CHAPTER 1

INTRODUCTION

1-1. Purpose and scope. This manual provides guidance for the planning, design, supervision, construction, and operation of dewatering and pressure relief systems and of seepage cutoffs for deep excavations for structures. It presents: description of various methods of dewatering and pressure relief; techniques for determining groundwater conditions, characteristics of pervious aquifers, and dewatering requirements; guidance for specifying requirements for dewatering and seepage control measures; guidance for determining the adequacy of designs and plans prepared by contractors; procedures for designing, installing, operating, and checking the performance of dewatering systems for various types of excavations; and descriptions and design of various types of cutoffs for controlling groundwater.

1-2. General.

a. It will generally be the responsibility of the contractor to design, install, and operate dewatering and groundwater control systems. The principal usefulness of this manual to design personnel will be those portions devoted to selecting and specifying dewatering and groundwater control systems. The portions of the manual dealing with design considerations should facilitate review of the contractor's plans for achieving the desired results.

b. Most of the analytical procedures set forth in this manual for groundwater flow are for "steady-state" flow and not for "unsteady-state" flow, which occurs during the initial phase of dewatering.

c. Some subsurface construction may require dewatering and groundwater control procedures that are not commonly encountered by construction contractors, or the dewatering may be sufficiently critical as to affect the competency of the foundation and design of the substructure. In these cases, it may be desirable to design and specify the equipment and procedures to be used and to accept responsibility for results obtained. This manual should assist design personnel in this work.

1-3. Construction dewatering.

a. Need for groundwater control. Proper control of groundwater can greatly facilitate construction of sub surface structures founded in, or underlain by, pervious soil strata below the water table by:

(1) Intercepting seepage that would otherwise emerge from the slopes or bottom of an excavation.

(2) Increasing the stability of excavated slopes and preventing the loss of material from the slopes or bottom of the excavation.

(3) Reducing lateral loads on cofferdams.

(4) Eliminating the need for, or reducing, air pressure in tunneling.

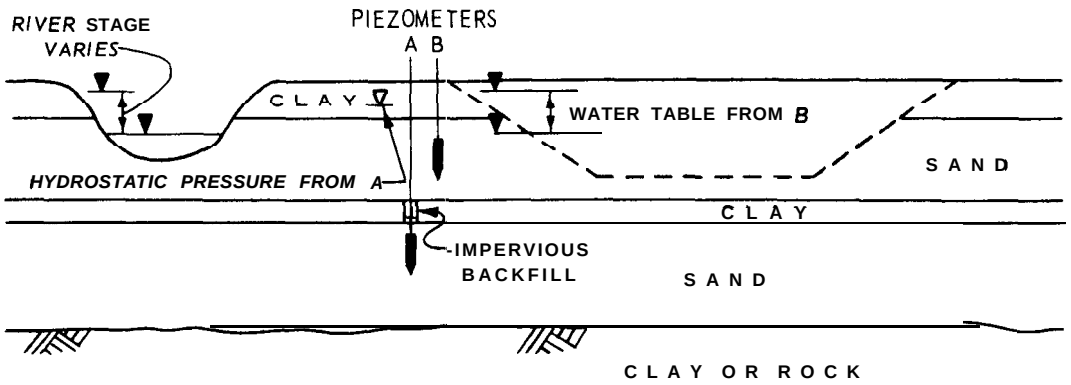
(5) Improving the excavation and backfill characteristics of sandy soils.

Uncontrolled or improperly controlled groundwater can, by hydrostatic pressure and seepage, cause piping, heave, or reduce the stability of excavation slopes or foundation soils so as to make them unsuitable for supporting the structure. For these reasons, subsurface construction should not be attempted or permitted without appropriate control of the groundwater and (subsurface) hydrostatic pressure.

b. Influence of excavation characteristics. The location of an excavation, its size, depth, and type, such as open cut, shaft, or tunnel, and the type of soil to be excavated are important considerations in the selection and design of a dewatering system. For most granular soils, the groundwater table during construction should be maintained at least 2 to 3 feet below the slopes and bottom of an excavation in order to ensure "dry" working conditions. It may need to be maintained at lower depths for silts (5 to 10 feet below sub grade) to prevent water pumping to the surface and making the bottom of the excavation wet and spongy. Where such deep dewatering provisions are necessary, they should be explicitly required by the specifications as they greatly exceed normal requirements and would not otherwise be anticipated by contractors.

(1) Where the bottom of an excavation is underlain by a clay, silt, or shale stratum that is underlain by a pervious formation under artesian pressure (fig. 1-1), the upward pressure or seepage may rupture the bottom of the excavation or keep it wet even though the slopes have been dewatered. Factor of safety considerations with regard to artesian pressure are discussed in paragraph 4-8.

(2) Special measures may be required for excavations extending into weathered rock or shale where substantial water inflow can be accommodated without severe erosion. If the groundwater has not been controlled by dewatering and there is appreciable flow



(Modified from "Foundation Engineering," G. A. Leonards, ed., 1962, McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.)

Figure 1-1. Installation of piezometers for determining water table and artesian hydrostatic pressure.

or significant hydrostatic pressures within the rock or shale deposit, rock anchors, tiebacks, and lagging or bracing may be required to prevent heave or to support exposed excavation slopes.

(3) An important facet of dewatering an excavation is the relative risk of damage that may occur to the excavation, cofferdam, or foundation for a structure in event of failure of the dewatering system. The method of excavation and reuse of the excavated soil may also have a bearing on the need for dewatering. These factors, as well as the construction schedule, must be determined and evaluated before proceeding with the design of a dewatering system.

c. Groundwater control methods. Methods for controlling groundwater may be divided into three categories:

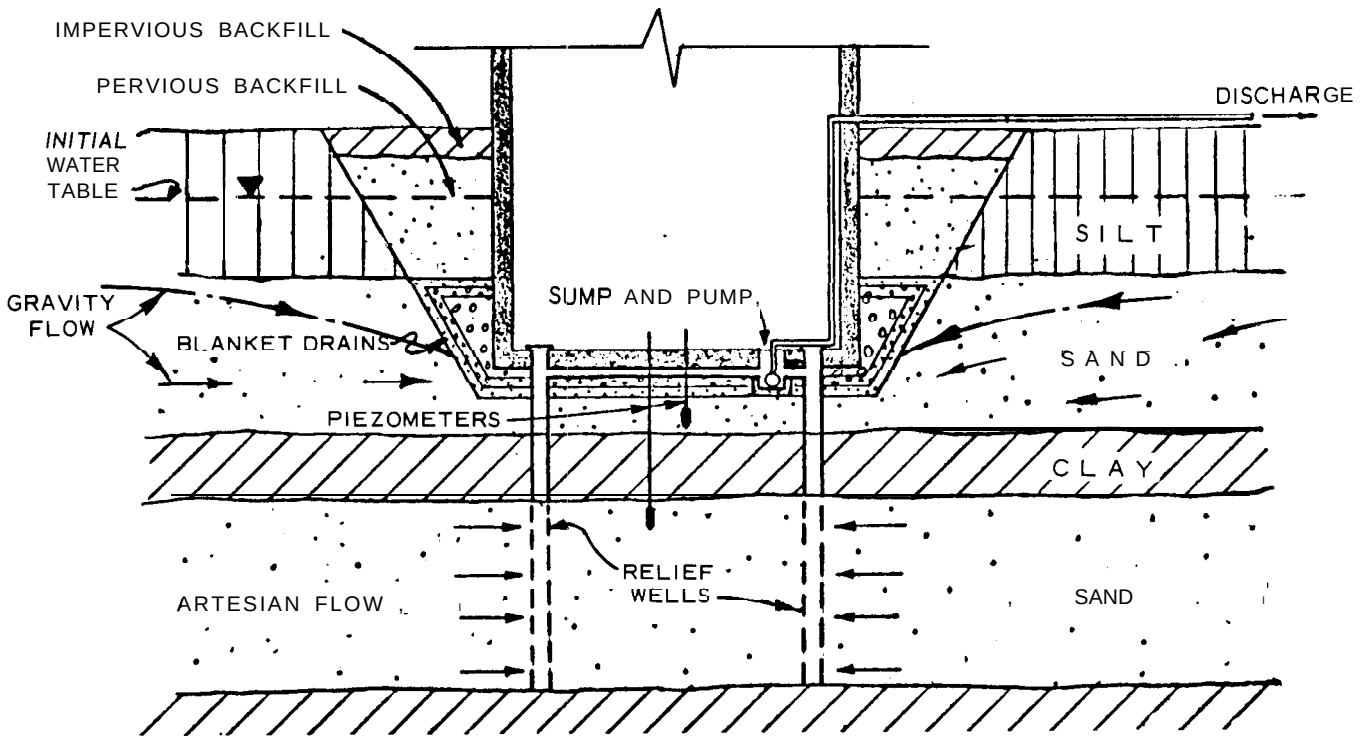
(1) Interception and removal of groundwater from the site by pumping from sumps, wells, wellpoints, or drains. This type of control must include consideration of a filter to prevent migration of fines and possible development of piping in the soil being drained.

(2) Reduction of artesian pressure beneath the bottom of an excavation.

(3) Isolation of the excavation from the inflow of groundwater by a sheet-pile cutoff, grout curtain, slurry cutoff wall, or by freezing.

1-4. Permanent groundwater control.

Many factors relating to the design of a temporary dewatering or pressure relief system are equally applicable to the design of permanent groundwater control systems. The principal differences are the requirements for permanency and the need for continuous operation. The requirements for permanent drainage systems depend largely on the structural design and operational requirements of the facility. Since permanent groundwater control systems must operate continuously without interruption, they should be conservatively designed and mechanically simple to avoid the need for complicated control equipment subject to failure and the need for operating personnel. Permanent drainage systems should include provisions for inspection, maintenance, and monitoring the behavior of the system in more detail than is usually required for construction dewatering systems. Permanent systems should be conservatively designed so that satisfactory results are achieved even if there is a rise in the groundwater level in the surrounding area, which may occur if water supply wells are shut down or if the efficiency of the dewatering system decreases, as may happen if bacteria growth develops in the filter system. An example of a permanent groundwater control system is shown in figure 1-2.



(Fruco & Associates, Inc.)

U.S. Army Corps of Engineers

Figure 1-2. Permanentgroundwater control system.