Designation: D420 – 18

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.

Current edition approved Feb. 1, 2018. Published March 2018. Originally published as D420 – 65T. Last previous edition approved in 2003 as D420 – 93(2003), which was withdrawn January 2012 and reinstated February 2018. DOI: 10.1520/D0420_D0420M-18.

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

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].