INTERNATIONAL

Designation: D5270/D5270M – 20

Standard Practice for (Analytical Procedures) Determining Transmissivity and Storage Coefficient of Bounded, Nonleaky, Confined Aquifers[1]

1. Scope*

1.1 This practice covers an analytical procedure for determining the transmissivity, storage coefficient, and possible location of boundaries for a confined aquifer with a linear boundary. This practice is used to analyze water-level or head data from one or more observation wells or piezometers during the pumping of water from a control well at a constant rate. This practice also applies to flowing artesian wells discharging at a constant rate. With appropriate changes in sign, this practice also can be used to analyze the effects of injecting water into a control well at a constant rate.

1.2 The analytical procedure in this practice is used in conjunction with the field procedure in Test Method D4050.

1.3 *Limitations*—The valid use of this practice is limited to determination of transmissivities and storage coefficients for aquifers in hydrogeologic settings with reasonable correspondence to the assumptions of the Theis nonequilibrium method (see Practice D4106) (see 5.1), except that the aquifer is limited in areal extent by a linear boundary that fully penetrates the aquifer. The boundary is assumed to be either a constant-head boundary (equivalent to a stream or lake that hydraulically fully penetrates the aquifer) or a no-flow (impermeable) boundary (equivalent to a contact with a significantly less permeable rock unit). The Theis nonequilibrium method is described in Practices D4105/D4105M and D4106.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard. Reporting of results in units other than SI shall not be regarded as nonconformance with this standard.

1.5 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of the practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without the consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4043 Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques

[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

D4050 Test Method for (Field Procedure) for Withdrawal and Injection Well Testing for Determining Hydraulic Properties of Aquifer Systems

D4105/D4105M Practice for (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Modified Theis Nonequilibrium Method

D4106 Practice for (Analytical Procedure) for Determining Transmissivity and Storage Coefficient of Nonleaky Confined Aquifers by the Theis Nonequilibrium Method

D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 *Definitions*—For definitions of common technical terms used within this practice, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *constant-head boundary*—the conceptual representation of a natural feature such as a lake or river that effectively fully penetrates the aquifer and prevents water-level change in the aquifer at that location.

3.2.2 *image well*—an imaginary well located opposite a control well such that a boundary is the perpendicular bisector of a straight line connecting the control and image wells; used to simulate the effect of a boundary on water-level changes.

3.2.3 *impermeable boundary*—the conceptual representation of a natural feature such as a fault or depositional contact that places a boundary of significantly less-permeable material laterally adjacent to an aquifer.

3.3 *Symbols and Dimensions:*

3.3.1 K_l[nd]—constant of proportionality, r_i / r_r.

3.3.2 Q [L^3T^{-1}]—discharge.

3.3.3 r [L]—radial distance from control well.

3.3.4 r_i[L]—distance from observation well to image well.

3.3.5 r_r[L]—distance from observation well to control well.

3.3.6 S [nd]—storage coefficient.

3.3.7 s [L]—drawdown.

3.3.8 s_i[L]—component of drawdown due to image well.

3.3.9 s_o[L]—drawdown at an observation well.

3.3.10 s_r[L]—component of drawdown due to control well.

3.3.11 T [L^2T^{-1}]—transmissivity.

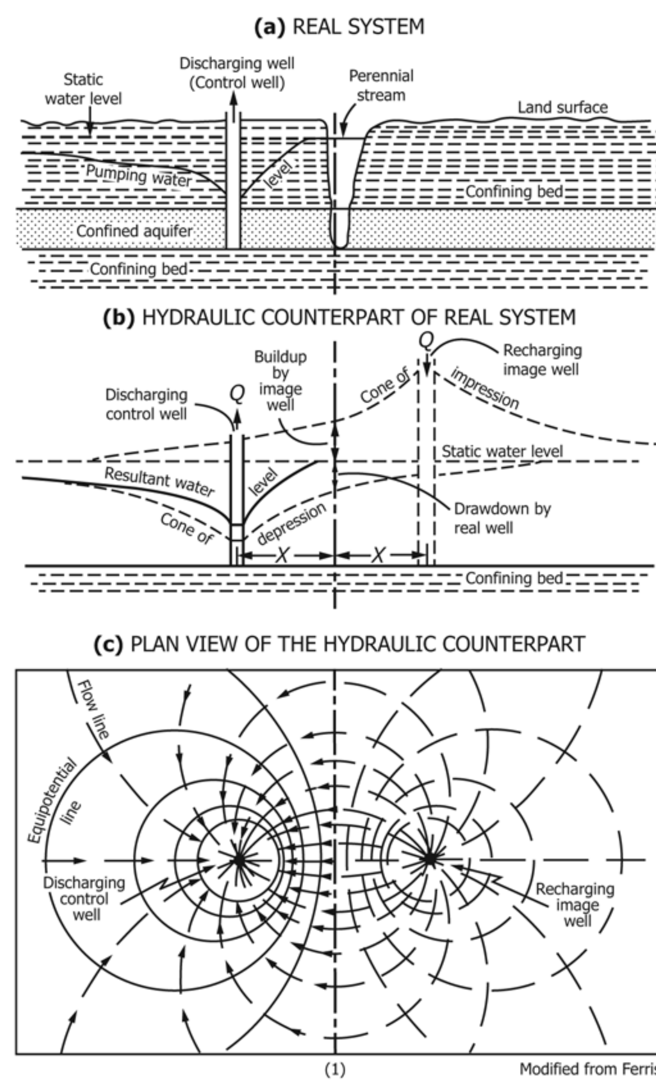
3.3.12 t [T]—time since pumping or injection began.

3.3.13 t_o[T]—time at projection of zero drawdown.

4. Summary of Practice

4.1 This practice prescribes two analytical procedures for analysis of a field test. This practice requires pumping water from, or injecting water into, a control well that is open to the entire thickness of a confined bounded aquifer at a constant rate and measuring the water-level response in one or more observation wells or piezometers. The water-level response in the aquifer is a function of the transmissivity and storage coefficient of the aquifer, and the location and nature of the aquifer boundary or boundaries. Drawdown or build up of the water level is analyzed as a departure from the type curve defined by the Theis nonequilibrium method (see Practice D4106) or from straight-line segments defined by the modified Theis nonequilibrium method (see Practice D4105/D4105M).

4.2 A constant-head boundary such as a lake or stream that fully penetrates the aquifer prevents drawdown or build up of head at the boundary, as shown in Fig. 1. Likewise, an impermeable boundary provides increased drawdown or build up of head, as shown in Fig. 2. These effects are simulated by treating the aquifer as if it were infinite in extent and introducing an imaginary well or "image well" on the opposite side of the boundary a distance equal to the distance of the control well from the boundary. A line between the control well and the image well is perpendicular to the boundary. If the boundary is a constant-head boundary, the flux from the image well is opposite in sign from that of the control well; for example, the image of a discharging control well is an injection well, whereas the image of an injecting well is a discharging well. If the boundary is an impermeable boundary, the flux from the image well has the same sign as that from the control well. Therefore, the image of a discharging well across an



NOTE 1—Modified from Ferris and others (**1**) and Heath (**2**).[3]

FIG. 1 Diagram Showing Constant-Head Boundary