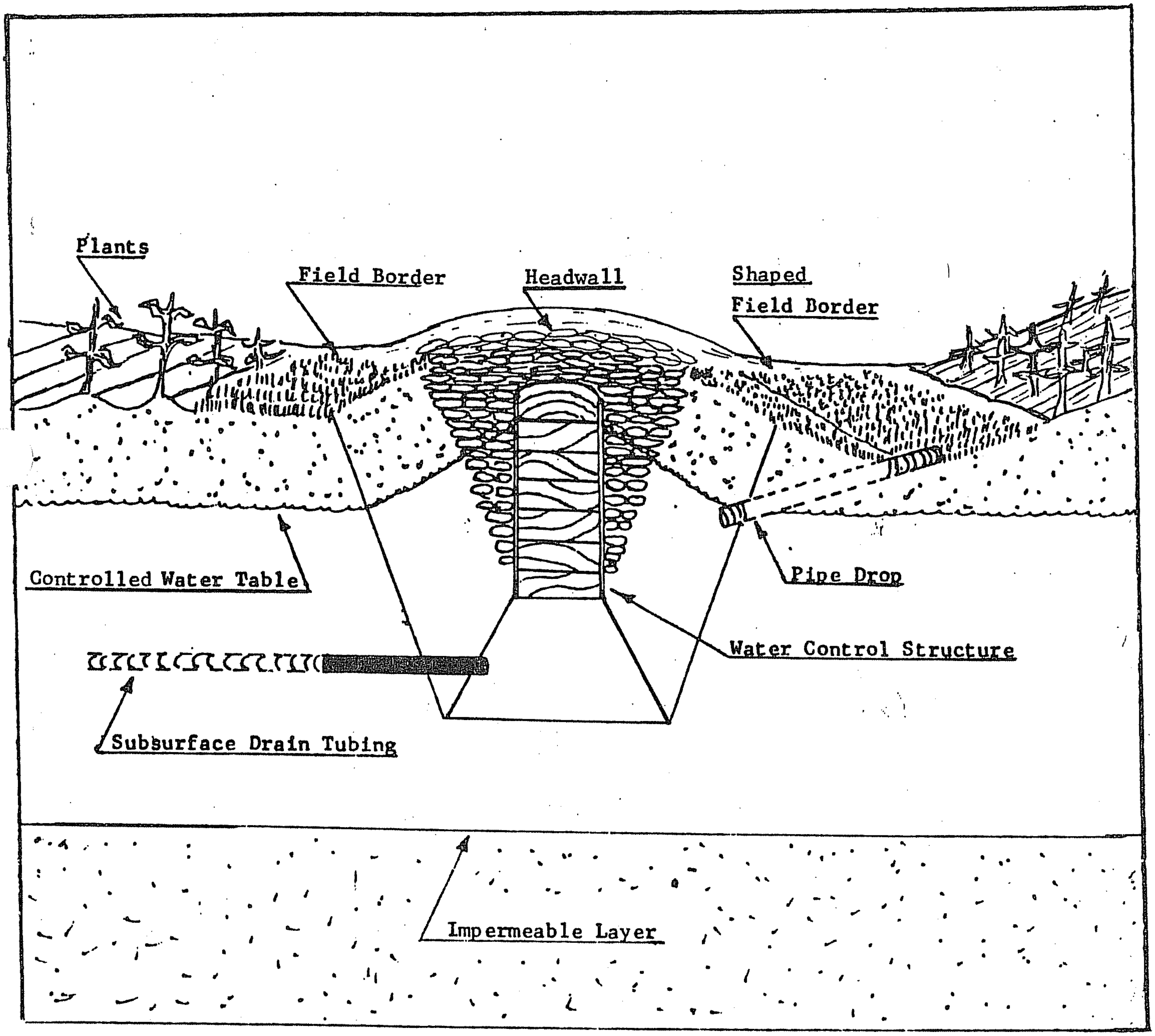
WATER TABLE MANAGEMENT GUIDE



GUIDELINES FOR PLANNING AND DESIGN
OF WATER TABLE CONTROL SYSTEMS UTILIZING SUBSURFACE DRAINS

DEFINITION

A water table control system is a combination of surface drains, subsurface drains, water control structures, and water conveyance facilities designed and installed to a planned spacing, depth, and grade for the efficient below ground distribution of irrigation water. An adequate water supply should be added as a part of the system.

PLANNING AND DESIGN GUIDELINES

GENERAL

Preliminary plans and designs should be made utilizing the basic criteria contained in the Practice Standards for Subsurface Drain, Precision Land Forming, Irrigation System (Surface and Subsurface), and Irrigation Water Conveyance (Pipeline). An adequate outlet and water supply must be available to meet the drainage and irrigation requirements. Hydraulic conductivity (permeability) tests should be made during periods of high water tables. Final designs should be made based on the computer capabilities of DRAINMOD.

DRAINAGE CAPACITY

The combined capacity of the surface and subsurface drains should remove the recommended drainage coefficient for the crops being grown. The required capacity of the subsurface drains may be any portion of the recommended drainage coefficient, but not less than ½ inch in 24 hours.

Irrigation Capacity

The irrigation capacity should be designed to apply a minimum of 5 to 7 gallons per minute per acre.

LAND PREPARATION

Irregularities in the land surface should be removed by leveling or smoothing so that grades in the directions of the rows are level or continuous in grade. Follow recommended grades as shown in the Practice Standard for Precision Land Forming.

FILTERS

Where needed, suitable filters should be used around the conduits to prevent the accumulation of sediment. Adequate soils investigation should be made and the recommendations in the Practice Standard for Subsurface Drains should be followed. When conduits are also used for irrigation, there is greater tendency for sediment accumulation in the lines than when used as drains only.

DESIGN OUTLINE-WATER TABLE CONTROL SYSTEM

BASIC DATA

Drainage Coefficient

Determine removal rate for surface and subsurface drains.

Irrigation Demand

Determine from Irrigation Guide. Use a minimum of 5 to 7 gpm/ac. This is approximately .25 acre inches of water per day.

Soils

Determine description and physical properties. Conduct a minimum of one hydraulic conductivity test for each ten (10) acres in the land unit.

Condition of Land Surface

Determine grading requirements (usually requires a topographic survey).

Water Supply

Show source, location, and capacity needed.

DESIGN COMPUTATIONS

Surface Drainage

Determine drainage area and check capacity of outlets. Maintain hydraulic grade line at least 0.5 ft. below normal ground.

Subsurface Drainage

Determine required drain lateral spacing. Determine size of laterals (minimum 4"). Determine size of main lines. Determine grades and depths for all lines.

Irrigation

Determine required capacity of all supply and distribution lines. Reduce spacing required by drainage by 25-40% when DRAINMOD is not available to design the system, lay out laterals parallel to each other, and as level and parallel with ground surface as practical. Minimum grades should be checked and filter used where needed. Generally, laterals should be limited to 660' in length.

Structure for Water Level Control

Determine size and location to carry drainage requirements. Where the ground surface is sloping, the water control structures should be placed so that the water level in the distribution system can be held at about 0.5' differences in elevation. DRAINMOD can determine the optimum weir elevation in the water control structure for crop to be grown. Observation wells should be strategically placed to monitor the water table elevations below the ground surface in each field. It is highly recommended that DRAINMOD be utilized to design the water management system when possible.

GUIDELINES FOR SYSTEM OPERATIONS

IRRIGATION

Operation of the system should be such that prolonged saturation of the crop root zone does not occur. For shallow rooted crops, such as strawberries or irish potatoes on porous soils, one successful method of operation includes raising the water table to near 12-18 inches of the ground surface until the surface layer of the soil reaches its water holding capacity. Once this condition is reached, the water table is allowed to recede by evapotranspiration to some predetermined level until the crop needs to be irrigated again. Additional water is then applied and the cycle repeated. This procedure allows air to move into the soil and plant root zone for optimum root development.

Another method that will conserve the most rainfall is to keep the weir crest of the structure at a high level during normal and dry periods. During wet periods the crest is lowered to prevent crop damage. When irrigating, the water is held as low as possible below the weir crest. An adequate supply of water still reaches the crop roots for optimum production. Keeping irrigation water below the weir crest provides the maximum potential to store rainfall that may occur. The soil characteristics of the field determine how the weir should be adjusted and correct elevation to hold the irrigation water level.

OBSERVATION WELLS

To facilitate control of the underground water table, it is helpful to know the water elevation in the field to be irrigated. This determination can be made by using a simple gauge made from a 4" PVC pipe, approximately 48" long. The pipe should be perforated with 1/8 inch holes and placed in the ground near the center of each irrigated block to form an observation well. A float with a painted wire may be placed in the well for easy reading of the ground water level. The wells should be placed equal distance from distribution laterals with 6 inches of the pipe above ground. Additional observation wells may be needed when more than one soil type within a field requires different drain spacings.

During the crop growing season it's most economical not to let the ground water table drop below the bottom of the drain conduits. This permits the conduits to drain when needed and requires the minimum amount of water to be pumped to raise the water table for irrigation.

DRAINAGE

The water management system should be designed and operated to provide maximum drainage benefits during periods of high rainfall. This is very important during the early part of the growing season when plants are small, more susceptible to drowning, and the ground water table is higher than normal to reach the root zone. During critical drainage periods, water level control structures should be fully opened to allow for design channel flow volumes.

IMPORTANT FACTORS IN PLANNING SUBIRRIGATION SYSTEMS

KNOWLEDGE OF SYSTEM AND KNOW HOW IT FUNCTIONS

It has been shown that subsurface drainage systems (subsurface drains and open channels) can be successfully used to provide water to crops. (Subirrigation). The basic concept is to put a head of water over the drain outlets to reverse the flow of water through the lines and into the soil profile. This process provides irrigation for plant growth.

DOES FIELD NEED IRRIGATION, DRAINAGE, OR BOTH?

Subirrigation is not recommended on well drained or excessively drained soils due to such factors as: (1) excessive slopes (>2-3%), (2) high permeability rates with low water table, and (3) difficult to maintain uniform water table in fields. If irrigation is needed alone, it's generally more practical to use overhead systems.

DRAINAGE PLUS IRRIGATION

At the present time, subirrigation is recommended only on soils that require drainage for trafficability and improved crop production. Planning drainage systems for subirrigation normally requires closer spacing. However, with closer spacing smaller lines may be installed. The additional cost for subirrigation will primarily come from adding a water supply, getting the water into the system, and structures for water level control. Generally, fields that respond well to drainage can be subirrigated successfully.

PLAN WATER MANAGEMENT SYSTEM FOR ENTIRE AREA

Expensive mistakes can be prevented by planning the entire unit of land where the landuser is ready, willing, and able to install a complete water management system. Careful considerations should be given the following factors:

(1) Land use by fields--present and future
(2) Effects on adjacent property owners
(3) Suitable outlet(s)
(4) Adequate water supply and location
(5) Types of soil conditions in the land unit
(6) Row lengths and directions
(7) Farm road locations
(8) Location, size, depth, and stabilization of open channels
(9) Location, size, and depth of subsurface drains
(10) Scheduling hydraulic conductivity tests to high water table conditions
(11) Additional conservation measures needed--land leveling, drop inlet pipes, field borders, etc.
(12) Engineering resources available--topographic surveys, structure design, etc.

DETERMINE ADEQUATE OUTLET(S) FOR SYSTEM

During the peak growing season the underground water table will be managed between 15-36 inches below ground surface. The depth will vary, dependent upon soil-plant characteristics. If intense rains occur during this period, it is very important the outlets be adequate to remove the excess water and prevent crop damage from drowning. This is the primary reason for installing the drain lines at a closer spacing when subirrigation is a part of the drainage system. The minimum capacity for subsurface drains should be the removal of 0.5 inches of water a day.

LOCATION AND AMOUNT OF WATER SUPPLY

The most important factor in planning a subirrigation system is having an adequate supply of good quality water. This is particularly true during the peak growing season when water demands are greatest. The major sources of water in the Coastal Plains of North Carolina are rivers, streams, ponds, and deep wells. The water supply and conveyance system should be capable of providing 5-7 gpm/acre during the peak growing season.

SECURE ADEQUATE ENGINEERING DATA

Detailed engineering surveys are necessary for determining: (1) outlet conditions, (2) structure locations, (3) depth and spacing of surface and subsurface drains, (4) location of water supply, (5) land leveling needs and (6) installing additional conservation measures. Generally, it is best to prepare a complete topographic map for the entire unit of land.

CONDUCT HYDRAULIC CONDUCTIVITY TESTS

Soil and water characteristics vary within a field. The hydraulic conductivity of soils varies even within the same series. It is recommended a minimum of one hydraulic conductivity test be conducted for each ten acres in the land unit. This information is vital in utilizing DRAINMOD for final design of the water management system. Information relative to depth to impervious material must be included in the permeability test data. The equipment and instructions for performing hydraulic conductivity tests are available at area offices.

SECURE CURRENT SOILS MAP

Current soils information can provide the planner and landuser with technical information relative to feasibility of installing a subirrigation water management system. The enclosed table provides a list of Coastal Plain soils grouped into two broad categories: (1) soil where water table management should be successful and (2) soils where water table management is not believed to be practical. This table is prepared as a guide only for feasibility purposes and does not eliminate the need to perform on-site investigations for each land unit.

UTILIZE DRAINMOD FOR FINAL DESIGN

Based on rainfall data for the past 25 years, hydraulic conductivity tests, crops, and other factors, the computer can project the best spacing for subsurface drains to manage water table at optimum level for desired crop(s). The objective is to minimize the number of plant stress days from either excessive or inadequate moisture during the growing season. Managing underground water table in Coastal Plain soils is relatively new technology in North Carolina. When adequate soils information is available, the DRAINMOD computer program should be used for design of the water management system.