Terraced)	15	25	36	46	70	88	116	170	205	287	364	437	502	624
Rolling Cultivated	21	35	50	64	91	114	151	187	226	315	400	480	550	685
Hilly Cultivated	28	43	63	82	116	146	200	250	305	435	550	665	770	980

Structure designed for runoff shown in this table will carry 100% of the runoff occurring from all rains falling in the average 50-year period. If material damage would be done to fields below by the diversion overtopping, this table should be used in design of the channel.

Runoff in Cubic Feet Per Second - 25 Yr. Frequency

Type of Water Shed	Acres													
	3	5	7½	10	15	20	30	40	50	75	100	125	150	200
	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.	cu. ft.
Rolling Timber	6	10	14	18	25	31	39	49	60	82	105	129	150	188
Hilly Timber	8	12	17	22	30	38	50	64	79	110	145	175	205	262
Rolling Pasture	12	20	28	36	49	61	80	100	122	170	215	255	295	372
Hilly Pasture	16	24	34	42	59	75	100	130	158	222	290	350	405	520
Cultivated (Terraced)	15	24	34	43	63	77	100	148	180	255	323	382	446	565
Rolling Cultivated	21	34	48	60	82	102	130	163	198	280	355	420	490	620
Hilly Cultivated	25	40	56	72	102	127	175	218	270	380	490	590	680	860

Structures designed for runoff shown in this section of the table will carry 99.7 % of all intense storms occurring in the average 50-year period. If only moderate damage can be done the field protected below by limited overtopping of the dike once or possibly twice in a 50-year period, the channel should be designed by this table.

Table 2. -- To be used in determining the depth, width and grade of the diversion channel needed.

Capacity in Cubic Feet Per Second of Diversion Channels with Slope on Dike Side of Channel 3:1, Upper Backslope 4:1

Calculated from Manning's Formula - N = .055

Grade in Channel	Depth of Flow	Bottom Width								
		3 ft.	4 ft.	5 ft.	6 ft.	8 ft.	10 ft.	12 ft.	16 ft.	20 ft.
4" Per 100	1" - 0"	8 cu. ft.	9 cu. ft.	10 cu. ft.	12 cu. ft.	15 cu. ft.	18c u. ft.	21c u. ft.	27 cu. ft.	33 cu. ft.
	1" - 6"	18	21	23	26	32	38	44	56	68
	2" - 0"	34	38	43	47	56	66	75	94	113
	2" - 6"	57	63	70	76	89	102	116	143	170
	3" - 0"	88	95	104	113	130	148	165	203	241
	3" - 6"	126	137	148	159	182	205	227	274	321
	4" - 0"	174	188	202	215	244	272	301	358	416
6" Per 100	1" - 0"	9	11	13	15	18	22	26	33	40
	1" - 6"	22	25	29	32	39	47	54	68	83
	2" - 0"	42	47	53	58	69	81	92	115	139
	2" - 6"	70	78	85	93	110	126	143	176	209
	3" - 0"	108	117	128	139	160	182	204	249	296
	3" - 6"	155	168	182	196	223	252	279	336	395
	4" - 0"	214	231	249	265	299	334	370	440	513
8" Per 100	1" - 0"	11	13	15	17	21	25	30	38	47
	1" - 6"	25	29	33	37	45	54	62	79	96
	2" - 0"	48	54	61	67	80	93	106	133	161
	2" - 6"	81	89	99	107	127	145	165	204	242
	3" - 0"	124	135	148	161	185	210	236	288	341
	3" - 6"	179	195	211	226	258	291	323	389	456
	4" - 0"	248	267	287	306	346	386	427	509	592

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