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.

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Standard Guide for Site Characterization for Engineering Design and Construction Purposes[1]

This standard is issued under the fixed designation D420; 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.

INTRODUCTION

Site characterization for engineering design and construction purposes involves both simple and complex techniques that may be accomplished by many different procedures and may be variously interpreted. These studies are frequently site specific and are influenced by geological and geographical settings, by the purpose of the site characterization, by design requirements for the project proposed, and by the background, training, and experience of the staff involved.

This document is a guide to the selection of the various ASTM standards that are available for the exploration of soil, rock, and groundwater for projects that involve surface and/or subsurface construction, or both. It is intended to improve consistency of practice and to encourage rational planning of a site characterization program. Since the subsurface conditions at a particular site are usually the result of a combination of natural, geologic, topographic, and climatic factors, and of historical modifications both natural and manmade, an adequate and internally consistent exploration program will allow evaluation of the results of these influences.

1. Scope*

1.1 This guide refers to ASTM methods to perform site characterization for engineering, design, and construction purposes. The objective of the site characterization should be to identify and locate, both horizontally and vertically, significant soil and rock types and groundwater conditions present within a given site area and to establish the characteristics of the subsurface materials by sampling or in situ testing, or both.

1.2 Laboratory testing of soil, rock, and groundwater samples is specified by other ASTM standards not listed herein. Subsurface exploration for environmental purposes is also outside the scope of this guide.

1.3 Prior to commencement of the site characterization the site should be checked for potentially hazardous or otherwise contaminated materials or cultural/archeological conditions. If evidence of unknown potentially hazardous or otherwise contaminated materials or conditions are encountered in the course of the site characterization, work shall be interrupted until the circumstances have been evaluated and revised instructions issued.

1.3.1 In addition the location and nature of underground and overhead utilities should be identified to ensure that there is no impact to the proposed site characterization. Impacts may include but are not limited to interference with geophysical methods, damaging utilities, creating an unsafe work condition, and limiting accessibility for exploratory equipment.

1.4 The values stated in either SI units or inch-pound units are to be regarded as the 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 non-conformance with the standard. Inch-pound units are provided in brackets for convenience.

1.5 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide 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 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.*

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.01 on Surface and Subsurface Characterization.

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

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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.

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

1.8 The procedures used to specify how data are collected/recorded or calculated, in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining the data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to be commensurate with these considerations. It is beyond the scope of this standard to consider significant digits used in analysis methods for engineering design.

1.9 *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]

C119 Terminology Relating to Dimension Stone
C294 Descriptive Nomenclature for Constituents of Concrete Aggregates
D75/D75M Practice for Sampling Aggregates
D653 Terminology Relating to Soil, Rock, and Contained Fluids
D1195/D1195M Test Method for Repetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements
D1196/D1196M Test Method for Nonrepetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements
D1452/D1452M Practice for Soil Exploration and Sampling by Auger Borings
D1586 Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
D1587/D1587M Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes
D2113 Practice for Rock Core Drilling and Sampling of Rock for Site Exploration
D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)
D2573/D2573M Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils
D3213 Practices for Handling, Storing, and Preparing Soft Intact Marine Soil
D3282 Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
D3385 Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer
D3404 Guide for Measuring Matric Potential in Vadose Zone Using Tensiometers
D3550/D3550M Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
D4044/D4044M Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers
D4050 Test Method for (Field Procedure) for Withdrawal and Injection Well Testing for Determining Hydraulic Properties of Aquifer Systems
D4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)
D4220/D4220M Practices for Preserving and Transporting Soil Samples
D4394 Test Method for Determining In Situ Modulus of Deformation of Rock Mass Using Rigid Plate Loading Method
D4395 Test Method for Determining In Situ Modulus of Deformation of Rock Mass Using Flexible Plate Loading Method
D4403 Practice for Extensometers Used in Rock
D4428/D4428M Test Methods for Crosshole Seismic Testing
D4429 Test Method for CBR (California Bearing Ratio) of Soils in Place (Withdrawn 2018)[3]
D4452 Practice for X-Ray Radiography of Soil Samples
D4506 Test Method for Determining In Situ Modulus of Deformation of Rock Mass Using Radial Jacking Test
D4544 Practice for Estimating Peat Deposit Thickness
D4553 Test Method for Determining In Situ Creep Characteristics of Rock (Withdrawn 2017)[3]
D4554 Test Method for In Situ Determination of Direct Shear Strength of Rock Discontinuities
D4555 Test Method for Determining Deformability and Strength of Weak Rock by an In Situ Uniaxial Compressive Test
D4623 Test Method for Determination of In Situ Stress in Rock Mass by Overcoring Method—Three Component Borehole Deformation Gauge
D4630 Test Method for Determining Transmissivity and Storage Coefficient of Low-Permeability Rocks by In Situ Measurements Using the Constant Head Injection Test (Withdrawn 2017)[3]
D4631 Test Method for Determining Transmissivity and Storativity of Low Permeability Rocks by In Situ Measurements Using Pressure Pulse Technique (Withdrawn 2017)[3]
D4633 Test Method for Energy Measurement for Dynamic Penetrometers

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

D4645 Test Method for Determination of In-Situ Stress in Rock Using Hydraulic Fracturing Method (Withdrawn 2017)[3]
D4700 Guide for Soil Sampling from the Vadose Zone
D4719 Test Methods for Prebored Pressuremeter Testing in Soils (Withdrawn 2016)[3]
D4729 Test Method for In Situ Stress and Modulus of Deformation Using Flatjack Method (Withdrawn 2017)[3]
D4840 Guide for Sample Chain-of-Custody Procedures
D4879 Guide for Geotechnical Mapping of Large Underground Openings in Rock (Withdrawn 2017)[3]
D4971 Test Method for Determining In Situ Modulus of Deformation of Rock Using Diametrically Loaded 76-mm (3-in.) Borehole Jack
D5079 Practices for Preserving and Transporting Rock Core Samples (Withdrawn 2017)[3]
D5088 Practice for Decontamination of Field Equipment Used at Waste Sites
D5092/D5092M Practice for Design and Installation of Groundwater Monitoring Wells
D5093 Test Method for Field Measurement of Infiltration Rate Using Double-Ring Infiltrometer with Sealed-Inner Ring
D5126 Guide for Comparison of Field Methods for Determining Hydraulic Conductivity in Vadose Zone
D5195 Test Method for Density of Soil and Rock In-Place at Depths Below Surface by Nuclear Methods
D5731 Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications
D5753 Guide for Planning and Conducting Geotechnical Borehole Geophysical Logging
D5776 Test Method for Bromine Index of Aromatic Hydrocarbons by Electrometric Titration
D5777 Guide for Using the Seismic Refraction Method for Subsurface Investigation
D5778 Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils
D5878 Guides for Using Rock-Mass Classification Systems for Engineering Purposes
D6026 Practice for Using Significant Digits in Geotechnical Data
D6032/D6032M Test Method for Determining Rock Quality Designation (RQD) of Rock Core
D6151/D6151M Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
D6169/D6169M Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations
D6282/D6282M Guide for Direct Push Soil Sampling for Environmental Site Characterizations
D6286 Guide for Selection of Drilling Methods for Environmental Site Characterization
D6391 Test Method for Field Measurement of Hydraulic Conductivity Using Borehole Infiltration
D6429 Guide for Selecting Surface Geophysical Methods
D6430 Guide for Using the Gravity Method for Subsurface Site Characterization
D6431 Guide for Using the Direct Current Resistivity Method for Subsurface Investigation
D6432 Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation
D6635 Test Method for Performing the Flat Plate Dilatometer
D6914/D6914M Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices
D7015 Practices for Obtaining Intact Block (Cubical and Cylindrical) Samples of Soils
D7046 Guide for Use of the Metal Detection Method for Subsurface Exploration
D7128 Guide for Using the Seismic-Reflection Method for Shallow Subsurface Investigation
D7400 Test Methods for Downhole Seismic Testing
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
G51 Test Method for Measuring pH of Soil for Use in Corrosion Testing
G57 Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method
IEEE/ASTM SI-10 American National Standard for Metric Practice

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms used in this standard, refer to Terminology D653.

4. Significance and Use

4.1 An adequate site characterization will provide pertinent information for decision making on one or more of the following subjects:

4.1.1 Location of the structure, both vertically and horizontally, within the area of the proposed construction and selection of construction methods and equipment.

4.1.2 Location and preliminary evaluation of suitable borrow and other local sources of construction aggregates.

4.1.3 Need for special excavating and dewatering techniques with the corresponding need for information, even if only approximate, on the distribution of soil water content or pore pressure, or both, and on the piezometric heads and apparent permeability (hydraulic conductivity) of the various subsurface strata.

4.1.4 Evaluation of slope stability in natural slopes, cuts, and embankments.

4.1.5 Conceptual selection of embankment types and hydraulic barrier requirements.

4.1.6 Conceptual selection of alternate foundation types and elevations of the corresponding suitable bearing strata.

4.1.7 Development of additional detailed site characterizations for specific structures or facilities.

4.2 The site characterization may require the collection of sufficiently large soil and rock samples of such quality as to allow adequate testing to determine the soil or rock classification or mineralogic type, or both, and the engineering properties pertinent to the proposed design.

4.3 This guide is not meant to be an inflexible description of requirements; methods defined by other ASTM standards or non-ASTM techniques may be appropriate in some circumstances. The intent is to provide a list to assist in preparation of a site characterization plan.

5. Reconnaissance of Project Area

5.1 Available technical data from literature, internet, or from personal communication should be reviewed before a field program is started. These include, but are not limited to, topographic maps, aerial photography, satellite imagery, geologic maps, soil surveys and mineral resource surveys, and engineering soil maps covering the proposed project area. Available site characterization reports of nearby or adjacent projects should be studied.

5.2 Older maps and reports may be obsolete and of limited value in the light of current knowledge; however comparing the old with the new can often reveal valuable information.

5.3 Each soil type has a distinctive soil profile due to age, parent material, relief, climatic condition, and biological activity. Consideration of these factors can assist in identifying the various soil types, each requiring special engineering considerations and treatment. Similar engineering soil properties are often found where similar soil profiles characteristics exist. Changes in soil properties in adjacent areas often indicate changes in parent material or relief.

5.4 In areas where descriptive data are limited by insufficient geologic or soil maps, the soil and rock in open cuts in the vicinity of the proposed project should be studied and various soil and rock profiles noted. Field notes of such studies should include data described later in this guide.

5.5 If a preliminary map covering the project area is desired, it can be prepared on maps compiled from aerial photography that show the ground conditions. The distribution of the predominant soil and rock deposits likely to be encountered during the site characterization may be shown using data obtained from geologic maps, landform analysis and limited ground reconnaissance. Experienced photo-interpreters can deduce much subsurface data from a study of black and white, color, and infrared photographs because similar soil or rock conditions, or both, usually have similar patterns of appearance in regions of similar climate or vegetation. This preliminary map may be expanded into a detailed engineering map by locating test holes, pits, and sampling stations and by revising boundaries as determined from the detailed subsurface survey.

5.6 In areas where documentary information is insufficient, some knowledge of subsurface conditions may be obtained from land owners, local well drillers, and representatives of the local construction industry.

6. Exploration Plan

6.1 Available project design and performance requirements must be reviewed prior to final development of the exploration plan.

6.2 Preliminary site characterization may be planned to aid the team in determining the areas or conditions needing more elaborate site characterization.

6.3 Permit and access requirements as well as private or governmental organization issues should be identified. Prior to any onsite activities, all necessary approvals and permits shall be obtained including those related to cultural and wildlife resources.

6.4 A complete site characterization covering soil, rock, and groundwater may encompass the following activities:

6.4.1 Review of available information, both regional and local, on the geologic history, rock, soil, and groundwater conditions occurring at the proposed location and in the immediate vicinity of the site.

6.4.2 Interpretation of aerial photography and other remote sensing data.

6.4.3 Field reconnaissance for identification of surficial geologic conditions, mapping of stratigraphic exposures and outcrops, and examination of the performance of existing structures.

6.4.4 On site examination of the surface and subsurface materials by geophysical surveys, borings, or test pits.

6.4.5 Recovery of representative disturbed samples for laboratory classification tests of soil, rock, and local construction material. These may be supplemented by intact specimens suitable for the determination of those engineering properties pertinent to the site characterization.

6.4.6 Identification of the position of the groundwater surfaces (water tables), perched groundwater zones, or potentiometric surfaces (piezometric surfaces) of artesian aquifers. The variability of these positions in both short and long time frames should be considered. Color mottling of the soil strata may be indicative of long-term seasonal high groundwater positions. The location of any surface water to groundwater interactions (caves, sinkholes, losing streams, springs, seeps, etc.) that may impact development, and may need protection during and after development.

6.4.7 Identification and assessment of the location of suitable foundation material and adequate onsite fill material.

6.4.8 Field identification of soil sediments, and rock, with particular reference to type and degree of decomposition (for example, saprolite, karst, decomposing or slaking shales), the depths of their occurrence and the types and locations of their structural discontinuities.

6.4.9 Evaluation of the performance of existing installations, relative to their structure foundation material and environment in the immediate vicinity of the site.

7. Equipment for Use in Exploration

7.1 *Pertinent ASTM Standards*—Practices D1452/D1452M, D2113, D4544, D5088, D5092/D5092M, D5778, D6151/D6151M; Test Methods D1586 and D4633, and Guides D6282/D6282M and D6286.

7.2 The type of equipment required for a site characterization subsurface depends upon various factors, including the type of subsurface material, depth of exploration, the nature of the terrain, and the intended use of the data.

7.2.1 *Hand Augers, Hole Diggers, Shovels, and Push Tube Samplers* are suitable for characterization of surficial soils to depths of 1 to 5 m [3 to 15 ft].

7.2.2 *Earth Excavation Equipment,* such as backhoes, draglines, and drilled pier augers (screw or bucket) can allow in situ examination of soil deposits and sampling of materials containing very large particles. Be aware of the possibility of permanent disturbance of potential bearing strata by unbalanced pore pressure in test excavations.

7.2.3 Soil and rock boring and drilling machines and proofing devices may be used to depths of 60 to 90 m [200 to 300 ft] in soil and to a much greater depth in rock. Well drilling equipment may be suitable for deep geologic exploration. Normally, samples are in the form of sand-sized cuttings captured from the return flow, but coring devices are available.

7.2.4 *Geophysical Equipment,* includes handheld or vehicle mounted devices for evaluating soil and rock. Equipment may be technique specific such as ground penetrating radar, or may be equipment connected to multiple probes inserted into an existing borehole.

8. Geophysical Exploration

8.1 *Pertinent ASTM Standards*—Test Methods D4428/D4428M, D5778, D7400, and G57; Guides D5753, D5777, D6429, D6430, D6431, D6432, D7046, and D7128.

8.2 Remote sensing techniques may assist in mapping the geological formations and for evaluating variations in soil and rock properties. Some ground control is generally required to verify information derived from remote sensing data.

8.2.1 Satellite and aircraft spectral mapping tools, such as LIDAR, may be used to find and map the areal extent of subsurface materials and geologic structure. Interpretation of the data obtained with these tools may also locate and identify significant geologic features that may be indicative of faults and fractures.

8.3 Surface, subsurface, and aerial geophysical survey methods may be used to supplement borehole and outcrop data and to interpolate between holes. Surface geophysical explorations can be useful in determining boring or test hole locations. If possible, the interpretation of geophysical studies should be verified by borings or test pits.

8.4 Seismic, ground penetrating radar, electromagnetic methods, and electrical resistivity methods can be particularly valuable when distinct differences in the properties of contiguous subsurface materials are indicated. Borehole geophysical logging can provide data on subsurface conditions that supplements core data and in some cases can provide data obtainable in no other way.

8.5 Shallow seismic refraction/reflection and ground penetrating radar techniques can be used to map soil horizons and depth profiles, groundwater surface, and depth to bedrock in many situations, but depth penetration and resolution vary with local conditions. Deep seismic and electrical methods may be used for mapping stratigraphy and structure of rock in conjunction with logs. Crosshole and downhole shear wave velocity measurements can provide soil and rock parameters for dynamic analyses and seismic site class determinations. Parallel seismic measurements can be used to determine depth extent of piles, sheet piles, bridge abutments, and retaining walls.

8.5.1 The seismic refraction method may be especially useful in determining depth to, or rippability of, rock in locations where successively denser strata are encountered.

8.5.2 The seismic reflection method may be useful in delineating geological units at depths below 10 ft [3 m]. It is not constrained by layers of low seismic velocity and is especially useful in areas of rapid stratigraphic change.

8.5.3 The ground penetrating radar method may be useful in defining soil and rock layers, voids and small caves manmade structures (for example, buried tanks and utilities) and historical landfills (dump sites) in the depth range of 0.3 to 10 m [1 to 30 ft].

8.5.4 Electromagnetic methods can be especially useful to map horizontal variations in stratigraphy.

8.5.5 The electrical resistivity method, Test Method G57, may be similarly useful in determining depth to rock and anomalies in the stratigraphic profile, in evaluating stratified formations where a denser stratum overlies a less dense stratum, and in locating prospective sand-gravel resources or sources of borrow material. Resistivity parameters also are required for the design of grounding systems and cathodic protection for buried structures.

8.6 Electromagnetic induction, electrical resistivity, and induced polarization (or complex resistivity) techniques may be used to map variations in water content, clay horizons, stratification, and depth to aquifer/bedrock.

8.7 Other geophysical techniques such as gravity, magnetic, and shallow ground temperature methods may be useful under certain specific conditions.

8.8 Table 1 in Guide D5753 is an excellent summary of 15 borehole geophysical logs, many of which are commonly used for site characterization.

9. Sampling

9.1 *Pertinent ASTM Standards*—Practices D75/D75M, D1452/D1452M, D1587/D1587M, D2113, D3213, D3550/D3550M, D4220/D4220M, D4452, D5079, and D7015; Test Method D1586; and Guide D4700, D4840, and D6169/D6169M.

9.2 Obtain samples that adequately represent each subsurface material that is significant to the project design and construction. The size and type of sample required is dependent upon the tests to be performed, the relative amount of coarse particles present, and the limitations of the test equipment to be used.

NOTE 1—The size of disturbed or bulk soil samples for routine tests may vary at the discretion of staff performing the site characterization, but the following quantities are suggested as suitable for most materials:
(a) Visual classification—50 to 500 g [2 oz to 1 lb];
(b) Soil constants and particle size analysis of non-gravelly soil—500 g to 2.5 kg [1 to 5 lb];
(c) Soil compaction tests and sieve analysis of gravelly soils—20 to 40 kg [40 to 80 lb];
(d) Aggregate manufacture or aggregate properties tests—50 to 200 kg [100 to 400 lb].

9.3 Accurately identify each sample with the boring, test hole, or test pit number and depth below reference ground

surface from which it was taken. Place a waterproof identification tag inside the container. Securely close the container, protect it to withstand rough handling. Properly identify the outside of the container using an indelible marker.

9.4 Keep samples for natural water content determination in sealed containers to minimize moisture loss. Practices D4220/D4220M and D5079 address the transportation of samples from field to laboratory.

10. Classification of Earth Materials

10.1 *Pertinent ASTM Standards*—Terminology C119; Descriptive Nomenclature C294; Practices D2487, D2488, D3282, D4083; Test Methods D5731, D5878, D6032/D6032M.

10.2 Additional description of samples of soil and rock may be added after submission to the laboratory for identification and classification tests in accordance with one or more ASTM laboratory standards or other applicable references, or both. Subsection 11.6.3 discusses the use, for identification and for classification purposes, of some of the standards listed in 10.1.

11. Determination of Subsurface Conditions

11.1 Subsurface conditions are positively defined only at the individual location(s) (for example, test pit, hole, boring, piezocone, or open cut) examined. Conditions between locations may be different from those encountered. A stratigraphic profile can be developed by detailed site characterizations only where determinations of a continuous relationship of the depths and locations of various types of soil and rock can be inferred. This phase of the site characterization may be implemented by plotting logs of soil and rock exposures in walls of excavations or cut areas and by plotting logs of the test borings. Then one may consider interpolation between, and extrapolation a reasonable distance beyond, these logs, and geophysical methods may then be used to increase the confidence of the intrapolations/extrapolations.

11.1.1 The spacing of the individual locations should depend on the geologic complexity of the project area and on the importance of soil and rock continuity to the project design. The site characterization at each location should be deep enough to identify strata that might be significantly affected by the proposed use of the site and to develop the engineering data required to allow analysis of the items listed in Section 5 for each project.

NOTE 2—Plans for a program of intrusive subsurface site characterization should consider possible requirements for permits for installation and proper closure of bore holes and wells at the completion of the site characterization.

11.2 Exploratory borings or test pits for roadbeds, airport paving, or vehicle parking areas should penetrate at least 1.5 m [5 ft] below the proposed subgrade elevation. Depths greater than 1.5 m [5 ft] may be required under special circumstances.

11.2.1 Exploratory borings for structures, excavations, or embankments should extend below the level of significant stress or groundwater influence from the proposed load as determined by subsurface stress analysis.

11.2.2 Exploratory borings for tunnels should extend one to two tunnel diameters below the proposed invert level or sufficiently deep to identify potentially critical ground conditions and alignment issues.

11.3 When project construction or performance of the facility may be affected by either pervious water-bearing materials or impervious materials that can block internal drainage, borings should extend sufficiently to determine those engineering and hydrogeologic properties that are relevant to the project design.

11.4 In all borrow areas the locations should be sufficient in number and depth to find the required quantities of material meeting the specified quality requirements.

11.5 Where frost penetration or seasonal desiccation may be significant in the behavior of soil and rock, borings should extend well below the depth from finished grade of the anticipated active zone.

11.6 Exploration records should be kept in a systematic manner for each project. Such records may include:

11.6.1 Description of each site or area explored. Each test hole, boring, test pit, or geophysical test site shall be clearly located (horizontally and vertically) with reference to some established coordinate system, datum, or permanent monument.

11.6.2 Logs of each test hole, boring, test pit, or cut surface exposure. Such logs should show clearly the field description and location of materials and water encountered, either by symbol or word description. Reference to a soil-color or rock-color chart designation, such as the Munsell Geological Rock-Color Chart is a substantial aid to an accurate description of soil and rock materials.

NOTE 3—Color photographs of rock cores, soil samples, and exposed strata may be of considerable value. Each photograph should include an identifying number or symbol, a date, and reference scale. A color reference chart should be used to address the effect of ambient lighting.

11.6.3 Identification of all soils based on Practice D2487, D2488, or D4083. Identification of rock materials based on Terminology C119 or Descriptive Nomenclature C294. Classification of soil and rock is discussed in Section 10.

11.6.4 Location and description of seepage and water-bearing zones and records of piezometric elevations found in each hole, boring, piezometer, or test pit.

11.6.5 The results and locations of in situ test results such as those mentioned in Section 12.

11.6.6 Percentage of core recovery and rock quality designation in core drilling as described in D2113 and D6032.

11.6.7 Graphical presentation of field and laboratory data. Such presentation and its interpretation facilitates comprehensive understanding of the subsurface conditions.

12. In Situ Testing

12.1 *Pertinent ASTM Standards*—Test Methods D1195/D1195M, D1196/D1196M, D1586, D2573/D2573M, D3385, D4044/D4044M, D4050, D4394, D4395, D4429, D4506, D4553, D4554, D4555, D4623, D4630, D4631, D4645, D4719, D4729, D4971, D5093, D5195, D5776, D5778, D6391, D6635, G51; Guides D3404, D5126; and Practice D4403.

12.2 In situ testing is useful for: (*a*) measurement of soil and rock parameters in their intact condition with all of the restraining or loading effects, or both, of the surrounding soil or rock mass, or (*b*) for rapid or closely spaced measurements, or both, of earth properties without the necessity of sampling.

NOTE 4—Other standards for in situ test procedures and automated data collection are being prepared by ASTM Committee D18 for publication at a later date.

13. Interpretation of Results

13.1 Interpret the results of an site characterization in terms of actual findings and make a reasonable effort to collect and include field and laboratory data from previous site characterizations in the same area. Extrapolation of data into local areas not surveyed and tested should be done only where geologically uniform stratigraphic and structural relationships are known to exist on the basis of other data. Cross sections may be developed as part of the site characterization if required to demonstrate the site conditions.

13.1.1 Cross sections included with the presentation of basic data from the site characterization should be limited to the ground surface profile and the factual subsurface data obtained at specific exploration locations. Stratigraphic units between the locations of intrusive explorations should only be indicated if supported by continuous geophysical profiles.

13.1.2 Cross sections showing interpretations of stratigraphic units and other conditions between intrusive explorations but without support of continuous geophysical profiles should be presented in an interpretative report appendix or in a separate interpretative report. The interpretive cross sections should be accompanied by notes describing anomalies or otherwise significant variations in the site conditions that should be anticipated for the intended design or construction activities.

NOTE 5—Additional exploration should be considered if there is not sufficient knowledge to develop interpretative cross sections, with realistic descriptions of anticipated variations in subsurface conditions, to meet project requirements.

13.2 Subject to the restrictions imposed by state licensing law, recommendations for design parameters can be made only by professional engineers and geologists specializing in the field of geotechnical engineering and familiar with purpose, conditions, and requirements of the study. Soil mechanics, rock mechanics, and geomorphological concepts must be combined with knowledge of geotechnical engineering or hydrogeology to make a complete application of the soil, rock, and groundwater investigation. Complete design recommendations may require a more detailed study than that discussed in this guide.

13.3 Delineate subsurface profiles only from actual geophysical, test-hole, test-pit, or cut-surface data. Interpolation between locations should be made on the basis of available geologic knowledge of the area and should be clearly identified. The use of geophysical techniques as discussed in Section 8 is a valuable aid in such interpolation.

14. Report: Test Data Sheet(s)/Form(s)

14.1 *Pertinent ASTM Standards*—Terminology D653; Practices D6026, E177; and Guide D4879.

14.2 The report of a site characterization should include:

14.2.1 The purpose and objective of the site characterization. The location of the characterized area in terms pertinent to the project. This may include sketch maps or aerial photos on which the test pits, bore holes, and sample areas are located, as well as geomorphological data relevant to the determination of the various soil and rock types. Such data include elevation contours, streambeds, sink holes, cliffs, and the like. Where feasible, include in the report a geologic map or an agronomic soils map, or both, of the characterized area. Maps should include a north arrow and scale.

14.2.2 A description of the site characterization procedures, including borings and test hole logs, graphic presentation of compaction, consolidation, or load test data tabulation of laboratory and field test results, and graphical interpretations of geophysical measurements.

14.2.3 A summary of the findings obtained under Sections 5, 8, 11, 12, and 13, using subhead titles for the respective sections and appropriate recommendations and disclaimers for the use of the report.

15. Precision and Bias

15.1 This guide provides qualitative data only; therefore, a precision and bias statement is not applicable.

16. Keywords

16.1 explorations; feasibility studies; field explorations; foundation explorations; geological explorations; geophysical explorations; groundwater; hydrologic explorations; maps; preliminary explorations; reconnaissance surveys; sampling; site characterization; site explorations; soil surveys; subsurface explorations

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (1998(2003)) that may impact the use of this standard. (February 1, 2018)

(1) Updated technology information and deleted references as they were not specifically referred to in the standard.

(2) Updated groundwater to one word.

(3) Editorial changes made throughout.

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