DRAINAGE AND SOIL

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PART 1

THE landscape designer is faced with two fairly distinct problems:

(i) those relating to surface drainage and

(ii) those relating to sub-surface, or subsoil, or under-drainage, of the interior of the soil.

I propose to deal with these separately.

Surface drainage

Consideration must be given to this in so far as it is possible and necessary to prevent excess water from arriving at, or gathering on the land, and the means of removing it.

Here we must consider:

(a) water from higher ground arriving over the surface or below ground;

(b) means to prevent erosion and damage to new works — especially banks;

(c) means to prevent damage by discharge from the land, especially during works of construction;

(d) means of carrying away the outflow of springs; this may equally be a subsoil drainage problem;

(e) means of draining ponds, diverting ditches and water-courses, and draining off low spots.

Some useful recommendations as to these matters is readily available in British Standard Codes of Practice[1] especially 2003/1959 entitled "Earthworks" para 3.04 et seq. This deals with "drainage of cuttings, slopes and interception of surface water," and under para 4.03 "Drainage of embankments, piping of springs, and treatment of ponds."

Reference is also made by BS Code of Practice 2001/57 para 835[2] to ground water levels and the need for intercepting drains.

Methods of dealing with these problems are generally, in landscape work, very similar to those adopted by engineers and architects for earth works, and normal specification applies to the construction of open ditches and piped drains. Some special consideration, however, is often needed when it is required to have both at once in the form of a piped open ditch, called a "french drain", and these are more frequently used in landscape work to catch the run-off of large open areas, especially sports fields. There are often contradictory recommendations as to the pipes and filling — as it is essential to keep the whole structure open to receive water at any point along its length, it is necessary to ensure that the pipes, which act as sinks, have a sufficient rate of infiltration and capacity to deal with the whole catchment area. When agricultural tiles are used the gaps must be adequate, and the grade self cleansing at least 2.5 ft. per sec.; when porous or permeable wall pipes are used the rate of infiltration must be checked with the makers. Gravel envelopes are essential for french drains — some engineers have used well graded material with the result that packing ensues and blocking occurs and water does not get down to the drain. My experience indicates that gravel, pebble, broken stone of 2½ in. to 1½ in. size ensures long term porosity. Sizes of pipes must be calculated by formulae appropriate to surfacewater sewers.

Special problems in respect of surface drainage arise on lands which are extremely flat, that is from zero gradient to 1 in 1,000 or thereabouts, and where such land is underlain with impermeable soil strata. It is sometimes possible to improve such land by land forming techniques which are common in the Midlands for agricultural land where ridge and furrow drainage is practised. Land forming for this pur-

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pose involves giving slopes to areas of the land towards an outlet or ditch.[4] Such work must be done with precision — there is an excellent description of the techniques in "Drainage of Agricultural Lands" by Luthin[3] and in "Soil and Water Conservation Engineering" by Frevett[9] and others where it is described as "bedding." The use and relevance of these techniques to landscape work lies almost entirely in the realms of sports fields constructed on flat alluvial areas where it is sometimes practicable to creat a crowned field, that is to construct it to the shape of a low elipse across the field, and catch the run-off in shallow side ditches.

Sub-surface or subsoil drainage

Our second division under this main heading is in respect of drainage below the surface — subsoil or underdrainage, or sub-surface drainage. This is concerned with the removal of water from within the soil itself and will need detailed consideration by the landscape designer. Some of the problems are:

(a) reduction of water tables;
(b) special difficulties with silt soils;
(c) top-water in clays.

In the case of the first of these, water tables only occur and can be substantially influenced by drainage techniques, in soils which exhibit some degree of permeability. Code of Practice 2001[2] on page 119 says "from clay to gravel, permeability may vary a hundred thousand million times." "Techniques of Landscape Architecture"[4] quotes a table which from "coarse sandy" soil type with a permeability of 18.7 in./hour to "clay" with 0.006 in./hour a range of 3,000 times. Tables which are proposed for the new British Standard for Landscape Operations give ranges of 10,000 times, in in./hour. Obviously a solution for a soil with a permeability approaching the "excellent" class of 1.0 to 2.5 in./hour has little relevance to soils having a permeability below 0.01 in./hour which is considered too slow for artificial drainage to be effective.

It may be considered therefore that soils which exhibit features such as a permeability of 0.10 in./hour and lower must be considered in separate classes — such soils are silts and clays.

Clays in the range just mentioned for all practical purposes do not have a water table[8] — only the vegetable soil is endowed with any degree of permeability — "the undisturbed subsoil plays no part in conducting water from the surface to the drain — rain penetrates the cultivated surface soil until it reaches the boundary between this and the subsoil, then flows along this boundary, d o w n the direction of greatest slope, until it arrives at a position vertically above a drain where the drain trench" has an artificial degree of permeability many thousands of times better than the adjacent subsoil. Drainage then of such soils is concerned with, in effect, cutting intercepting drains across the contours, and trapping water as it travels along the boundary with the subsoil. Depth is not important in this context.

Where water tables do occur in soils of a sandy, or gravelly, or loamel char-

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acter with higher levels of permeability it is of course possible to influence the level of the table where it exists by piped drainage and the depths at which such pipes are put *is* critical.

In many silts soils there are special problems and I shall devote much more later to a discussion of them.

Drainage during construction works

It is necessary for me to make special reference to the considerations applicable to drainage works during periods of construction works, (and including in this the period immediately following up to 2 or 3 years) where special works are often essential to enable the work to be performed economically and to prevent damage to or by the works.

Periods of construction including the first few years of establishment in large landscape operations are periods when the works are particularly vulnerable. The radical disturbance of soil structure by compaction during earth movement, by cultivations and by moving materials and machinery about the job, generally much in excess of normal agricultural operations, cause a diminution of, and a very slow return to, optimum permeable soil conditions. Additionally in silts in particular which are water unstable, top crusts are formed by rainfall, which gives rise to damage by quick sheet run-off, causing gully erosion and damage to adjacent land and property. There is some interesting discussion in this in "Biology and Engineering"[5] under the title "The effect of vegetation on Drainage and Floods."

Remedial and preventative measures include ripping and subsoiling with special tines and great care as to soil conditions when machines operate, to prevent compaction.

Other measures are as mentioned above under "surface drainage" and include cut-off drains to protect, and catch run-off. The design of cut-off drains in these conditions must be considered on the basis of the engineering formulae already referred to above, than on normal field drainage principles, because the reduction in permeability may well prevent any soakage into the soil and cause a discharge more akin to hardened areas such as roads and roofs than to "natural" areas. I have already mentioned "french" drains in this connection and it may well be that a rainfall intensity of $1\frac{1}{2}$ in./hour may have to be used in design. Damage caused by intense storms can be considerable, and may give rise to claims from third parties when the direction and amount of run-off has been altered by levelling or other works.

The degree of vulnerability of construction works often diminishes considerably with time, being greatly influenced by the growth to maturity of ground vegetation and the return to optimum permeability of the soil aided by natural agents. However, this latter process may take many years and Crompton of Newcastle University, says[6] that there are some soils which often radical disturbance take 50 years to return to optimum conditions —

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" optimum " being a condition of land which has been for many years covered with undisturbed grass.

Drainage effecting a permanent influence on soil water

There are two methods generally in use which effect a lasting influence upon the soil/water regime; these are piped drainage and mole drainage. In landscape works both have uses and are often combined, the former being regarded as a permanent capital investment and the latter as a form of tillage or cultivation to be repeated after a period of years dependent upon soil and weather.

The best descriptions and studies of mole ploughing have been made by H. H. Nicholson in Chapter X of "Principles of Field Drainage"[4] and should be referred to by landscape designers who practice in areas where the right clays predominate. Normal agricultural mole drainers are adequate for use in construction work, but for maintenance cultivations special cable drawn implements are essential to avoid damage and to the best of my knowledge there is only one on the market[7].

The recent publication " Techniques of Landscape Architecture "[7] refers in this apart from the absence of guidance as connection to use in " pure clays " — quite to what is "pure," reference to Nicholson[4] who lays down some rules for the type of suitable soil and describes them in a more accurate way by reference to the proportions of sand, silt and clay, and in my experience the only way to ensure reasonable results in the absence of positive identification is to have a mechanical analysis made of it.

As to piped drainage (or underdrainage or subsoil drainage), techniques of design are of the utmost importance to landscape architects — and with costs in the order of 10s. per yard, that is hundreds of £s per acre, it is necessary to consider this separately.

(to be continued)

Reference to textbooks and papers referred to in the text

1 *British Standard Code of Practice CP* 2003 (1959) *published by the Council for Codes of Practice,* 2 *Park Street, London, W.C.*1.

2 *British Standard Code of Practice CP* 2001/1957 — *" Site Investigations." Published by the Council for Codes of Practice,* 2 *Park Street, London, W.C.*1.

3 *" Drainage of Agricultural Lands," The American Society of Agronomy, Madison, Wis., U.S.A.*

4 *" The Principles of Field Drainage," H. H. Nicholson, Cambridge Press.*

5 *" Biology and Civil Engineering," The ICE, Great George Street, London.* 1949.

6 *" Soil Structure," E. Crompton, University School of Agriculture, Newcastle on Tyne. H.M.S.O. Reprint from N.A.A.A. quarterly review No.* 41.

7 *" Techniques of Landscape Architecture." Edited by A. E. Weddle Heineman, London.*

8 *" Scientific Research in Soil Drainage," Journal of Agricultural Science, Vol. XXIV, Part* 4—1934.

9 *" Soil and Water Conservation Engineering " — Frevert and others. John Wiley, New York.*