Designation: D5920 – 14

Standard Test Method (Analytical Procedure) for Tests of Anisotropic Unconfined Aquifers by Neuman Method[1]

This standard is issued under the fixed designation D5920; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method covers an analytical procedure for determining the transmissivity, storage coefficient, specific yield, and horizontal-to-vertical hydraulic conductivity ratio of an unconfined aquifer. It is used to analyze the drawdown of water levels in piezometers and partially or fully penetrating observation wells during pumping from a control well at a constant rate.

1.2 The analytical procedure given in this test method is used in conjunction with Guide D4043 and Test Method D4050.

1.3 The valid use of the Neuman method is limited to determination of transmissivities for aquifers in hydrogeologic settings with reasonable correspondence to the assumptions of the theory.

1.4 The values stated in SI units are to be regarded as standard.

1.5 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

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

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

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

D4106 Test Method 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 general technical terms used within this guide, refer to Terminology D653.

3.2 *Symbols and Dimensions:*

3.2.1 b *[L]*—initial saturated thickness of the aquifer.

3.2.2 d *[L]*—vertical distance between top of screen in pumping well and initial position of the water table.

3.2.3 d_D *[nd]*—dimensionless d, equal to d/b.

3.2.4 $J_0(x)$—zero-order Bessel function of the first kind.

3.2.5 K_r $[LT^{-1}]$—hydraulic conductivity in the plane of the aquifer, radially from the control well.

3.2.6 K_Z $[LT^{-1}]$—hydraulic conductivity normal to the plane of the aquifer.

3.2.6.1 *Discussion*—The use of the symbol K for the hydraulic conductivity is the predominant usage in groundwater literature by hydrogeologists, whereas, the symbol k is commonly used for this term in soil and rock mechanics and soil science.

3.2.7 l *[L]*—vertical distance between bottom of screen in control well and initial position of water table.

3.2.8 l_D *[nd]*—dimensionless l, equal to l/b.

3.2.9 Q $[L^3T^{-1}]$—discharge rate.

3.2.10 r *[L]*—radial distance from control well.

3.2.11 s *[L]*—drawdown.

[1] This test method 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**

3.2.12 s_c *[L]*—corrected drawdown.

3.2.13 s_D *[nd]*—dimensionless drawdown, equal to $4\pi Ts/Q$.

3.2.14 s_{wt} *[L]*—drawdown of the water table.

3.2.15 *S [nd]*—storage coefficient, equal to $S_s b$.

3.2.16 S_s *[L^{-1}]*—specific storage.

3.2.17 S_y *[nd]*—specific yield.

3.2.18 *t [T]*—time since pumping started.

3.2.19 t_r *[T]*—time since recovery started.

3.2.20 t_s *[nd]*—dimensionless time with respect to S_s, equal to Tt/Sr^2.

3.2.21 t_y *[nd]*—dimensionless time with respect to S_y, equal to $Tt/S_y r^2$.

3.2.22 t_β *[T]*—time, *t*, corresponding to intersection of a horizontal line through the intermediate data with an inclined line through late data on semilogarithmic paper.

3.2.23 $t_{y\beta}$ *[nd]*—dimensionless time, t_y, corresponding to the intersection of a horizontal line through intermediate data with an inclined line through late data in Fig. 1.

3.2.24 $(t/r^2)_e$ *[T]*—t/r^2 corresponding to the intersection of a straight line through the early data with $s = 0$ on semilogarithmic paper [TL^{-2}].

3.2.25 $(t/r^2)_l$ *[T]*—t/r^2 corresponding to the intersection of a straight line through the late data with $s = 0$ on semilogarithmic paper.

3.2.26 *T [L^2T^{-1}]*—transmissivity, $K_r b$.

3.2.27 *z [L]*—vertical distance above the bottom of the aquifer.

3.2.28 z_1 *[L]*—vertical distance of the bottom of the observation well screen above the bottom of the aquifer.

3.2.29 z_2 *[L]*—vertical distance of the top of the observation well screen above the bottom of the aquifer.

3.2.30 z_D *[nd]*—dimensionless elevation, equal to z/b.

3.2.31 z_{1D} *[nd]*—dimensionless elevation of base of screen, equal to z_1/b.

3.2.32 z_{2D} *[nd]*—dimensionless elevation of top of screen, equal to z_2/b.

3.2.33 α—degree of anisotropy, equal to K_z/K_r.

3.2.34 β *[nd]*—dimensionless parameterα r^2/b^2.

3.2.35 Δs_e *[L]*—the difference in drawdown over one log cycle of time along a straight line through early data on semilogarithmic paper.

3.2.36 Δs_l [L]—the difference in drawdown over one log cycle of time along a straight line through late data on semilogarithmic paper.

3.2.37 σ *[nd]*—dimensionless parameter S/S_y.

4. Summary of Test Method

4.1 *Procedure*—This test method describes a procedure for analyzing data collected during a withdrawal well test. This test method should have been selected using Guide D4043 on the basis of the hydrologic characteristics of the site. The field test (Test Method D4050) requires pumping a control well that is open to all or part of an unconfined aquifer at a constant rate for a specified period and observing the drawdown in piezometers or observation wells that either partly or fully penetrate the aquifer. This test method may also be used to analyze an injection test with the appropriate change in sign. The rate of drawdown of water levels in the aquifer is a function of the location and depths of screened open intervals of the control well, observation wells, and piezometers. The drawdown may be analyzed to determine the transmissivity, storage coefficient,

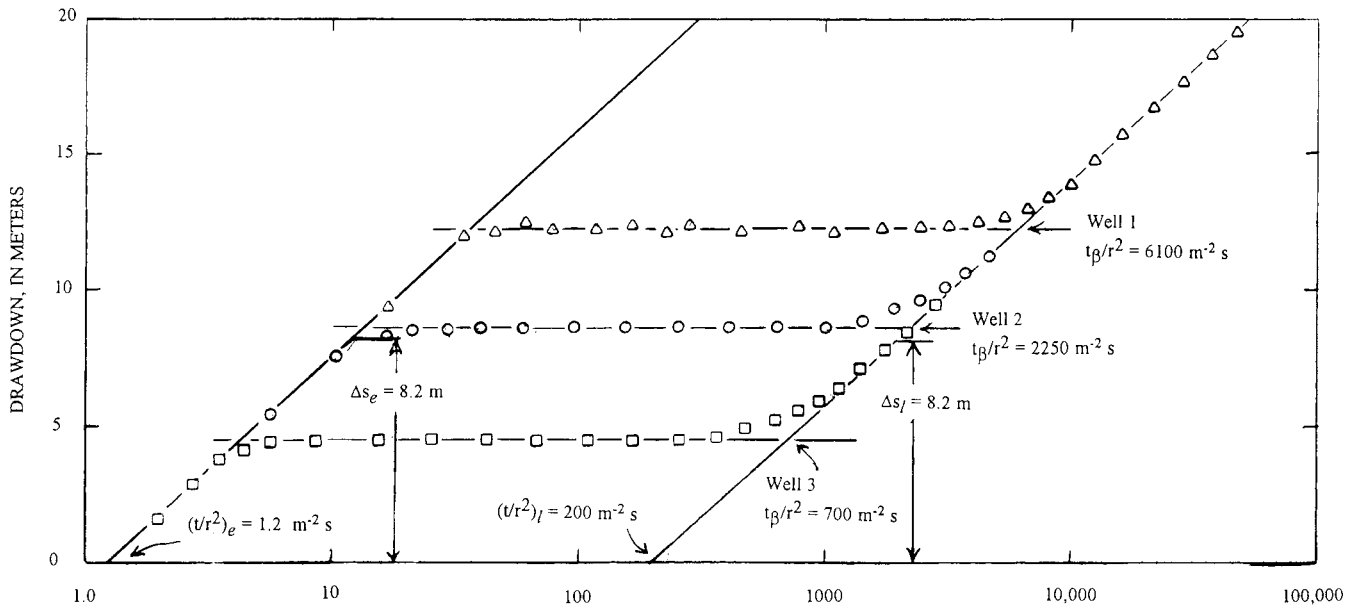

FIG. 1 Aquifer-Test Analysis, Example Two