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TILE DRAINAGE

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INTRODUCTION:

Bulletin No. 264 describes how mole drainage can be used to remove surplus water from the soil. Where conditions are unsuitable for mole drains, or where a more permanent drainage system is desired, tile drains may be used. Tile drains may also be used in conjunction with mole drains, the tile drains forming the main drains into which the mole drains discharge. It is essential, however, that tile drains be properly planned and carefully constructed if they are to function efficiently, as they should, for an indefinite period. This Bulletin outlines the important factors in design and construction of tile drains.

FIELD TILES:

Tile drains are made of "field tiles," sometimes called "field pipes" or "drain tiles." They are cylindrical pipes, usually made of earthenware, but sometimes of concrete, one foot long, and of internal diameter from three inches upwards. When laid end-to-end in the bottom of a properly graded trench they form a channel through which surplus water in the soil can escape to an outlet in an open drain. Field tiles should be strong, sound and well shaped. Earthenware field tiles are usually not affected by soil acids or alkalis, but concrete tiles may be, and many cases are known of complete disintegration and collapse of concrete tiles, particularly in acid peats. It is most important that concrete field tiles should be very strong and well made. Their use in very acid soils is always a doubtful proposition.

ACTION OF TILE DRAINS:

It used to be thought that field tiles needed to be porous, so that water could enter the drains through pores in the tiles. This is a fallacy. The water actually enters the drain through the open joints between adjacent tiles. Porosity is actually a disadvantage, as porous tiles are usually weak.

DIAMETER OF TILE DRAINS:

A tile drain should be large enough in diameter to enable it to discharge surplus water as fast as it can pos-

sibly reach the drain through the soil. If the diameter is not large enough to do this, then water will back up in the drain and the surrounding subsoil. This will be indicated by the drain running "full bore," and if this happens for more than an hour or so, it shows that the tile is too small. This is particularly harmful if mole drains discharge into the tile drain as it may cause rapid deterioration of the moles.

The diameter required for any particular drain depends essentially on the area drained, the fall of the drain and the nature of the subsoil. It is not generally realised that once clay soils have become saturated they discharge water into the drains more rapidly than coarse-textured soils, which give a slower discharge for a longer period. Therefore, other things being equal, tile drains in clay soils need to be larger.

The minimum diameter of tiles that should be used depends more on liability to blockage than on the area drained. Tiles smaller than three inches in diameter should never be used, and a minimum diameter of four inches is to be preferred. In the event of dips in the drain due to sinking or faulty grading of the trench, partial or complete blockage will occur by silting. This is likely to be much more serious with three-inch than with four-inch tiles.

The following tables can be used to give an approximate idea of the maximum areas (in acres) which should be drained into tiles of various sizes on various grades, in clay soils (Table 1) and coarse textured soils (Table 2), for the sizes of tiles commonly available in New Zealand.

TABLE 1 — CLAY SOILS

Size of Tile.	Fall. 1 in 500 acres.	1 in 300 acres.	1 in 200 acres.	1 in 100 acres.
3in. ..	2/3	¾	1	1½
4in. ..	1½	1½-2	2-2½	2½-3
6in. ..	4-4½	5	5-7	7-10

NOTE: If mole drains are led into the tiles, the above areas should be appreciably reduced.

TABLE 2—COARSE-TEXTURED SOILS

Size of Tile.	Fall. 1 in 500 acres.	1 in 300 acres.	1 in 200 acres.	1 in 100 acres.
3in. ..	1½-2	2-2½	2½-3	3-4
4in. ..	4	5	5-7	7-10
6in. ..	10-12	15-17	17-20	20-30

FALL OF TILE DRAINS:

The fall on which tile drains can b constructed depends to a large exte on the fall of the land surface. How ever, by careful taking of levels ar planning, the drains can be graded a suitable fall even if the land surfa is flat or falls the wrong way, pr vided a deep enough outlet ditch available.

To avoid blockage through siltin the aim should be to construct the ti drains so that the fall is not flatt than 1 in 300. Where flatter fal than this have to be used, extra ca must be used in construction. If t fall is too great, under-scouring ar collapse of the drain is possible. Abo 1 in 50 is the desirable maximum.

It is of the greatest importance th the drains should be constructed on uniform grade, or with the fall i creasing towards the outlet. The fa should never decrease unless a s trap is provided at the change grade. Any irregularities in fall a likely to lead to blockage.

DEPTH AND DISTANCE APAR OF TILE DRAINS:

As a general rule, tile drains shou be spaced closer together and sha lower in clay soils than in coarse-te tured soils. However, in practi many factors complicate the questi of depth and spacing and rarely ca any definite formula be applied. F example, particularly in clay soils, t depth of earth over the tile shou never be less than 15 inches to avo damage by machinery. If partic larly-rapid drainage is desired, as market gardening, drains should spaced closer than usual.

Table 3 will serve as a general gui to depth and spacing:

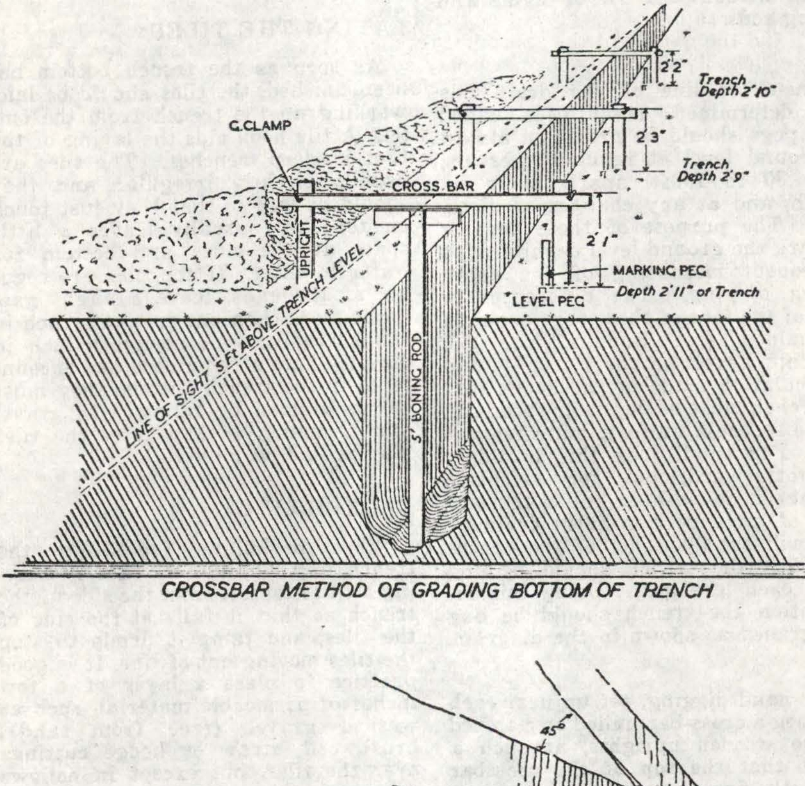
TABLE 3

Type of Soil.	Depth.	Distar apar
Clay & clay loams ..	2′ - 2′ 6″	30′- 7
Silt & silty clay loams	2′ 6″ - 4′	60′-10
Sand & sandy loams	3′ - 4′ 6″	100′-30

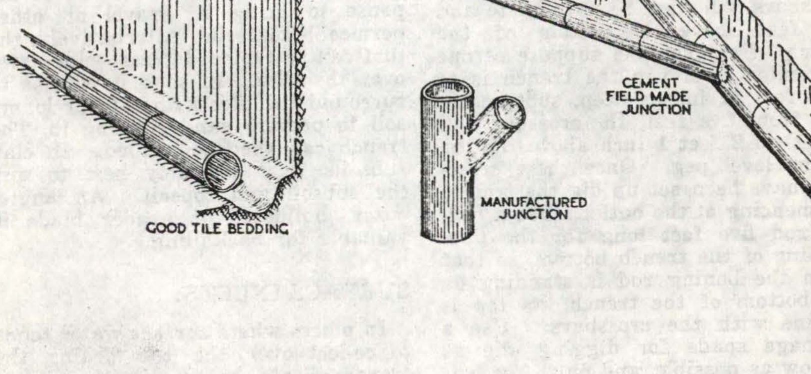
DIGGING AND GRADING TH TRENCH:

Although hand digging is still us for small jobs, trench-diggi machines are being increasingly us on larger jobs. Some machines ca not be made to dig accurately enou and the final grading of the tren bottom must be done by hand. Oth machines are capable of digging t trench and grading it correctly, b

CONSTRUCTION OF TILE DRAINS



CROSSBAR METHOD OF GRADING BOTTOM OF TRENCH



whether hand or machine digging is employed, for all but the smaller most straight-forward jobs, levels must first be taken and sighting rails and boning rods used for grading the trench. The practice of trying to grade the trench by judgment, e.g., by following the flow of water, often leads to an unsatisfactory job. It is also important to realise that trench-digging machines cannot dig a properly graded trench without the use of sights and boning rods.

When the line of the drain has been determined, stout pegs called level pegs should be driven in almost to ground level at regular intervals, from 60 to 100ft. apart, along its length, and at any changes of direction. The purpose of these pegs is to mark the ground level definitely for subsequent measuring of the depth during digging. The differences in level of the tops of these pegs are then determined (see Bulletin No. 266, "Taking Levels on the Farm"), and a calculation made of the depth that the trench must be dug near each level peg to secure a uniform and adequate fall. For small jobs this is fairly straightforward, but for extensive schemes it is wise to enlist the services of an expert in farm drainage who will supply a list of the depths to which the trench should be dug below each level peg. Using this information the trench should be dug and graded as shown in the diagram.

For hand digging, set up near each level peg a cross-bar nailed or clamped to two wooden uprights, at such a height that the top of the crossbar is exactly five feet above the level at which the bottom of the trench will be when completed. The tops of these crossbars will then be parallel to and five feet above the bottom of the trench. For example, suppose at one particular level peg the trench is to be 2 feet 11 inches deep, subtracting this from five feet, the crossbar will be set up 2 feet 1 inch above the top of the level peg. Once these crossbars have been set up dig the trench, commencing at the outlet. Use a boning rod five feet long for the final grading of the trench bottom, so that when the boning rod is standing on the bottom of the trench, its top is in line with the crossbars. Use a drainage spade for digging, dig as narrow as possible, and finish the bottom of the trench using a tile scoop. This will form a curved groove in which the tile will bed neatly.

For machine digging a similar procedure for grading is followed, except that the crossbars will be set up to one side of the trench to allow the machine to work. In an alternative and slightly more accurate hand-digging method, the crossbars are erected seven feet above the bottom of the trench. A string is stretched tight over the crossbars and a rod seven feet long is used to grade the bottom.

LAYING THE TILES:

As soon as the trench bottom has been finished, the tiles should be laid, working up the trench from the outlet. A tile hook aids the laying of the tiles in deep trenches. The tiles are usually slightly irregular and they should be laid so that they just touch on top; this usually leaves a little space at the sides and bottom for water to enter. If the tiles are regular at the ends, leave a slight gap, never more than one-sixteenth inch in sands or silts, or one-eighth inch in clay. Where soft patches are encountered in the trench bottom, they must be made good by filling with gravel and ramming. In bad cases the tiles may be laid on planks.

BACKFILLING:

When backfilling (re-filling) the trench, first "blind" the tiles by shaving a little topsoil from the side of the trench so that it falls at the side of the tiles, and tamp it firmly to stop the tiles moving out of line. It is good practice to place a layer of a few inches of permeable material, such as washed gravel (free from sand), brushwood, straw or hedge cuttings over the tiles, but except in hollows or depressions where water collects over the drain, it is probably not worth while going to appreciable expense to bring in gravel or other permeable material. Alternatively, the turf can be replaced grass—side down over the tiles. In sand it is wise to surround the tiles with turf or loamy soil to prevent sand running in. The trench can then be refilled. In clay subsoils it is probably best to mix the subsoil and topsoil. An angle-dozer, bulldozer or grader blade is valuable for backfilling.

SURFACE INLETS:

In places where surface water tends to collect over the tile drains, the trench should be filled with washed gravel, reaching as near to the surface as possible. This will allow the surface water to enter readily.

UNCTIONS:

Where one tile drain joins another, is best to buy and instal a properly ade Y junction. Alternatively, an ıspection box in the form of a manble, with a lid below cultivation vel, and its bottom 18 inches or more elow the tiles is very useful. It will lso serve as a silt trap.

REE ROOTS:

Roots of trees, particularly willows nd poplars, may enter and block tile rains. Glazed tiles with cemented oints should be used within a chain f such trees.

UTLET TO OPEN DRAIN:

The outlet into the open drain is he most vulnerable part of the tile rain, and if blocked the whole system vill become ineffective and may silt p. Many tile drain systems have een ruined in this way. The tile rain should discharge above water evel in the open drain, though this nay be impossible in high floods. The est protection for the outlet is to ise galvanised iron or reinforced conrete pipe or other strong pipe, for he last ten feet or so of the drain, irmly bedded in concrete placed in the rench. The pipe should extend well ut over the drain. Such an outlet will resist collapse and blocking and s readily seen. A grill over the outlet will prevent rats or rabbits blocking the drain.

PLAN OF DRAINS:

It is absolutely essential that an accurate plan be made showing the location of the drains. This should be kept in a safe place. It will be of great value in finding the drains if blockage occurs, and is invaluable if the property changes hands.

PLANNING A TILE DRAINAGE SYSTEM:

In some cases it is quite obvious where the drains should run. Quite often, and particularly in extensive schemes, it is by no means obvious. Many factors must be taken into account in planning tile drainage. The nature of the subsoil affects depth and spacing. The nature of the land surface is important. It is usually best to arrange the main drains to follow the depressions of the natural surface-drainage system. Subsidiary or lateral drains should run across the fall if possible, to cut off the water. The source of water to be drained is of great importance. Does it come from direct rainfall, run-off or seepage from higher grour l, or springs? Sometimes flat land can be drained by cutting off water seeping from higher ground by judiciously placed intercepting drains along the foot of the slope. The possibility of using a combination of mole drains and tile drains must be considered. Main open drains may need to be deepened or re-located to fit the tile system. Collaboration with the local Drainage Authority is advisable. Future development and subdivision of the area must be considered. If a farmer contemplating draining an extensive area is not thoroughly experienced it would be best for him to secure expert advice and an estimate of costs before proceeding, and to have the work planned and supervised by an expert in farm drainage design.

JOINING MOLE DRAINS TO TILE DRAINS:

Often when draining clay soils the frequency of tile drains can be reduced by combining mole drains with tile drains. For example, in gently undulating fields, tile drains can be laid in the depressions to act as main drains, and mole drains drawn in the rising ground on either side, to connect with the tile drains. There are many ways of joining moles to tile drains, one of the simplest of which is to cover the tiles before backfilling with clinker or with a layer of screened, washed, three-quarter inch gravel, and draw the mole drains through this layer. The mole drains can easily be pulled again when they become ineffective. This method is widely used in England.

EFFECT ON DRAINS:

The question is often asked: " Will tile drains overdrain the land, causing it to be too dry in summer?" It should be realised that the water that drains away is merely harmful surplus water and that it is impossible to drain out the water that the plants actually use. The action of the drains is thus almost entirely beneficial. But in very light sandy soils or in peat, where the normal summer water table is high, drains which are too deep can be harmful. In heavy soils over-drainage is most unlikely.

COSTS AND RETURNS:

Each drainage scheme presents individual problems. Varying local costs of tiles, transport and machine operation also have a great effect on total costs. It will almost always be found, however, that a well-planned drainage scheme will more than pay for itself in increased production.

PUMPING FOR DRAINAGE:

Where a stream flowing past a property that is to be drained is at too high a level, it may be possible to pump the water that discharges from the tile drains up to the stream, thus providing a fall artificially. Pumping schemes should be carefully planned.

CONCLUSION:

Provided the system is well planned and carefully constructed, tile drainage is an efficient and economical means of ridding the land of s plus water and thus increasing p duction. It can be combined with m drainage when conditions are suital

For more complete information tl it is possible to give in this Bullet the reader is referred to the bo "The Draining of Farm Lands," Hudson & Hopewell, from which Ta 1 and 2 have been taken. This b gives full information on farm dra age under New Zealand conditio Attention is also drawn to the f that the Department of Agricult has established at some of the m centres Advisory Officers on Fa Drainage and it is recommended t their advice be sought before a sche is planned.)