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Standard Guide for Maintenance and Rehabilitation of Groundwater Monitoring Wells[1]

This standard is issued under the fixed designation D5978; 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—Editorial changes were made throughout in December 2011.

INTRODUCTION

This guide for maintenance and rehabilitation promotes procedures appropriate to groundwater monitoring wells installed to evaluate the extent and nature of contamination, progress of remediation, and for long-term monitoring of either water quality or water level.

1. Scope

1.1 This guide covers an approach to selecting and implementing a well maintenance and rehabilitation program for groundwater monitoring wells. It provides information on symptoms of problems or deficiencies that indicate the need for maintenance and rehabilitation. It is limited to monitoring wells, that are designed and operated to provide access to, representative water samples from, and information about the hydraulic properties of the saturated subsurface while minimizing impact on the monitored zone. Some methods described herein may apply to other types of wells although the range of maintenance and rehabilitation treatment methods suitable for monitoring wells is more restricted than for other types of wells. Monitoring wells include their associated pumps and surface equipment.

1.2 This guide is affected by governmental regulations and by site specific geological, hydrogeological, geochemical, climatological, and biological conditions.

1.3 *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.*

1.4 *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 *ASTM Standards:*[2]

D652 Method of Test for Measuring Mica Stampings Used in Electronic Devices and Incandescent Lamps (Withdrawn 1956)[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1889 Test Method for Turbidity of Water (Withdrawn 2007)[3]

D4044 Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

D4412 Test Methods for Sulfate-Reducing Bacteria in Water and Water-Formed Deposits

D4448 Guide for Sampling Ground-Water Monitoring Wells

D4750 Test Method for Determining Subsurface Liquid Levels in a Borehole or Monitoring Well (Observation Well) (Withdrawn 2010)[3]

D5088 Practice for Decontamination of Field Equipment Used at Waste Sites

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[1] This guide 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.

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

D5092 Practice for Design and Installation of Ground Water Monitoring Wells
D5254 Practice for Minimum Set of Data Elements to Identify a Ground-Water Site
D5299 Guide for Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
D5408 Guide for Set of Data Elements to Describe a Groundwater Site; Part One—Additional Identification Descriptors
D5409 Guide for Set of Data Elements to Describe a Ground-Water Site; Part Two—Physical Descriptors
D5410 Guide for Set of Data Elements to Describe a Ground-Water Site;Part Three—Usage Descriptors
D5472 Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well
D5474 Guide for Selection of Data Elements for Groundwater Investigations
D5521 Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers

2.1.1 In addition, ASTM Volume 11.01 on Water (I) and Volume 11.02 on Water (II) contain numerous test methods and standards that may be of value to the user of this guide.

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of common technical terms in this standard, refer to Terminology D652 and Guide D5521.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *well development*—actions taken during the installation and start-up of a well for the purpose of mitigating or correcting damage done to the adjacent geologic formations and filter materials that might affect the well's ability to produce representative samples.

3.2.2 *well maintenance*—any action that is taken for the purpose of maintaining well performance (see Discussion) and extending the life of the well to provide samples that are representative of the groundwater surrounding it. Maintenance includes both physical actions taken at the well and the documentation of those actions and all operating data in order to provide benchmarks for comparisons at later times.

3.2.2.1 *Discussion*—Desired level of well performance can vary depending on the design objectives.

3.2.3 *well preventive maintenance*—any well maintenance action that is initiated for the purpose of meeting some preestablished rule or schedule that applies while well performance is still within preestablished ranges.

3.2.4 *well reconstructive maintenance*—any preventive or rehabilitative well maintenance action involving the replacement of a major component (for example, pump, surface protection).

3.2.5 *well redevelopment*—any preventive or rehabilitative well maintenance action, taken after start-up, for the purpose of mitigating or correcting deterioration of the filter pack or adjacent geologic formations, or both, due to the well's presence and operation over time, usually involving physical development procedures, applied in reaction to deterioration.

3.2.6 *well rehabilitation*—for the purposes of this guide, synonymous with well rehabilitative or restorative maintenance.

3.2.7 *well rehabilitative or restorative maintenance*—any well maintenance action that is initiated for the purpose of correcting well performance that has moved outside of preestablished ranges.

4. Significance and Use

4.1 The process of operating any engineered system, such as monitoring wells, includes active maintenance to prevent, mitigate, or reverse deterioration. Lack of or improper maintenance can lead to well performance deficiencies (physical problems) or sample quality degradation (chemical problems). These problems are intrinsic to monitoring wells, which are often left idle for long periods of time (as long as a year), installed in non-aquifer materials, and installed to evaluate contamination that can cause locally anomalous hydrogeochemical conditions. The typical solutions for these physical and chemical problems that would be applied by owners and operators of water supply, dewatering, recharge, and other wells may not be appropriate for monitoring wells because of the need to minimize their impact on the conditions that monitoring wells were installed to evaluate.

4.2 This guide covers actions and procedures, but is not an encyclopedic guide to well maintenance. Well maintenance planning and execution is highly site and well specific.

4.3 The design of maintenance and rehabilitation programs and the identification of the need for rehabilitation should be based on objective observation and testing, and by individuals knowledgeable and experienced in well maintenance and rehabilitation. Users of this guide are encouraged to consult the references provided.

4.4 For additional information see Test Methods D1889, D4412, D5472, and Guides D4448, D5409, D5410 and D5474.

5. Well Performance Deficiencies

5.1 Proper well design, installation, and development can minimize well performance deficiencies that result in the need for maintenance and rehabilitation. Practice D5092 and Guide D5521 should be consulted. Performance deficiencies include: sand, silt, and clay infiltration; low yield; slow responses to changes in groundwater elevations; and loss of production.

5.2 *Preventable Causes of Poor Well Performance:*

5.2.1 Inappropriate well location or screened interval. These may be unavoidable if a requirement for site characterization or monitoring exists,

5.2.2 Inappropriate drilling technique or methodology for materials screened,

5.2.3 Inadequate intake structure design (screen, filter material, and so forth),

5.2.4 Inappropriate well construction materials. This may lead to corrosion or collapse,

5.2.5 Improper construction, operation, or maintenance, or combination thereof, of borehole or well, wellhead protection, well cap, and locking device,

5.2.6 Ineffective development,

5.2.7 Inappropriate pump selection, and

5.2.8 Introduction of foreign substances.

5.3 *Physical Indicators of Well Performance Deficiencies Include:*

5.3.1 *Sand, Silt, and Clay Infiltration*—Causes include inappropriate and inadequate well drilling (for example, auger flight smearing), improper screen and filter pack, improper casing design or installation, incomplete development, screen corrosion, or collapse of filterpack. In rock wells, causes include the presence of fine material in fractures. The presence of sand, silt, or clay can result in pump and equipment wear and plugging, turbid samples, filterpack plugging, or combination thereof.

5.3.2 *Low Yield*—Causes include dewatering, collapse or consolidation of fracture or water-bearing zone, pump malfunction or plugging, screen encrustation or plugging, and pump tubing corrosion or perforation.

5.3.3 *Water Level Decline*—Causes include area or regional water level decline, well interference, and chemical or microbial plugging or encrustation of the borehole, screen, or filterpack.

5.3.4 *Loss of Production*—Usually caused by pump failure, but can also be caused by dewatering, plugging, or well collapse.

5.3.4.1 *Well Collapse*—Can be caused by tectonism, ground subsidence, failure of unsupported casing (that is, in caves or because of faulty grout), corrosion and subsequent failure of screen and casing, improper casing design, local site operations, freeze-thaw, or improper chemical or mechanical rehabilitation.

5.3.5 Observation of physical damage or other indicator.

6. Sample Quality Degradation

6.1 All of the preceding physical well performance deficiencies can result in sample quality degradation by dilution, cross-contamination, or entrainment of solid material in water samples. In addition, chemical and biological activity can both degrade well performance and sample quality. Any change in well or aquifer chemistry that results from the presence of the well can interfere with accurate characterization of a site.

6.2 *Physical Indicators*—Chemical and biological activity that can lead to sample quality degradation include:

6.2.1 *Chemical Encrustation*—Precipitation of calcium or magnesium carbonate or sulfate, iron, or sulfide compounds can reduce well yield and specific capacity.

6.2.2 *Biofouling (Biological Fouling)*—Microbial activity can result in slime production and the precipitation of iron, manganese, or sulfur compounds and occasionally other materials such as aluminum oxides. Biofouling may be accompanied by corrosion or encrustation, or both, and can result in reduced specific capacity and well yield. Biochemical deposits can interfere with sample quality by acting as chemical sieves.

6.2.3 *Corrosion*—Corrosion of metal well and pump components (that is, stainless steel, galvanized steel, carbon steel, and low carbon steel) can result from naturally aggressive waters (containing H_2S, NaCl) or electrolysis. The presence of contaminants contributes to corrosion through contributions to microbial corrosion processes and formation of redox gradients. Nonaqueous phase solvents may degrade PVC and other plastics. Other environmental conditions such as heat or radiation may contribute to material deterioration (such as enhanced embrittlement). Metals such as nickel or chromium may be leached from corroding metals. Degradation of plastic well components may result in a release of monomers (such as vinyl chloride) to the environment (see Note 1).

NOTE 1—Naturally aggressive (for metals) waters have been defined as low pH (<7.0), high DO (>2 mg/L), high H_2S (>1 mg/L), high dissolved solids (>1000 mg/L), high CO_2 (>50 mg/L), and high Cl^- content (>500 mg/L). However, local conditions may result in corrosion at less extreme values. Expression of corrosion is also dependent on materials load.

6.2.4 *Change in Turbidity*—Causes include biofouling and intake structure, screen or filter pack clogging or collapse. Increase in turbidity may not always be the result of a problem with the well. Changes in the purging and sampling procedures and devices used can affect the turbidity of water from a monitoring well. For example, using a bailer where a pump was previously utilized, or pumping at a higher rate than previously used could increase turbidity; likewise, pumping a well that was previously bailed could increase turbidity.

6.2.5 *Change in Sand/Silt Content or Particle Counts*—Causes include biofouling (resulting in clogging or sloughing) and intake structure clogging or collapse. Increase in the sand/silt content may not always be the result of a problem with the well. Changes in the purging and sampling procedures and devices used can affect the sand/silt content of water from a monitoring well. For example, using a bailer where a pump was previously utilized, or pumping at a higher rate than previously used could increase the sand/silt content; likewise, pumping a well that was previously bailed could increase the sand/silt content.

6.3 *Chemical Indicators (Observed in Groundwater Samples)*—Chemical and biological activity that can lead to sample quality degradation include (see Note 2):

NOTE 2—Changes in chemical indicators can also be a result of site-wide changes in hydro-geochemistry.

6.3.1 *Iron (Changes in Total Fe, Fe^{2+}/Fe^{3+}, Iron Minerals and Complexes)*—Causes include corrosion, changes in redox potential, and biofouling.

6.3.2 *Manganese (Changes in Total Mn, Mn^{2+}/Mn^{4+}, Manganese Minerals and Complexes)*—Causes include changes in redox potential and biofouling.

6.3.3 *Sulfur (Changes in Total $S^{2-}/S^0/SO_4^{2-}$, Sulfur Minerals and Complexes)*—Causes include changes in redox potential and biofouling.

6.3.4 *Changes in Redox Potential (Eh)*—Causes include microbial activity and changes in O_2, CH_4, CO_2, N, S, Fe, and Mn species present in the system.

6.3.5 *Changes in pH*—Causes include corrosion; microbial activity; dissolved gases such as oxygen, carbon dioxide, and hydrogen sulfide; and encrustation.

6.3.6 *Changes in Conductivity*—Causes include changes in total solids content, microbial activity, and corrosion.

6.3.7 *Changes in the Type and Concentration of Gases*—Dissolved oxygen, carbon dioxide, nitrogen, hydrogen sulfide, and methane are indicators of redox status and microbial activity.