Our district is unique in that it contains the spacious Park where the Ravinia Outdoor Opera renders its Annual Music Festival. These open air concerts given during July and August attract thousands of music lovers. We were informed by many visitors as well as by the management that annoyance there from mosquitoes has been much less than usual, really almost non-existent.

The extensive U. S. Army Post of Fort Sheridan bounds our district on the north. We made inquiry to the Medical Branch of this the Sixth Service Command regarding what measures were being taken to prevent the spread of malarial infection through men returned here from infected foreign areas. In reply the Surgeon General U.S.P.H.S. informed us of the meticulous care exercised by the Army Medical Branch through rigid quarantine and frequent blood tests to see that all such cases are free of infection before leaving their Army Post.

Nevertheless the frequent shifts of civilian and military population due to the war effort has made our work here increasingly important. We hope to continue and expand it next year as much as our funds permit.

Highland Park, Illinois,
November 6th, 1943.

GEORGE B. DANA,
President of the Board.

DEVELOPMENTS IN MOSQUITO CONTROL

UNDERGROUND DRAINAGE FOR MALARIA CONTROL

By Nelson H. Rector, Sanitary Engineer (R)
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From Monthly Report of Malaria Control in War Areas
U. S. Public Health Service, Atlanta, Georgia

Underground drainage for malaria control was used by Le Prince and Gorgas in Panama more than 30 years ago. Their drainage systems were constructed of tile laid in narrow contour trenches and covered with broken stone. The trenches were completely filled with broken stone without an earth backfill so that they could carry some surface water. Large stone was placed in the bottom of the ditch and smaller stone in the top layer at the ground surface. To prevent the deposition of impervious material in the voids between the stones, the spoil was placed on the downhill side of the trench.

Satisfactory underground drainage may be constructed of brickbats, rock, gravel, tile or poles covered by a layer of leaves, straw or other filter material and backfilled with earth. Properly constructed drains of this type are inexpensive to install and require little or no maintenance. Some systems have been reported to be giving satisfactory service after more than 50 years of use. Underground drainage as a factor in malaria control is gaining widespread recognition; it has been proved to be one of the most effective methods for permanently eliminating Anopheles breeding places caused by seepage.

Seepage outcrops are caused by a change in permeability of the soil; e.g., a sandy loam topsoil underlain by a clay subsoil. Water flowing through the loam is arrested by the clay subsoil and must flow along this more impervious stratum until it reaches an outcrop on a hillside, stream bank or used in larvicidal control and about 750,000 lineal feet of ditching was completed. During that month, 46 major drainage projects were in operation in 14 states and nearly 20 miles of new ditches were constructed. That Service has carried on a considerable amount of underground drainage such as that used in Panama by LePrince and Gorgas more than 30 years ago. The drainage systems consist of land tile laid in contour trenches on crushed stone of comparatively large size and covered with broken stone of smaller size. The latter is not covered with an earth backfill so that some surface water in addition to ground water is removed. Spoil is placed on the downhill side of similar location. The line of seepage outcrop may be relatively short or it may extend along the entire toe of slope of a hill and become the source of a marsh or swamp.

Permanent seepage marshes provide excellent breeding places for Anopheles mosquitoes. The water is fresh and abundant vegetation provides food and protection for the larvae. Such areas are generally small, but in some instances marshes and ponds covering several acres have been formed by seepage outcrops. When located near towns or other centers of population, these breeding areas may provide a constant supply of malaria carrying mosquitoes.

It is most important that the design of an underground drainage system

HILLSIDE SEEPAGE DITCHES

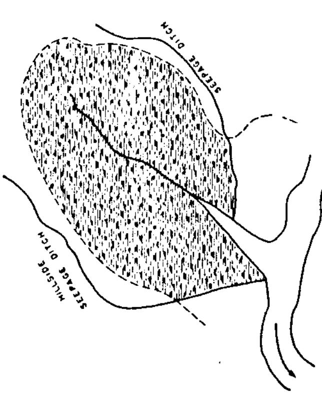

Fig. 1

MULTIPLE SEEPAGE DITCHES

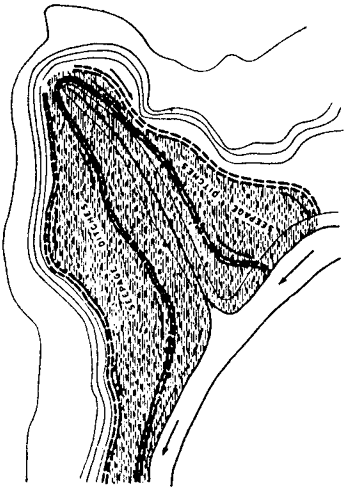

Fig. 2

UNDERGROUND DRAIN USING TILE

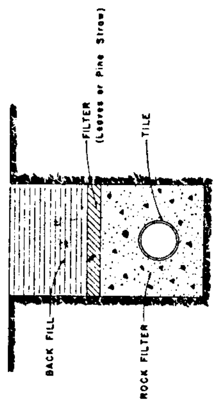

Fig. 3

UNDERGROUND POLE DRAIN

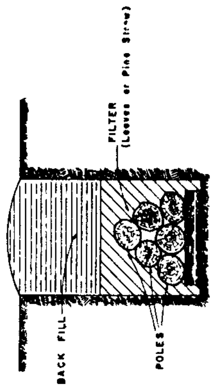

Fig. 4

for the elimination of seepage areas be properly planned and executed. In general, a deep, narrow trench is constructed just above the toe of slope of the hill, and this trench usually follows a contour (Fig. 1). The depth of the trench will be determined by the elevation of the seepage stratum and by the elevation of the outlet ditch. Whenever possible, the ditch should be at least 3 feet deep. A 2-inch earth auger or post-hole digger may be used for locating the depth of the water table and determining the type of underlying subsoil. This information is indispensible in locating the ditch and establishing the grade. Underground drainage must be executed by an engineer familiar with this work, as the conventional design for land drainage will not be effective. Where the seepage outcrop extends well up on the side of a steep slope, it may be necessary to construct a series of parallel contour ditches only a few feet apart along the side of the hill (Fig. 2). The line of the drain should be as straight as possible, but when line changes occur, the tangents should be

DETAIL OF TILE OUTLET

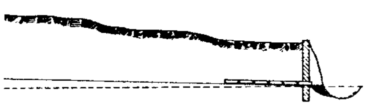

Fig. 5

STABILIZATION OF DITCH BANKS

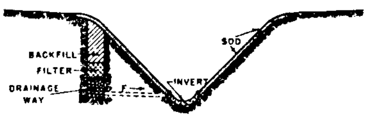

Fig. 6

SUB-DRAINAGE OF DITCHES

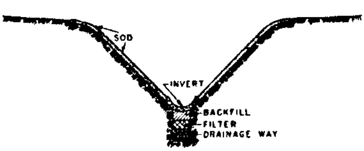

Fig. 7

DRAINING SPRING-FED MARSHES

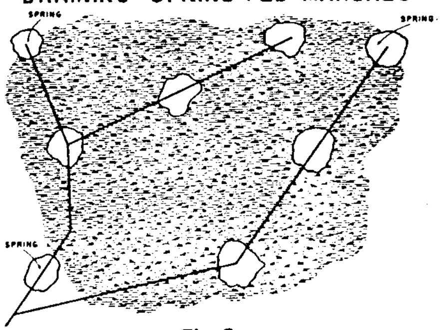

Fig. 8

POTHOLES ALONG BED OF DITCH

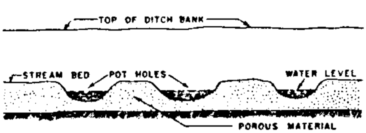

Fig. 9

METHOD OF REPAIR

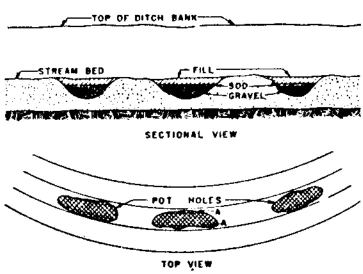

Fig. 10

connected by a smooth curve. Each lateral should enter the main drain at an acute angle.

Narrow trenches, usually from 1 to 2 feet wide will be sufficient for all systems. Generally, it is best not to have the trench longer than 500 or 600 feet. If great care is taken in the construction of the individual ditches in the system, there is no great objection to making the ditches somewhat longer. However, with the average crew, long underground drains are seldom satisfactory. The grade of drains consisting of material other than tile should not exceed 2 feet per 100 feet. Grades of 0.20 to 0.50 feet per 100 feet will tend to make the system more permanent since none of the soil will be lost by erosion. A profile of the system must be made in order to lay a grade suitable to the topography.

Tile, rock, brickbats, stone, poles or other suitable material should be placed in the trench to a depth of from 12 to 18 inches and covered with straw, grass, leaves or brush to a depth of 6 to 12 inches after thorough compaction. The trench is then backfilled to a height of about 1 foot above the original ground level (Figs. 3 and 4). Care must be taken in placing the material in the trench so that voids will be left to allow a free flow of water. When tile is used, it is surrounded with broken stone, above which the straw, grass, hay or leaves are placed in the drainage way. If the soil is very sandy, the filter should extend down around the drain. The backfill should be tamped down to make it as water-tight as possible.

If poles are used as the material in the drains, the joints should not coincide. Experience has proved that failures always occur in the filter when two or more joints are placed together. The poles should be from 4 to 8 inches in diameter and 3, 5, 7 or more may be used in the cross-section of the drain, depending on the volume of water to be carried. The placing of materials should begin at the upper end of a ditch so that the chips, debris or flotage will be washed away rather than into the finished drain.

Although poles placed underground and submerged in water will last indefinitely, they deteriorate rapidly when exposed to air and may thereby cause a failure of the whole system. The drain outlet should be protected by building head-walls of brick and mortar, concrete or rock. Two or more joints of tile should be used in the drain at the head-wall to provide further protection for the drainage material (Fig. 5).

Uses of underground drainage for malaria control other than intercepting seepage outcrops are: (1) sub-draining open earth ditches and concrete inverts; (2) stabilizing ditch banks; (3) draining marshes caused by springs; and (4) providing outlets for overflowing drinking fountains and artesian wells (Figs. 6, 7, 8).

If the banks of a ditch are saturated with seepage and tend to cave in or are hard to hold in place, they can be stabilized by using a small underground drain as shown in Figure 6. A narrow trench is dug perpendicular to the seepage outcrop and sufficiently deep to intercept the flow, or to a depth which will permit drainage into the outlet ditch. This drain may be placed as illustrated, or it may be several feet from the edge. The trench should be filled with any suitable material as has already been explained, the filter placed, and the backfill made as in any underground drainage ditch. A joint of small tile is used to carry the seepage water from the drain into the ditch, and should enter the side of the invert at an acute angle.

Figure 7 illustrates the method for sub-draining open earth ditches and inverts. If a great amount of seepage water is encountered which seems to prohibit the construction of an invert in the ditch, the difficulty may be removed by sub-draining the ditch to lower the water table as shown in the diagram. The drain is constructed directly under the proposed invert and should be from 12 to 18 inches in depth. If the grade of the ditch is sufficient to allow the construction of spillways, the underground drains can be made shorter and their effectiveness increased. On ditches having a steep grade, the spillway will serve three purposes; namely, decrease the grade of the main ditch, prevent erosion, and make possible the construction of short underground drains.

Sub-draining open earth ditches will eliminate water standing in potholes and behind small obstructions. To prevent erosion, it is desirable to provide spillways on open earth ditches having steep grades. The spillways may be constructed of brick and mortar, concrete or masonry. It is not advisable to use regular curves to break the grade at the spillways as in the case of invert ditches, but rather to use abrupt drops of about 6 inches, making the spillway similar to stair steps. These abrupt drops will tend to decrease the velocity of the water so that erosion of the ditch bottom will be decreased. The banks should be riprapped at the spillways.

Figure 8 illustrates drainage of marshes fed by springs. Springs causing marshes and swamps may be irregularly located with reference to contours and for this reason cannot be eliminated by the regular contour trench. To eliminate the swamp, a system of underground drains consisting of the main ditch and a separate lateral for each spring must be installed as shown in the diagram. The laterals should enter the main ditch at an acute angle. Two laterals should not enter the main ditch directly opposite each other, but should be alternated.

Along ditches through sandy soil or soil containing a large amount of gravel, it will be noted that in dry weather, potholes occur at intervals along the stream bed. Upon close examination it will be observed that the soil between the potholes is quite porous and permits the natural flow of water below the ditch bottom. It will also be observed that this porous material has been washed out to a depth below the hydraulic gradient of the ditch, producing the potholes as shown in Figure 9.

Holes thus formed in the ditch bottom often provide excellent breeding for Anopheles mosquitoes since the conditions are similar to those formed by seepage outcrops. To destroy these breeding places only one thing need be done; that is fill in the missing portions of the porous stream bed. This task may be accomplished by filling the holes to the approximate water level with gravel, using larger stones in the bottom and smaller ones toward the top. The gravel should be covered with a thick layer of sod turned grass side down, and the job completed by covering the sod with a compacted layer of dirt to the original elevation of the stream bed.

If the holes are large, it will be advisable to fill in the sides with dirt to provide a narrow channel before placing the rock or gravel. Considerable time will be saved by following this method since a much smaller amount of gravel or rock will be required. The flow in most cases is small and the narrow channel or drainage way will suffice to carry the water. After the holes have been properly filled, the water flow is below the ditch bottom at all places so that no Anopheles breeding places exist.

The following may be listed as points in favor of underground drainage over open ditches:

1—Completely eliminates mosquito breeding and hence obviates any need for inspection or larvicide work.

2—Low cost of material.

3—Low cost of construction (costly supervision not necessary).

4—Low cost of maintenance.

5—Permanency.

6—No land lost for right-of-way, since cultivation can be extended over the drain.

7—Can be used where other types of drainage are impossible.

The two most important factors relating to any malaria control drainage project are the ultimate cost, and the permanency of the system. When properly planned and executed, underground drains are not expensive to construct and will give many years of satisfactory service free from maintenance. In view of these points, underground drains should be used for malaria control drainage whenever conditions indicate the feasibility of this method.

OLD SALT MARSH DITCHES

By William Thom
Middlesex County, N. J.

Why is it that old Salt Marsh Ditches do not function as well as new ditches, even though they are cleaned at frequent intervals?

As time goes on this question will become more paramount in the minds of mosquito control workers throughout the state; at least in Middlesex County we have already discovered its importance, because many of our ditches were installed more than forty years ago and we have observed during the past few years that the marsh areas encompassed by the older ditches do not drain off as rapidly as similar areas surrounded by ditches of recent construction. In many cases, wet areas may be found within a few feet of the old ditches long after the tides have receded and it is apparent that evaporation, rather than percolation, plays the greater part in the removal of water in these areas.

Our marshes are now pretty thoroughly covered with ditches: In fact, we have reached the point where the further extension of laterals would seriously interfere with the harvesting of the Salt Hay Crop. Consequently, we must find other means of draining the marsh surface, or resort more and more to the use of oil and larvicide.

In the approach to the question we have raised, I believe that it would be well, first, to review briefly the structure of a salt marsh.

Salt Marshes are built by the action of the ocean's tides in the deltas of rivers where the silt laden current of the river is retarded by the incoming tide and fans out, depositing silt on either side of its channel. The heavier materials, gravel and sand, find bottom first, usually in the channel and on either side farther up stream while the finely pulverized materials are carried off by the receding tides to be finally deposited in the still water along the more sheltered areas of the shore. As these areas fill up, the deposits are carried further and further outward toward the headlands or to a point where wave action keeps the silt in solution until carried in again by the rising tide.

This process is carried on until the silt has been deposited to such a height that it becomes exposed at low tide, forming what is commonly called a mudflat or young marsh. It is at this point that vegetation first appears. This first vegetation is almost purely aquatic and contains little if any fiberous material.

This growth screens the incoming tides of flotage and by impeding the tidal flow causes a more rapid deposit of fine silt. Evaporation of the tide water now begins to take place and the resulting residue of various salts mingles with the silt. Marsh sod now begins to form. It consists of a more or less porous mass of flotage, roots, etc. held together in a matrix of silt heavily impregnated with brine. This sod layer continues to rise until only occasional tides cover it. As the period of time between covering tides lengthens, the type of vegetation changes and becomes more fiberous with longer and more numerous roots.

I have often noticed while walking over a salt marsh that the sod seems to be firmer and somewhat higher near the banks of natural streams while near the upland the marsh appears to be lower and much softer under foot.