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Standard Guide for Selection and Documentation of Existing Wells for Use in Environmental Site Characterization and Monitoring[1]

This standard is issued under the fixed designation D 5980; 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.

ϵ[1] NOTE—Paragraph 1.7 was added editorially October 1998.

1. Scope

1.1 This guide covers the use of existing wells for environmental site characterization and monitoring. It covers the following major topics: criteria for determining the suitability of existing wells for hydrogeologic characterization and ground-water quality monitoring, types of data required to document the suitability of an existing well, and the relative advantages and disadvantages of existing large- and small-capacity wells.

1.2 This guide should be used in conjunction with Guide D 5730, that provides a general approach for environmental site investigations.

1.3 This guide does not specifically address design and construction of new monitoring or supply wells. Refer to Practices D 5092 and D 5787.

1.4 This guide does not specifically address ground-water sampling procedures. Refer to Guide D 5903.

1.5 The values stated in SI units are to be regarded as the standard. However, dimensions of materials used in the water well industry are given in inch-pound (English) units by convention, therefore, inch-pound units are used where necessary in this guide.

1.6 *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.*

1.7 *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.*

2. Referenced Documents

2.1 Pertinent ASTM guides addressing specific information necessary to utilize existing wells for hydrologic and water-quality data for environmental site characterization. A comprehensive list of guides, standards, methods, practices, and terminology is contained in Guide D 5730. Other guidance documents covering procedures for environmental site investigations with specific objectives or in particular geographic settings may be available from federal, state, and other agencies or organizations. The appropriate agency or organization should be contacted to determine the availability and most current edition of such documents.

2.2 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well)[2]

D 5092 Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers[2]

D 5254 Practice for a Minimum Set of Data Elements to Identify a Ground-Water Site[2]

D 5408 Guide for Set of Data Elements to Describe a Ground-Water Site; Part One—Additional Identification Descriptors[2]

D 5409 Guide for Set of Data Elements to Describe a Ground-Water Site; Part Two—Physical Descriptors[2]

D 5410 Guide for Set of Data Elements to Describe a Ground Water Site; Part Three—Usage Descriptors[2]

D 5474 Guide for Selection of Data Elements for Ground-Water Investigations[2]

D 5521 Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers[2]

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[1] This guide is under the jurisdiction of ASTM Committee D-18 on Soil and Rockand is the direct responsibility of Subcommittee D18.21 on Ground Water and Vadose Zone Investigations.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

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D 5730 Guide to Site Characterization for Environmental Purposes with Emphasis on Soil, Rock, the Vadose Zone, and Ground Water[3]

D 5753 Guide for Planning and Conducting Borehole Geophysical Logging[3]

D 5787 Practice for Monitoring Well Protection[3]

D 5903 Guide for Planning and Preparing for a Ground-Water Sampling Event[3]

D 5978 Guide for Maintenance and Rehabilitation of Ground Water Monitoring Wells[3]

D 5979 Guide for Conceptualization and Characterization of Ground-Water Systems[3]

3. Terminology

3.1 *Definitions*—Except as noted below, all definitions are in accordance with Terminology D 653:

3.1.1 *aquifer*, *n*—a geologic formation, group of formations, or part of a formation that is saturated and is capable of providing a significant quantity of water (see Practice D 5092).

3.1.2 *monitoring well (observation well)*, *n*—a special well drilled in a selected location for observing parameters such as liquid level or pressure changes or for collecting liquid samples. The well may be cased or uncased, but if cased the casing should have openings to allow flow of borehole liquid into or out of the casing.

3.1.3 *observation well*, *n*—for the purposes of this guide, an existing well constructed for other purposes that is also used to measure water levels and to collect ground-water quality samples. Observation well may be referred to as ″well” in this guide.

3.1.4 *supply (production) well*, *n*—well primarily installed for public supply, irrigation, and industrial use. Supply wells may be used as an observation well.

4. Significance and Use

4.1 This guide describes a general approach for the use of existing wells in environmental investigations with a primary focus on the subsurface and major factors affecting the surface and subsurface environment.

4.2 Existing wells represent a valuable source of information for subsurface environmental investigations. Specific uses of existing wells include:

4.2.1 Well driller logs provide information on subsurface lithology and major water-bearing units in an area. Existing wells can also offer access for downhole geophysical logging for stratigraphic and aquifer interpretations. Examples include natural gamma logs in cased wells and an entire suite of methods in uncased bedrock wells (see Guide D 5753). This information can assist in developing the preliminary conceptual model of the site.

4.2.2 Well tests using existing wells may provide information on the hydrologic characteristics of an aquifer.

4.2.3 Monitoring of water levels in existing wells, provided that they are cased in the aquifer of interest, allow development of potentiometric maps and interpretations of ground-water flow directions.

4.2.4 Existing wells are the primary means by which regional drinking water quality is evaluated and monitored.

4.2.5 Existing wells may assist in the mapping of contaminant plumes, and in ongoing monitoring of ground-water quality changes at the site-specific level.

4.3 Data from existing wells should only be used when characteristics of the well have been sufficiently documented to determine that they satisfy criteria for the purpose for which the data are to be used.

5. General Considerations in Selection and Use of Existing Wells

5.1 Selection and use of existing wells should take place in the context of a conceptual framework consisting of a description of the system, including, as necessary, physical and cultural characteristics such as climate, hydrology, ecology, physiography, population, water use and land use, and hypotheses about processes of interest that occur within that system. A step-wise approach for conceptualization and characterization is a direct approach to develop the framework for Hydrologic Systems as described in Kolm **(1)**, (see Guide D 5979). Conceptualization of hydrologic and regional ground-water quality systems can be formulated using the methods outlined in Alley **(2)**. The framework is reviewed and refined by an iterative process of data collection and analysis, testing hypotheses with data collected, and identifying data needs to further revise the framework. Refinement must be made within the limits established by the accuracy, precision, and completeness of the data. Methods for data collection are selected that will provide data appropriate for testing hypotheses which evaluate the conceptual framework.

5.2 Well design and installation can critically affect the quality of water level measurements and ground-water samples. Such effects apply both to existing wells and to wells specifically installed for a purpose. The effects of well design and installation, therefore, need to be considered regardless of whether existing wells are selected or if wells are specifically installed for a specific purpose. The most common feature of an existing well that may render it unsuitable for water level measurement or water-quality monitoring is that multiple hydrogeologic units are connected causing water levels and water-quality parameters to reflect a mixing of multiple hydrogeologic units. Such data cannot be reliably compared with data from wells completed in the individual hydrogeologic units.

5.3 Major steps in the selection of existing wells for environmental investigations include: developing specific criteria for evaluating the suitability of existing wells in relation to the objectives of the investigations (see Section 6), conducting an inventory of existing wells in the area of interest (see 8.1), documenting the characteristics of the wells identified in the inventory that are relevant to the selection criteria (see 8.2), and identification of wells that satisfy the selection criteria (see Section 9).

6. Well-Selection Criteria

6.1 Assessing the suitability of existing wells for hydrological and ground-water quality studies requires development of specific well-selection criteria. The criteria are based on

[3] *Annual Book of ASTM Standards*, Vol 04.09.

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considerations of project objectives by defining the problem to be solved, the conceptual framework, and data-collection requirements.

6.2 *Specific Well-Selection Criteria*—Specific criteria will depend on the objectives of the investigation. The following general criteria will apply to most situations:

6.2.1 The well is suitably located for use in relation to the conceptual framework.

6.2.2 The well must be completed in the targeted hydrogeologic unit or units.

6.2.3 Well design and construction must not bias water level measurements or water-quality sampling results (see Note 1). Section 7 provides information on the general characteristics of major types of existing wells.

NOTE 1—Gillham et al. **(3)**, provides information on the suitability of materials coming in contact with water samples and that table provides information on the compatibility of well casing materials with different organic contaminants.

6.2.4 The well is accessible for measurements and sampling.

6.2.5 The well's maintenance condition may not compromise it as a sampling point; however, there are examples that may compromise it as a sampling point, that is, a cracked casing allowing non-screened water into the well.

6.3 *Examples of Well Selection Criteria*—The following are illustrative examples of criteria for specific investigation objectives (see Note 2).

NOTE 2—These are illustrative examples and should not be construed as recommended criteria.

6.3.1 A project to determine the quality of potable ground water might require the following selection criteria: wells selected must be used for public water supply, must be geographically distributed over the entire aquifer of interest, and must be able to be sampled prior to any water treatment.

6.3.2 All wells or a subset of wells down-gradient from a hazardous-waste site would be unsuitable to include in a network designed for a study to determine non-point source ground-water quality.

6.3.3 Choosing a well located down-gradient of a complex mix of land uses would be inappropriate in a study designed to assess the effects of specific land uses on ground-water quality.

6.3.4 A supply well screened over a long interval would not be appropriate for investigating small-scale vertical variations in water quality down-gradient of a landfill, or for potentiometric mapping.

6.3.5 A well constructed of PVC (polyvinylchloride) with glued joints would not be suitable for sampling if the volatile-organic compounds of interest in the ground water also are found in the glue used to join the sections of well casing. Similarly, a well constructed of steel may not be suitable for the sampling of metals.

6.3.6 Selecting an observation well in an area undergoing rapid development would be avoided in constructing a network of wells for evaluating long-term trends in ground-water quality because of the possibility of the well being destroyed by later development.

7. General Characteristics of Major Types of Existing Wells

7.1 There are two general categories of existing wells available for hydrologic and ground-water quality studies: large- and small-capacity supply or production wells installed for drinking, irrigation, and industrial use (see 7.2 and 7.3); and wells specially designed and installed to monitor hydrologic or water-quality studies, or both, (see 7.4). Each type of well has its own general advantages and disadvantages.

7.2 *Large-Capacity Supply Wells*—Large capacity supply wells are usually developed for drinking water systems that supply multiple households, and for irrigation and industrial purposes.

7.2.1 *Advantages*:

7.2.1.1 Documentation of well construction commonly is good.

7.2.1.2 Large-capacity wells generally are well developed and fully purged.

7.2.1.3 Long-term access may be possible, particularly for municipal wells.

7.2.1.4 Large-capacity wells generally provide a larger vertical mix of water in an aquifer or aquifer system than small-capacity wells, and thus can provide a more integrated measure of regional ground-water quality than small-capacity wells.

7.2.1.5 Much of the water produced for irrigation and municipal water is from large-capacity wells equipped with taps which allow a direct sample of the pumped water.

7.2.1.6 Long-term water-quality and quantity data may be available.

7.2.2 *Disadvantages*:

7.2.2.1 Large-capacity wells may not have flow-rate controls and a sampling point near the well head.

7.2.2.2 High pumping rates may entrain artifacts, such as colloids or suspended material, into the sample stream.

7.2.2.3 Pumping schedules could be irregular: for example, irrigation wells generally are pumped seasonally, and could lead to seasonal variations in water quality that actually are an artifact of the pumping regime.

7.2.2.4 Large capacity wells may have a long vertical gravel pack, screened or open intervals might span more than one aquifer or aquifer system, making them unsuitable for potentiometric mapping or water quality monitoring. For example, dilution of contaminant concentrations wells with long screen intervals may result in large errors if concentrations are used for detailed delineation of the geometry and concentrations of contaminant plumes or for detection of contaminants in low concentrations (Pohlmann and Alduino **(4)**).

7.2.2.5 Wells with high pumping rates may draw water from water-bearing units other than those screened even if the well is screened solely within one unit, thus, the vertical integration of water from water-bearing units might be unknown.

7.2.2.6 Local hydraulics may be atypical of regional ground-water movement as a result of compaction or enhanced downward flow.

7.2.2.7 Municipal wells that produce water not meeting water-quality standards are usually abandoned, implying that

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the remaining population of municipal wells is biased toward acceptable water quality.

7.2.2.8 Down-hole chlorination or other chemical treatment might affect water chemistry, so that samples do not reflect ambient ground-water composition.

7.2.2.9 Depth-dependent differences in water quality could be lost, as water sampled could reflect a mixture of water obtained at different depths.

7.3 *Small-Capacity Supply Wells*—Small-capacity supply wells are usually developed for domestic water use involving a single household.

7.3.1 *Advantages*:

7.3.1.1 Domestic wells are a major source of drinking-water supply for rural population, so wells reflect this resource use.

7.3.1.2 Good to excellent areal and depth coverage in some areas, particularly for water-table aquifers.

7.3.1.3 Small-capacity pumping rates limit withdrawal of water from water-bearing formations other than those screened.

7.3.1.4 The low pumping rates of small-capacity wells are less likely to entrain artifacts, such as colloids or suspended material, into the sample stream than the high pumping rates of large-capacity wells.

7.3.2 *Disadvantages*:

7.3.2.1 Domestic wells may not be available in urban and suburban areas.

7.3.2.2 Documentation of well-construction characteristics may not be available.

7.3.2.3 Well construction, pressure tanks and treatment, and/or pumps may preclude being able to collect a sample at the well head.

7.3.2.4 The relation between well locations, septic systems, and other potential processes that could affect ground-water chemistry must be established in order to correctly assess what conditions water-quality data truly reflect.

7.3.2.5 The open interval may provide connections for more than one water-bearing unit, making a well unsuitable for potentiometric mapping or water quality monitoring.

7.4 *Existing Monitoring Wells*—Existing monitoring wells may be available that have been installed for purposes other than the current investigations.

7.4.1 *Advantages*:

7.4.1.1 Well construction details are usually well documented.

7.4.1.2 Well construction usually avoids interconnection of different water-bearing units.

7.4.1.3 Well construction is usually designed to optimize quality of ground-water samples.

7.4.2 *Disadvantages*—Well location, screen interval, or well construction details may not be suitable for the purpose of the current environmental investigation.

8. Well Inventory and Documentation

8.1 *Well Inventory*—Selection of wells begins with an inventory of existing production wells or previously installed monitoring wells in the locale of interest (see Guide D 5521). In order to collect information related to well selection criteria (see Section 6 and 8.2).

8.1.1 Well records of municipal, irrigtion, and industrial wells can be obtained from the appropriate state agency, local ground-water management district, natural resource district, and local offices of the U.S. Geological Survey, Water Resources District. Ganley **(5)** identifies the primary sources of domestic well records and identifies other locations where records may be available as of 1989.

8.1.2 If the locale of interest is not too large, a property-owner survey may identify additional wells that have not been recorded elsewhere. Interviews with well owners may also provide additional information that is missing from state or local agency records.

8.2 *Well Documentation*—Well documentation involves collection of all available data that are relevant to the well selection criteria. Practice D 5254 identifies the minimum set of data elements to identify a ground water site and Guides D 5408, D 5409 and D 5410 identify additional data elements. Table 1 and Fig. 1 identifies types of information available from state agency well record forms as of 1989 **(5)**. Figure 3 provides a checklist for documenting well information. Well documentation should include, but not necessarily be limited to:

8.2.1 Well identification number, type, location, elevation, and depth.

8.2.2 Lithologic log describing character and depths of different materials encountered during well drilling.

8.2.3 Hydrogeologic unit or units that supply water to the well. If accurate well logs are not available, additional investigations, such as borehole geophysical logging may be required. The major hydrogeologic units in an area must be well established in order to correlate water-bearing units in an existing well to hydrogeologic units in the area.

8.2.4 Well construction details, such as casing type, depth, screened interval, filter pack, grouts, and seals. Refer to Practice D 5092 for additional information on important elements of well design and construction. Other major sources of information on this topic include: Aller et al. **(6)**, Driscoll **(7)**, Harlan et al. **(8)**, Lehr et al. **(9)**, Nielsen and Schalla **(10)**, and McCaulou et al. **(11)**.

8.2.5 Well water levels. Measurements should reflect water levels without the influence of pumping if unstressed potentiometric mapping is desired.

8.2.6 Well yields, and any other well test results.

8.2.7 Land use in the vicinity of the well (see Figs. 2 and) **(13)**.

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WELL-INFORMATION CHECK LIST

PROJECT:____________________

Station ID:____________________ Local well ID:____________________

Well type (public-supply, domestic-supply, observation, etc.):____________________

Item	*Date item filed*
Ground-Water Site Inventory (GWSI) form	______
Paper copt of GWSI form in file:	______
Well-owner information	______
Copies of permission to drill, sample, etc. (list permits):____________________	
____________________	______
Copies of field notes and logs:	
Drillers log	______
Lithologic log	______
Cuttings	______
Cores	______
Well -construction record	______
Well-development record	______
Geophysical logs: List logs:____________________	______
Checks on well-construction integrity	______
Other____________________	______
Well-location information:	
Location map(s)	______
Site-sketch map	______
Written description of location	______
Well-casing elevation (elevation, and method and date of determination)	______
Photographs of well and vicinity, if taken, with measuring point identified:	
Land use land cover form (Figure 2) (enter dates of updates):	______
Water-quality records for each sampling event (for example, purging, field measurements, field forms)	______
	______
	______
	______
	______
Water-level measurements:	______
	______
	______
	______
	______
	______
	______
Other information (for example, historical water-level records, type pf pump in well, location of sampling point, sampling history):	______
____________________	______
____________________	______
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NOTE 1—Source: U.S. Geological Survey.

FIG. 1 Example of a Well-Information Check List Modified from (12) GWSI USGS Ground-Water Site Inventory

TABLE 1 Technical Information Items and Tabulations for Agency Well Record Forms

LAND-USE/LAND-COVER FIELD SHEET Page 1 (04/93)

1. Project name____
Field-check date_____/______/______ Person conducting fied inspection:____________________
Well-station ID:_________________________ Latitude:_________________ Loongitude:_________________
Entered by_________________ Date_____/_____/_____ Checked by________________ Date_____/_____/_____

2. LAND USE AND LAND COVER CLASSIFICATION—(modified from Anderson and others. 1976, p.8). Check all land uses that occur within each approximate distance range from the sampled well. Identify the predominant land use within each distance range and estimate its percentage of the total area within a 1/4-mile radius of the well.

Land use and land cover	*within 100 ft*	*100ft–1/4 mi*	*Comments*
I. URBAN LAND			
—Residential			
—Commercial			
—Industrial			
—Other (Specify)__________			
II. AGRICULTURAL LAND			
—Nonirrigated cropland			
—Irrigated cropland			
—Pasture			
—Orchard, grove, vineyard, or nursery			
—Confined feeding			
—Other (Specify)__________			
III. RANGELAND			
IV. FOREST LAND			
V. WATER			
VI. WETLAND			
VII. BARREN LAND			
Predominant land use			
Approximate percentage of area covered by predominant land use			

3. AGRICULTURAL PRACTICES within 1/4 mile of the sampled well.

a. Extent of irrigation—indicate those that apply.
Nonirrigated____ Supplimental irrigation in dry years only_____ Irrigated_____

b. Method of irrigation—indicate those that apply.
Spray_____ Flood_____ Furrow_____ Drip_____ Chemigation_____ Other_____(Specify)________________

C. Source of irrigation water—indicate those that apply.
Ground water_____ Surface water_____ Spring_____
Sewage effluent_____(treatment): Primary_____ Secondary_____ Tertiary_____

d. Pesticide and fertilizer application—Provide information about present and past pesticides and fertilizers used, application rates, and application methods.
____
____

e. Crop and animal types—Provide information about present and past crop and animal types, and crop rotation practices.
____
____

NOTE—Source: U.S. Geological Survey

FIG. 2 Example of a Land-Use and Land-Cover Field Sheet Modified from (12)

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