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Definitions For The Minimum Set Of Data Elements For Ground Water Quality

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U.S. Environmental Protection Agency
Office of Ground Water and Drinking Water
Washington, D.C.

July 1992

ACKNOWLEDGEMENTS

This document represents a three year effort on the part of many individuals to improve the protection of ground water resources through the use of data elements to increase effective information sharing and cross media interaction.

The Environmental Protection Agency (EPA) staff principly involved in managing, coordinating and developing this project were, Harriet Colbert, Caryle Miller, Robin Heisler, Dr. Norbert Dee, Michelle Zenon and Jean Sammon. Jane Marshall and William McCabe provided technical assistance and developed the well diagrams.

Many people from the State and Federal ground water community served on the Minimum Set of Data Elements for Ground Water Quality Workgroup. The Workgroup participants are listed in Appendix B.

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INTRODUCTION

INTRODUCTION

Background

The protection of our nation's ground water resources is receiving widespread attention at all levels of governmental the need to protect this vital resource to sustain the life and health of citizens and the ecosystem becomes increasingly clear. As a part of the Environmental Protection Agency's (EPA) continuing commitment to the protection of the Nation's ground water resources and in keeping with its Ground Water Protection Strategy for the 1990s[1], the Agency has identified the critical need for improved means for the collection, accessibility and utilization of ground water information. As such, EPA's Office of Ground Water and Drinking Water is improving the accessibility, transfer and use of information through the establishment of a Minimum Set of Data Elements for Ground Water Quality (MSDE).

The MSDE project was developed as a result of a Ground Water Data Requirements Analysis which was completed in 1987. An issue consistently identified during the conduct of the requirements analysis was the need to improve access to ground water data and the need to standardize elements used in data base development to increase information sharing capabilities. In response, EPA conducted a workshop in 1988 to discuss development of a minimum set of data elements for ground water quality.[2] The goals of the workshop participants were to a) achieve consensus on a minimum set of data elements that would facilitate the collection and sharing of ground water and related data across agencies and b) identify implementation issues that must be resolved to encourage collection of an MSDE throughout the ground water community. The workshop participants developed a draft list of data elements. An EPA Order (7500. 1) was established in 1989 which made the elements and their use a requirement for EPA and its contractors. The Order stated that "a dictionary defining elements in the minimum data set will be developed by the Office of Ground Water Protection" (now the Ground Water Protection Division).[3] At that time, a draft

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[1] U.S. Environmental Protection Agency, Office of The Administrator, Protecting The Nation's Ground Water: EPA's Strategy for The 1990s, The Final Report Of The EPA ground water Task Force, EPA Publication No. 21Z-1020, July 1991.

[2] U.S. Environmental Protection Agency, Office of ground water Protection, EPA Workshop to Recommend A Minimum Set of Data Elements for Ground Water: Workshop Findings Report, EPA 440/6-88-005, June 1988.

[3] U.S. Environmental Protection Agency, EPA Order - Minimum Set of Data Elements For Ground Water, September 1989.

definition for each element was recommended by the Office of Ground Water Protection.[4]

The development of the final list of elements and their definitions involved an intensive, iterative process of drafting and peer review by an MSDE Work Group of over 100 representatives from EPA, other Federal Agencies, and the States. The list of work group members is provided in Appendix B. It has taken approximately four years to complete this project. The primary task of the Work Group was to comment on and provide recommended changes to the elements' names and draft definitions. The Work Group completed two separate review cycles of element names and draft definitions with suggested data conventions.[5]

Purpose

EPA is pleased to present this document that identifies and defines a minimum set of data elements for ground water quality. The purpose of this document is to present the definitions for a minimum set of key ground water data elements that are needed to share data efficiently within the ground water community at all levels of government. The data elements in the minimum set were selected based on the following criteria:

- those elements that are needed to communicate ground water data across related programs;

- those elements that are common to all programs and completely adequate for some programs;

- those elements that provide a road map to other ground water data; and

- those elements that provide a link between ground water quality and well location information.

Implementation of the MSDE will be useful under the following conditions:

- When States, Federal agencies or other officials are considering creating a new ground water quality data base; or

[4] U.S. Environmental Protection Agency, Office of Ground Water Protection, Minimum Set of Data Elements for Ground Water: DEFINITIONS and FORMATS, January 1990 (unpublished).

[5] Ibid., July 23, 1990.

- officials want to modernize an existing data base. Officials may wish to modernize their data base because they have a significant amount of new data or because they want to help move their agency(ies) towards achieving consistency among its data bases.

The use of the MSDE is required in both of these circumstances for EPA and its contractors, and States are encouraged to voluntarily adopt its use in State data base systems. It is also important to remember that this document represents the *minimum* data elements one should include when selecting elements for information collection activities pertaining to ground water quality. In addition to the elements in this minimum set, Agencies should collect data for any element that they feel is necessary for the effective management of their ground water resources. This document does not preclude the EPA or its contractors from imposing more stringent accuracy requirements. For example, an EPA Regional Office may choose to require data providers to report a more stringent degree of accuracy than is indicated in the MSDE for the Latitude data element.

Data Element Presentation

This document is organized by data element. The 21 elements in the minimum set are presented on the following page. The elements are divided into four categories:

(1) General descriptor;

(2) Geographic descriptors;

(3) Well descriptors; and

(4) Sample descriptors.

Throughout this document, the term “well(s)” is used to mean well(s), spring(s) or other ground water locations. Some elements, however, may not apply to all types of ground water locations. For example, element 13-- Screen/Open Interval -- will not apply to springs. Such limitations of data elements will be noted in the text.

This document provides the following four components for each data element:

- the element’s name;
- the element’s definition;
- a discussion of the element’s definition; and
- examples of possible data conventions for the element.

The element’s name is the most succinct and widely recognized name for that particular element. The element’s definition is a concise statement of the meaning of the data element in the context of the minimum set of data elements for ground water quality. The discussion section presents the purpose of the element and elaborates on and clarifies its definition.

MINIMUM SET OF DATA ELEMENTS FOR GROUND WATER QUALITY

Element Category	Element Names
General Descriptor: describes where the well information is maintained	1. Data Sources
Geographic Descriptors: describe the well or spring in relation to the earth's surface	2. Latitude 3. Longitude 4. Method Used to Determine Latitude and Longitude 5. Description of Entity 6. Accuracy of Latitude and Longitude Measurement 7. Altitude 8. Method Used to Determine Altitude 9. State **FIPS**[a/] Code 10. County **FIPS**[a/] Code
Well Descriptors: describe various features of a well or spring	11. Well Identifier 12. Well Use 13. Type of Log 14. Depth of Well at Completion 15. Screened/Open Interval
Sample Descriptors: describe different aspects of collecting, analyzing, and recording the results of a ground water sample	16. Sample Identifier 17. Depth to Water 18. Constituent or Parameter Measured 19. Concentration/Value 20. Analytical Results Qualifier 21. Quality Assurance Indicator

[a/] Federal Information Processing Standard.

And finally, the examples section presents various means of establishing a data convention for the element.

The intent in presenting examples is to serve as a guide and offer suggestions on how the information could be presented in a data base. EPA is not prescribing formats or data conventions for most of the elements in the minimum set. EPA considers the need to develop formats for these data elements to be the responsibility of those who will oversee the actual physical design of the data base.

A number of different examples of data formats are presented for each element due to the realization that a format that is appropriate for one data base may not be appropriate for another. However, the first example listed under each element represents widely accepted design practices of storing data fields separately. Adopting this preferred data format will help make data bases more consistent and will ease data sharing. The first example decomposes individual components of the element into separate fields that are listed on separate lines. For example, element 7-- Altitude -- has three components: 1) the measuring point; 2) the altitude of the measuring point; and 3) the units the altitude measurement is expressed in. The preferred example format for the altitude element, therefore, decomposes these components as illustrated in the following example:

L
+ 00100
M

where **L** represents the measuring point for this hypothetical well is the land surface; **+00100** is the altitude of the measuring point and **M** reveals that the altitude was measured in meters. Decomposing the components of an element into separate fields will help data users interpret the data and make it easier for data base managers to correct data errors if necessary. For more information on storing data element components in separate fields, as well as other key considerations involving the implementation of the MSDE, see Appendix A.

Specific formats or data conventions are not prescribed for most of the elements, however, the MSDE does prescribe formats for a number of data elements to assure compliance with EPA and Federal Information Processing Standards policy. Required EPA formats in this document are the Locational Data Policy (LDP) and the Facility Identification Data Standards (FIDS).[6,7] The LDP establishes the principles for collecting and documenting latitude/longitude coordinates for facilities, sites and monitoring and observation points under the jurisdiction of EPA. The FIDS establishes a data standard for unique facility identification codes to be maintained in all EPA data collections containing information on facilities regulated by EPA. The FIDS codes are complied with in the Well Identifier data element. Federal Information Processing

[6] U.S. EPA, Office of Information Resources Management, Information Resources Management Policy Manual - Locational Data, April 8, 1991.

[7] U.S. EPA, Office of Information and Resources Management, Information Management and Services Division, EPA Order - Facility Identification Data Standard, April 9, 1990.

Standards (FIPS) establish Federal government-wide standards for a variety of data. Throughout this document, FIPS codes have been complied with for dates, State Codes and County Codes.

As a result of the two peer review cycles, some of the data element names and definitions changed several times before the final elements and definitions were selected. Major differences between the final list of elements and earlier versions, such as the list in the EPA Order establishing the elements as Agency policy, are as follows:

- The three elements pertaining to source organizations for various data are combined into a single new element called Data Sources.

- Latitude and Longitude are separated into two separate data elements based on the EPA Locational Data Policy.

- The two elements Depth to Top and Depth to Bottom of Open Section are combined into one element named Screened/Open Interval. The information collected under this new element will remain the same, the only difference is the data will be reported as an interval under a single element instead of two elements.

Other differences in the final list and previous versions are minor changes in nomenclature for the purpose of clarification.

EPA believes that as a result of the intense review of these elements and their definitions by the Work Group, this document represents the most critical elements and most technically-accurate definitions for a minimum set of data elements for ground water quality. In developing this final document, EPA considered every comment registered by the Work Group and drafted the definitions based upon the weight of evidence provided by the Work Group. Where necessary, EPA resolved issues using its best professional judgment.

With this document, EPA presents the final list of elements comprising the minimum set of data elements for ground water quality and the elements' definitions. The Ground Water Protection Division, Office of Ground Water and Drinking Water, is pleased to offer this document as one of many continuing commitments to support the protection of our Nation's ground water resources.

GENERAL DESCRIPTOR

GENERAL DESCRIPTOR

1. DATA SOURCES

DEFINITION: The names of the organizations to direct questions regarding the following data: (1) latitude and longitude coordinates, (2) altitude, (3) well log information, (4) sample collection and (5) laboratory sample analyses.

DISCUSSION: The purpose of this element is to provide a point of contact to whom data users can direct questions pertaining to the following data: (1) latitude and longitude coordinates, (2) altitude, (3) well log information, (4) sample collection and (5) laboratory sample analyses. For the source of data for the well log, data providers should list the organization(s) which stores the logs. Although the organization maintains the log, the organization may not have the authority to release information from the log. Authority to release information may have to come from the well owner. In such cases, the organization listed should be able to provide the name of the well owner. Data providers should list those organizations that are best qualified to answer questions regarding the particular data type. Such questions may include detailed inquiries regarding the methods used to collect coordinates or samples, or apparent anomalies in the data.

The definition of this element does not require data providers to list contact names or telephone numbers of the organizations since this information may change frequently. Data managers, however, may choose to require this or any other data source information that they feel is necessary to meet their needs. Since there may be several data sources for a given well, the field for this element will be a repeating field.

The following examples suggest a few means of expressing a data convention for this element. For these examples, the following abbreviations are suggested for each data type:

a = altitude; **sc** = sample collection; **w** = well log information;

e = latitude/longitude coordinates; **sa** = laboratory sample analysis

EXAMPLES:

COMPUTER FORMATTED DATA	DATA SOURCE REPRESENTED
Dept. Environmental Management Ground Water Section Montgomery AL 36130 w	Department of Environmental Management Ground Water Section Montgomery, Alabama 36130 data source for well log information
Georgia Geological Survey Atlanta GA 30365 a	Geological Survey, State of Georgia Atlanta, Georgia 30365 data source for altitude
USEPA Region X Geographic Information Systems Section Seattle WA 98101 e	U.S. Environmental Protection Agency Region 10 Geographic Information Systems Section Seattle, Washington 98101 data source for latitude/longitude coordinates

GEOGRAPHIC DESCRIPTORS

2. LATITUDE

DEFINITION: A coordinate representation that indicates a location on the surface of the earth using the earth's equator as the latitude origin, reported in degrees (**D**), minutes (**M**), seconds (**S**) and fractions of a second in decimal format (if fractions of a second are available). A "+" (plus) symbol represents latitudes north of the equator. A "-" (minus) symbol represents latitudes south of the equator.

DISCUSSION: The purpose of this element is to provide a standardized locational coordinate that will assist data users in geographically locating a wells (For an illustration of Latitude, see Figure 1.) Due to an increasing need for precise, reliable locational coordinates, and the emergence of sophisticated geographic information system (GIS) data bases, latitude and longitude have become the national standards for locational information. Therefore, to promote consistency in the collection and reporting of locational information, data providers are required to use these national locational standards.

EPA has specified formatting requirements in its policy on locational data.[9] The latitude coordinate must be expressed in decimal format that allows possible precision to the ten-thousandths of seconds and be preceded by either a "+" (plus) or "-" (minus) symbol to represent wells north or south of the equator, respectively. Latitude will be reported in this format: **+/-DDMMSS.SSSS.**[10]

The following examples provide some samples of the data convention for this element. These examples are consistent with the format outlined in EPA's locational data policy.

EXAMPLES: **+300510.1000**
represents latitude 30° 05' 10. 1" north of the equator.

+421005.0000
represents latitude 42° 10' 05" north of the equator.

-163000.0000
represents latitude 16° 30' 00" south of the equator.

+400114.0135
represents latitude 40° 01' 14.0135" north of the equator.

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8 Throughout this document, ***well(s)*** means: wells, springs or other ground water locations.

9 U.S. EPA, Office of Information Resources Management, Information Resources Management Policy Manual - Locational Data, April 8, 1991.

10 Ibid.

3. LONGITUDE

DEFINITION: A coordinate representation that indicates a location on the surface of the earth using the prime meridian (Greenwich, England) as the longitude origin, reported in degrees (**D**), minutes (**M**), seconds (**S**), and fractions of a second in decimal format (if fractions of a second are available). A "+" (plus) symbol represents longitudes east of the prime meridian. A "-" (minus) symbol represents longitudes west of the prime meridian.

DISCUSSION: The purpose of this element is to provide a standardized locational coordinate that will assist data users in geographically locating a well. (For an illustration of Longitude, see Figure 1.) Due to an increasing need for precise, reliable locational coordinates and the emergence of sophisticated geographic information system (GIS) databases, latitude and longitude have become the national standards for locational information. Therefore, to promote consistency in the collection and reporting of locational information, data providers are required to use these national locational standards.

EPA has specified these formatting requirements in its policy on locational data.[11] Longitude coordinates must be expressed in decimal format that allow possible precision to the ten-thousandths of seconds and be preceded by either a "+" (plus) or a "-" (minus) symbol to represent wells east or west of the prime meridian (Greenwich, England), respectively. Longitude will be reported in this format: **+/-DDDMMSS.SSSS.**[12]

The following examples provide some samples of the data convention for this element. These examples are consistent with the format outlined in EPA's locational data policy.

EXAMPLES: **-0930407.0000**
represents longitude 093° 04' 07" west of the prime meridian.

+0480520.500
represents longitude 048° 05' 20.5" east of the prime meridian.

-1220322.0325
represents longitude 122° 03' 22.0325" west of the prime meridian.

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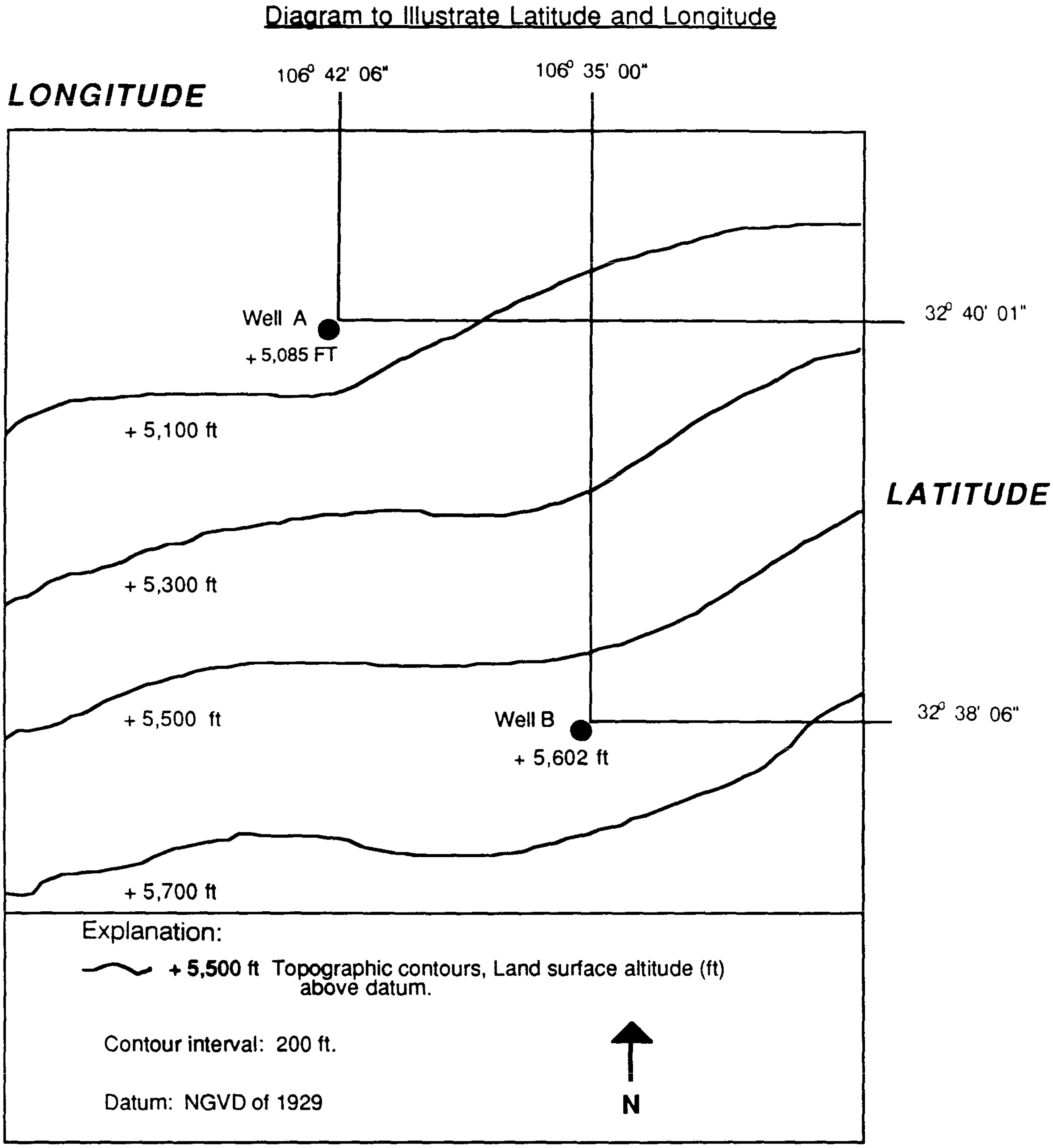
11 Ibid.
12 Ibid.

Figure 1



Topographic map view illustrating location of wells (Latitude and Longitude), their relation to land surface altitude and the reference datum (NGVD 1929)

4. METHOD USED TO DETERMINE LATITUDE AND LONGITUDE

DEFINITION: The procedure used to determine the Latitude and Longitude coordinates **(Technology of Method Used),** the standard used for three dimensional and horizontal positioning **(Reference Datum),** the method used for map interpolation **(Scale of Map),** and the date on which the coordinates were determined **(Date).** Latitude always precedes longitude.

DISCUSSION: In order for Method Used To Determine Latitude and Longitude to be most meaningful to secondary users, data must be collected and documented so that there is sufficient information to independently reproduce the same locational coordinates.

Standard documentation of "method" is done best by representing the method as a code and having qualifying data elements for datum and map scale. In additiom EPA has adopted Global Positing System as the technology of choice for collecting locational **data.**[13] Each of the components to achieve sufficient data collection and documentation for this data element is discussed below

(1) Technology of Method Used: is the method used to determine the latitude/longitude coordinates of the well (i.e., address matching, map interpolation, Loran-C, Global Positioning System (GPS), etc.). Data users may choose to check coordinates determined through conversions from other systems since there is a chance for substantial error if the data provider did not make the proper conversion.

It is likely that the method used will be an essential qualifier used to search lists and create subsets of coordinates in automated data bases. For this reason, it is essential to ensure consistency in this data field and establish a definitive list of the valid values for the field. Method codes are presented below:

Latitude/Longitude Method Codes:

SUR-GPS = surveyed using differential-mode global positioning system (GPS). This mode uses two receivers where one is set at a known point. Data are processed relative to a known point over time. With this mode,

[13] U.S. EPA, Office of Research and Development Locational Data Policy Implementation Guidance - Global Positioning Systems Technology And Its Application in Environmental Programs - GPS Primer, EPA/600/R-92/036, February, 1992.

		very high orders of accuracy can be achieved. Survey quality GPS equipment used in compliance with standards and specifications defined by the Federal Geodetic Control Committee can easily achieve sub-meter positional accuracies with respect to the National Geodetic Reference System.[14] Navigational-type GPS units used in differential-mode can typically achieve accuracies in the 1 to 4 meter range.
NAV-GPS	=	navigation-quality GPS. Surveyed using absolute-mode global positioning system. This mode uses a single receiver and determines a location with respect to several satellites, not from a known point. This mode is several degrees of magnitude (approximately 100 meters) less accurate than differential-mode.
SUR-C	=	cadastral survey. Surveyed using conventional methods from a previously established global positioning system or triangulation control point.
MAP	=	digital or manual interpolation from a map or photo.
LORAN-C	=	Loran-C navigation device or radiotriangulation.
ADDMAT	=	address-matched to a sub-portion of a street block.
PHOTO-GM	=	aerial photography
SPCSCONV	=	conversion from state plane coordinate system
TSRCONV	=	conversion from township-section-range (etc.) system
UTMCONV	=	conversion from Universal Transverse Mercator (UTM) coordinates
PHOTORAW	=	digital or manual raw photo extraction
RMTSEN	=	remote sensing
ZIP	=	zip code centroid
UNKNOWN	=	method unknown

[14] The National Geodetic Reference System is the name given to all Geodetic Control contained in the National Geodetic Survey data base including horizontal and vertical control, gravity data, astronomic data and satellite data.

(2) Reference Datum: The national reference datum for latitude and longitude is a national standard for three dimensional and horizontal positioning established by the U.S. National Geodetic Survey. In general, a datum is a mathematical equation used to describe the earth's surface. There are in existence several national reference datum systems. Nearly all of EPA's data is in NAD27. Providers of latitude and longitude data need to specify the reference datum their coordinates are based on in order for others to accurately interpret the data. If the reference datum is not available, data providers should specify that this information is not available.

The current datum is the North American Datum of 1983 (NAD 83). This system was completed in July 1986, and adopted by Federal Register Notice Volume 54, No. 113, June 14, 1989, Docket No. 89-14076. It combines and replaces several local datums including the North American Datum of 1927 (NAD 27), Old Hawaiian Datum, Puerto Rico Datum, St. Paul Island Datum, St. George Island Datum and St. Lawrence Island Datum.

NAD 83 is based on an earth model (ellipsoid or spheroid) known as Geodetic Reference System of 1980 (GRS 80), which is functionally equivalent to the World Geodetic System of 1984 (WGS 84) developed by the U.S. Department of Defense for its global positioning system. A number of U.S. trust territories, including Guam, American Samoa, and Wake, have not been added to NAD 83 at this time. All coordinate information for these islands should be given in the local datum.

Reference Datum should be in the format *BB* where BB is the year of the datum. The following are U.S. National Geodetic Survey codes for the National Reference Datum for Latitude and Longitude:

83	=	North American Datum of 1983 (NAD 83)
27	=	North American Datum of 1927 (NAD 27)
05	=	World Geodetic System of 1984 (WGS 84)
10	=	World Geodetic System of 1972 (WGS 72)
15	=	Old Hawaiian Datum
20	=	Puerto Rico Datum
25	=	St. Paul Island Datum
30	=	St. George Island Datum
35	=	St. Lawrence Island Datum
40	=	Guam 1963
45	=	Wake-Eniwetok 1960
50	=	Midway Astro 1961
55	=	American Samoa Datum
60	=	Johnson Island 1961
00	=	Reference Datum not specified

(3) Scale of Map: indicates the scale of the map used to determine the latitude and longitude coordinates of the well or spring. If map interpolation is the method used to determine latitude/longitude coordinates, the data element for scale should be the "X" value of the 1:X ratio. For example if the scale is 1:24,000 (i.e., one inch on a map is equal to 24,000 on the ground), the value of the scale is "24,000". If map interpolation is not the method used to determine latitude/longitude, then the data element value for scale is NOT APPLICABLE. If the scale of the map used is unknown, then the data element value for scale is UNKNOWN. The following codes are established to ensure consistency and establish a definitive list of the valid values for the method codes.

Scale	Data Element Value
7.5' x 7.5' (1:20,000)	20,000
7.5' x 15' (1:20,000)	20,000
7.5' x 7.5' (1:24,000)	24,000
7.5' x 15' (1:24,000)	24,000
7.5' x 7.5' (1:25,000)	25,000
7.5' x 15' (1:25,000)	25,000
15' x 15' (1:62,500)	62,500
7.5' x 20 (1:63,360)	63,360
7.5' x 36' (1:63,350)	63,350
1:15,840	15,840
1:20,000	20,000
1:24,000	24,000
Not Applicable	NOT APPLICABLE
Unknown	UNKNOWN

(4) Latitude/Longitude Date the Latitude/Longitude Date is the date on which the data provider determined the latitude and longitude coordinates. This date is important because it can provide additional information on the accuracy of the latitude and longitude coordinates. Due to technological advances in cartography and locational positioning systems, data users also may want to use this information to update old latitude and longitude values, especially if they need very precise location information.

The Latitude/Longitude Date format is based on Federal Information Processing Standard (FIPS) Publication **4-1**[15]**,** which sets the standard for date representation for all Agencies of the Federal Government as yyyymmdd where y = year, m = month, and d = day.

The following examples suggest three means of expressing a data convention for this element.

EXAMPLES: **MAP**
83
24,000
19860305
represents the Latitude/Longitude Method is digitally interpolated from a map or photo (MAP); the reference datum is based on the North American Datum of 1983 (83); the scale of the map is 1:24,000 for which the data element value is equal to 24,000 (24,000); and the Date on which the coordinate was determined is March 5, 1986 (19860305).

NAV-GPS
27
NOT APPLICABLE
19811204
represents the Latitude/Longitude Method is surveyed using absolute-mode global positioning system (NAV-GPS); the reference datum is based on the North American Datum of 1927 (27); the scale of the map is not applicable (NOT APPLICABLE); and the date on which the coordinate was determined is December 4, 1981 (19811204).

SUR-GPS/83/NOT APPLICABLE/1980
represents the Latitude/Longitude Method is surveyed using differential-mode global positioning system (SUR-GPS); the reference datum is North American Datum of 1983 (83); the scale of the map is not applicable (NOT APPLICABLE); and the date on which the coordinate was determined is in the year 1980 (1980).

[15] U S Department of Commerce, National Bureau of Standards, Representation for Calendar Date and Ordinal Date for Information Interchange, Federal Information Processing Standards (FIPS) Publication 4-1, January 27, 1988.

5. DESCRIPTION OF ENTITY

DEFINITION: A textual description of the entity to which the latitude and longitude coordinate refers.

DISCUSSION: Latitude/longitude coordinates are often collected to represent an entity but are actually a particular point or portion within the entity. Secondary users need to know exactly what the latitude/longitude coordinates define.

Throughout this document, the term "wells" is used to mean wells, springs or other ground water locations. Although there are certain data elements that clearly only pertain to wells (e.g., Depth To Well At Completion and Screened/Open Interval). The data elements in this document can be used as a tool to collect, use and share information on ground water locations such as springs and boreholes. Therefore, as required by the EPA Locational Data Policy, a description of the entity (exact place where the coordinates are collected) must be indicated.

The format of the description data element is a free-format, text field. There should be, however, two components documented for "Description Of Entity":

- Whether the coordinate describes a point, line, or area.
- The specific and exact description of the point, line or area that the latitude/longitude coordinate is ***of*** and not a general description of what the latitude/longitude ***represents.*** For example, the description should indicate that the latitude/longitude is of a specific well site within a well field rather than of the well field in general.

It is very important that data collectors be consistent in their use of the description field. The exact place used to represent the location of the entity should be selected when planning the data collection process.

The following examples suggest ways of expressing this data element.

EXAMPLES: Spring - The lat/long coordinate of spring X at the point where it flows into surface water Y.

Well - The latitude/longitude coordinate is the point where the well is located within a well field. The well identifier is ALD98060001.*

**See data element number 11, Well Identifier, for explanation of well identification.*

6. ACCURACY OF LATITUDE AND LONGITUDE MEASUREMENT

DEFINITION: The quantitative measurement of the amount of deviation from true value present in a measurement (estimate of error). It describes the correctness of a measurement.

DISCUSSION: The distance represented by a degree of latitude remains constant throughout the world whereas the distance represented by a degree of longitude varies from the poles to the equator. For example, the number of meters on the ground represented by a 1.0 second accuracy for longitude at the equator (0 degrees latitude) would be larger than ± 1 second accuracy at the poles (90 degrees latitude). Additionally, ± 1.0 second of accuracy for latitude and for longitude is similar only at the equator. The issue of requiring a particular level of latitude/longitude accuracy has been addressed by the EPA Locational Accuracy Task Force (LATF). The Task Force has recommended an accuracy goal of 25 meters.[16] **At a minimum, values for latitude and longitude should always be complete to the second and in accordance with the 25 meter accuracy goal.** However, data systems should be capable of handling latitude data to the full length of the format (i.e., either + or - DDMMSS.SSSS) to accommodate more precise measurements likely in the future. Likewise, data systems should also be capable of handling longitude data to the full length of the format (i.e., either + or - DDDMMSS.SSSS) to accommodate more precise measurements likely in the future.

It is important to keep in mind that the accuracy limit was established as a goal and not a standard because the achievement of maximum locational data accuracy is necessarily technology-based (i.e., the quality of locational data should be as good as the most practicable data collection technology). Currently technology constraints may limit the accuracy of locational data to 25-100 meters. However, the technology to produce highly accurate locational coordinates is improving rapidly. Techniques for map digitization, address matching, and global positioning are becoming more feasible every day. Therefore, the LATF recommendation is to have the best available technology applied to collection of locational data.

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[16] U.S. EPA, Office of Administration and Resources Management, Locational Data Policy Implementation Guidance - Guide To The Policy, March 1992.

Global Positioning System (GPS) technology has been determined to be an effective way of producing accurate locational data. When the constellation of satellites upon which this technology depends is fully deployed in 1992, means for collecting accurate locational data will be available. At that time, accuracies of 10 meters or better will be achievable with a high degree of confidence and precision. Note that accuracy is not the same as precision. Precision is a quantification of the range of variation normally present in a measurement technique (i.e., precision describes the likelihood of the same values being repeated in another measurement).

To be fully descriptive, coordinate pairs require two accuracy measurements; one for latitude and one for longitude. Due to the additional burden on data storage, however, the EPA requires in the Locational Data Policy (LDP)[17] that only the lowest accuracy measurement be recorded, regardless of whether it is for longitude or for latitude. With such an arrangement, the user community will know that both coordinates are *at least* as accurate as the reported value.

Accuracy is to be presented as a range within which there is confidence that the true latitude/longitude value falls. The format for presentation of accuracy is: **±X units** where units are degrees, minutes, seconds, or decimal fractions of a second. Accuracy should be presented to one decimal place smaller than the units in which the latitude/longitude coordinates are reported. Therefore, if coordinates are presented in whole-tenths-of-seconds, it is because they have been “rounded up” from some value in hundredths-of-seconds, and the accuracy is described as the range, in hundredths of seconds. In general, to meet the 25 meter goal, accuracy should be determined within fractions of a second.

[17] U .S. EPA Office of Information Resources Management, Information Resources Management Policy Manual - Locational Data Policy, April 8, 1991.

EXAMPLES: The following examples suggest ways of expressing this data element.

+ 432430.3
± 0.05

Represents a latitude value of + 43°24'30.3" (+432430.3) which is the least accurate of the latitude/longitude coordinates, for this example. This value has an accuracy range of ± five one-hundredths of a second (± 0.05) assuming that the latitude /longitude coordinates have been reported to the tenths of seconds.

-1295720.8
± .03

Represents a longitude value of -129°57'20.8" (-1295720.8) which is the least accurate of the latitude/longitude coordinates, for this example. This value has an accuracy range of ± three one-hundredths of a second (± 0.03) assuming that the latitude/longitude coordinates have been reported to the tenths of seconds.

7. ALTITUDE

DEFINITION: The vertical distance from the National Reference Datum for Altitude to the land surface or other **measuring point** in feet or meters. If the measuring point is above the National Reference Datum for Altitude a “+” (plus) sign shall precede the reported altitude value. If the measuring point is below the National Reference Datum for Altitude a “-” (minus) sign shall precede the reported altitude value.

DISCUSSION: The purpose of this element is to provide a vertical reference for use in well construction and monitoring activities at wells, springs, or other ground water locations (for an illustration of Altitude, see Figure 2). Altitude is commonly referred to as elevation.

Measuring Point: the measuring point is the point at the well which is used as a reference for making vertical measurements. The following list presents the measuring points most commonly used by agencies and suggested associated codes:

A = airline
C = top of well casing
K = Kelly Bushing
L = land or ground surface
U = underground surface (e.g., caves)

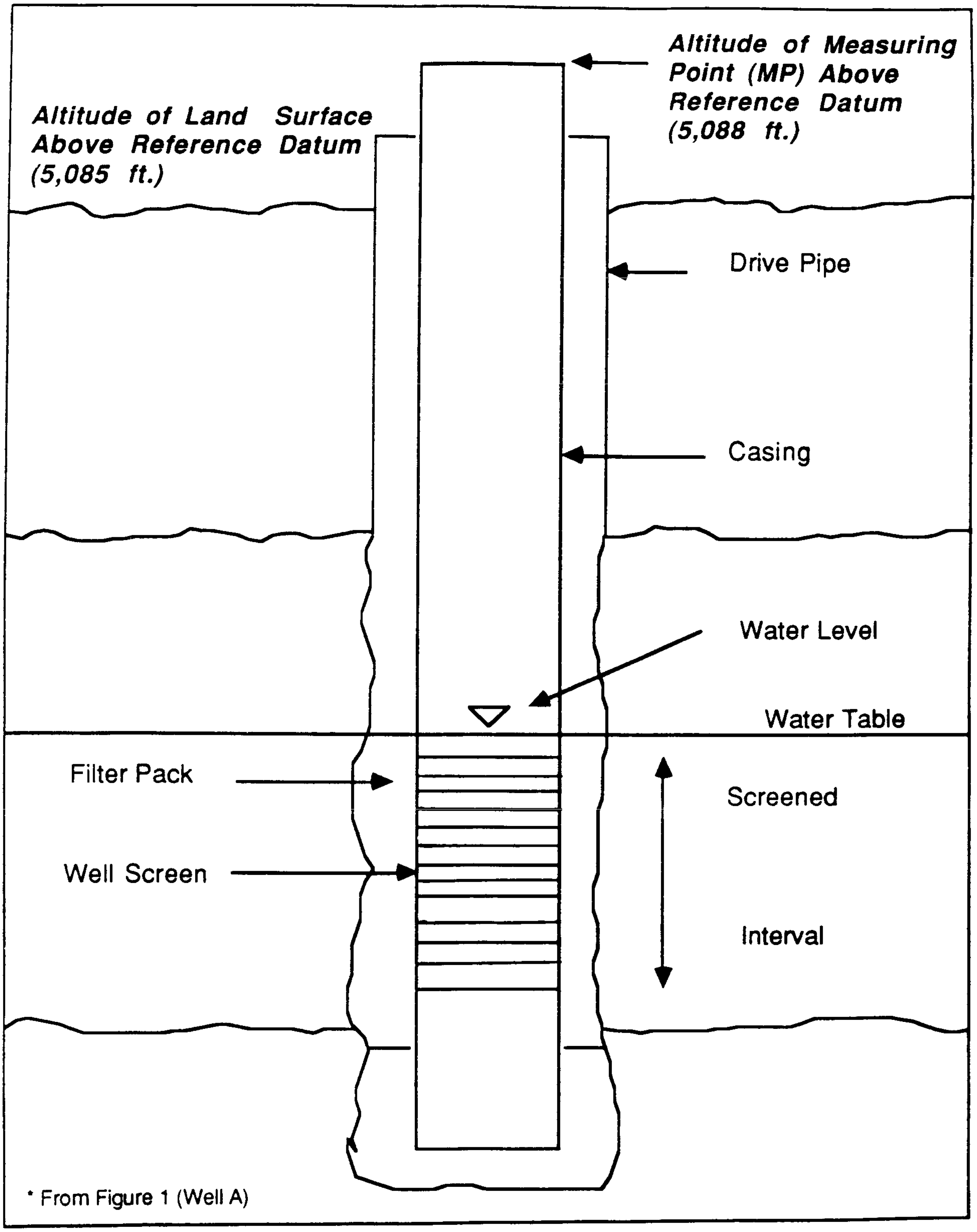
The following examples suggest ways to express a data convention for this element. Meters is the preferred unit of measurement within EPA systems.

EXAMPLES: **L**
+00100
M
represents the measuring point is the land or ground surface (L); and the altitude of the measuring point, as well as the altitude of the land surface, is 100 (+00100) meters (M) above the National Reference Datum for Altitude.

C/-5.25F
represents the measuring point is the top of the well casing (C); and the altitude of the measuring point is 5.25 (-5.25) feet (F) below the National Reference Datum for Altitude.

Figure 2

Diagram to Illustrate Altitude



Cross Section of a Screened Water Well Located Above Sea Level

8. METHOD USED TO DETERMINE ALTITUDE

DEFINITION: The method used to determine the altitude value **(Altitude Method),** the National Reference Datum on which the altitude measurement is based **(National Reference Datum for Altitude)** and the date the measurement was taken **(Altitude Date).**

DISCUSSION: The purpose of this element is to provide users with qualitative information to assess the accuracy of the altitude value. The definition consists of the following three components: (1) Altitude Method, (2) National Reference Datum for Altitude and (3) Altitude Date. Each of these components is discussed below.

(1) Altitude Method: the Altitude Method is the method the data provider used to determine the altitude value. A description of the method used provides some indication of the accuracy of the altitude value. For example, data users may choose to place more confidence in an altitude determined from using an absolute-mode global positioning system rather than in an altitude manually interpolated from a map or photo. In addition, data users may want to check an altitude interpolated from a map or photo since a chance for gross error exists if the data provider did not make a correct interpolation. Data providers or managers also may want to add codes to this element that provide a more explicit determination of the accuracy of the altitude value (e.g., ± 0.5 meters or ± 50 feet).

The following presents descriptions of Altitude Methods and suggested codes:

Altitude Method Codes:

A = surveyed using differential-mode global positioning system. This mode uses two receivers in which one receiver is set at a known point. Data are processed relative to a known point over time. If proper modeling is used, global positioning system heights can generally be determined to a precision of approximately 0.1 meters.

B = surveyed using absolute-mode global positioning system. This mode uses a single receiver and determines a location with respect to several satellites, not from a known point. This mode is less accurate than the differential-mode.

C = surveyed from a benchmark using conventional survey methods. A benchmark has a known altitude based on a National Reference Datum. Examples of benchmarks include a disc in the ground, a chiseled square in a headwall, a nail in a post, etc.

D = digitally interpolated from a map or photo.

E = manually interpolated from a map or photo.

(2) National Reference Datum for Altitude the National Reference Datum for Altitude is a national standard for vertical control established by the National Geodetic Survey. The two National Reference Data for Altitude are the National Geodetic Vertical Datum of 1929 (NGVD 29) and the North American Vertical Datum of 1988 (NAVD 88). The name "NGVD 29" is a synonym for the "Sea Level Datum of 1929 and was adopted by the National Geodetic Survey in May 1976. The actual datum, however, remained the same. Although based on the observed heights of sea level at a number of tide gauges, the datum is not mean sea level. The National Geodetic Survey is in the process of completing the newer NAVD 88. Data providers need to use an appropriate code for specifying the National Reference Datum that they used as the benchmark for the altitude determination. If the National Reference Datum for Altitude is not available, data providers should specify that this information is not available.

The following are suggested codes for the National Reference Datum for Altitude:

National Reference Datum for Altitude Codes:

29 = National Geodetic Vertical Datum of 1929
88 = North American Vertical Datum of 1988
00 = National Reference Datum for Altitude is not available

(3) Altitude Date the Altitude Date is the date on which the data provider determines the altitude. This date is important because it can provide additional information on the accuracy of the altitude value. Due to technological advances in determining altitude, data users also may use the Altitude Date to identify altitude values they would like to update, especially if they need precise locational information.

Altitude Date format is based on Federal Information Processing Standard (FIPS) Publication **4-1**[18]**,** which sets the standard for date representation for all Agencies of the Federal government as yyyymmdd, where y = year, m = month, and d = day. The following examples suggest various ways for expressing a data convention for this element.

EXAMPLES: B
88
19811204
represents the Altitude Method is surveyed using absolute-mode global positioning system (B); the National Reference Datum for Altitude is the North American Vertical Datum of 1988 (88); and the Altitude Date is December 4, 1981 (19811204).

D
29
1986
represents the Altitude Method is digitally interpolated from a map or photo (D); the National Reference Datum for Altitude is the National Geodetic Vertical Datum of 1929 (29); and the Altitude Date is the year 1986 (1986).

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[18] U S Department of Commerce, National Bureau of Standards, Representation for Calendar Date and Ordinal Date for Information Interchange, Federal Information Processing Standards (FIPS) Publication 4-1, January 27, 1988.

GEOGRAPHIC DESCRIPTOR

9. STATE FIPS CODE

DEFINITION: A Federal Information Processing Standard (FIPS) alphabetic or numeric code to indicate the location of the state (or its equivalent such as territory or province) in which the well is located.

DISCUSSION: The purpose of this element is to identify the state, territory, foreign country, dependency or special sovereignty in which a well is located. This code is especially important to identify data by state when those data are contained in a multi-state data base.

State FIPS Codes are an accepted national convention for identifying states or their equivalents. FIPS Codes for states and outlying areas of the U.S. are expressed as two-digit numeric or alpha codes. Given the wide use of State FIPS Codes, data providers are required to use this data standard to specify the state (or its equivalent) in which a well is situated.

A complete list of State FIPS Codes can be found in the following publication:

U.S. Department of Commerce, Codes for the Identification of the State. the District of Columbia and the Outlying Areas of the United States. and Associated Areas, Federal Information Processing Standards (FIPS) Publication 5-2, National Bureau of Standards, Washington, D. C., May 28, 1987.

The following are examples of the data convention for State FIPS Codes. The most common preference is the alphabetic code.

EXAMPLES: MI
represents the alphabetic State FIPS Code for the State of Michigan.

26
represents the numeric State FIPS Code for the State of Michigan.

OK
represents the alphabetic State FIPS Code for the State of Oklahoma.

40
represents the numeric State FIPS Code for the State of Oklahoma.

AS
represents the alphabetic State FIPS Code for the U.S. sovereignty of American Samoa.

60
represents the numeric State FIPS Code for the U.S. sovereignty of American Samoa.

GEOGRAPHIC DESCRIPTOR

10. COUNTY FIPS CODE

DEFINITION: A Federal Information Processing Standard (FIPS) numeric code to indicate the location of the county (or county equivalent) in which a well is located.

DISCUSSION: This information will allow data users to easily organize and present ground water quality and other data at the county level. It is particularly important for counties with the same names located in different States.

County FIPS Codes are an accepted national standard for identifying counties or their equivalents. County FIPS Codes are expressed as three-digit numeric codes and are available for all counties, or their equivalents, of the 50 states, the District of Columbia, and U.S. possessions. Given the wide use of County FIPS Codes, data providers are required to use this data standard to specify the county or its equivalent in which a well is located.

A complete list of County FIPS Codes can be found in the following publication:

U.S. Department of Commerce, Counties and Equivalent Entities of the United States, its Possessions, and Associated Areas, Federal Information Processing Standards (FIPS) Publication 6-4, National Institute of Standards and Technology, Washington, D. C., August 31, 1990.

The following are examples of the data convention for County FIPS Code.

EXAMPLES: **085**
represents Sioux County in the State of North Dakota.

137
represents Putnam County in the State of Ohio.

073
represents Kingfisher County in the State of Oklahoma.

WELL DESCRIPTORS

WELL DESCRIPTOR

11. WELL IDENTIFIER

DEFINITION: A unique well identifier assigned by the responsible organization.

DISCUSSION: The purpose of this element is to (1) provide a means of uniquely identifying each well (or spring or other ground water location) and (2) provide a means of linking all data associated with each well. If there are multiple wells (casings) in a single borehole (frequently used for monitoring ground water at different depths), then each well (casing) should have its own Well Identifier. Also, if there are multiple completions of a single well, then data base managers may choose to assign a unique Well Identifier to each well completion.

A variety of conventions exist for uniquely identifying wells. In fact, most states have developed their own well identification systems. As such, data providers may report Well Identifiers using these existing systems or in any format that they feel is most appropriate for their circumstances. The only requirements are that the Well Identifier must (1) be associated with a particular known well; (2) be unique; and (3) follow and incorporate EPA's Facility Identification Data Standard if the well is part of a facility regulated by **EPA**[19]. In addition, each individual well at an EPA site should have a unique identifier (e.g., well 01, well 02, well 03, etc.). The code for the EPA Facility Identification Data Standard is 12 digits in length, beginning with the two digit alphanumeric State FIPS code and followed by a ten digit arbitrary number that is assigned by EPA's Facilities Index System (FINDS).

A variety of well identification systems exist. For purposes of elaborating on this element, the examples below suggest several ways of expressing a data convention for this element. The use of latitude and longitude in well identification systems results from the convention used by the U.S. Geological Survey. However, the use of latitude and longitude in the Well Identifier in no way suggests that data users should use the Well Identifier for purposes of well location information.

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[19] U.S. EPA, EPA Order - Facility Identification Data Standard, Information, Management and Services Division, April 9, 1990.

Use of the Well Identifier for purposes of well location information must be avoided as the original latitude and longitude coordinates may be revised over time using more precise locational methods while the Well Identifier may not change. The use of latitude and longitude is just one means of developing a unique number for the Well Identifier and data users should not interpret any other information from it.

The following examples show various ways to express a data convention for this data element.

EXAMPLES: ALD980600001

represents a Well Identifier based on EPA's Facilities Index System (FINDS) for a facility located in Alabama. The identifier consists of the State FIPS code for the facility (AL) and a ten-digit number randomly generated by FINDS (D980600001) representing well #1 at the facility.

+300510
-0750407
03

represents a Well Identifier based on an estimate of the well's location at a latitude of 30°05'10" (+300510) and a longitude of -075°04'07" (-0750407) and is the third well that is present at the same latitude/longitude location (03).

llS/17E
22dca17

represents a Well Identifier located in township 11 south (11S), range 17 east (17E), section 22 (22), quarter section d (d), quarter-quarter section c (c), quarter-quarter-quarter section a (a), and the 17th sequentially numbered well within quarter-quarter section c (17).

014-1035-55432SD890EC33Y6

represents a Well Identifier based on the three-digit County FIPS code (014), a four-digit submitting agency code (1035), and a 16-digit alphanumeric well code (55432SD890EC33Y6).

62-000498

represents a Well Identifier based on a state formulated two-digit county code (62), and the 498th sequentially numbered well in that county (000498).

WELL DESCRIPTOR

12. WELL USE

DEFINITION: The principal current use of the well, or if the well is not currently in use, then the original or principal purpose for its construction.

DISCUSSION: The purpose of this element is to assist data users in distinguishing between the various uses of wells. Knowing the use of a well is particularly important when data users interpret ground water quality data. For example, a data user may be very concerned if a sample taken from a public water supply well violates maximum contaminant levels (MCLs) for certain constituents. Alternatively, if the same sample was taken from a remedial action monitoring well at a Superfund site rather than a public water supply well, the data user may not be as immediately concerned.

Wells have many different uses that will vary depending on several factors such as geographic location and the structure of the regional economy. For example, agricultural states may have a need to include a number of specific well uses in their data base (e.g., irrigation wells, livestock wells, irrigation return flow wells, agricultural drainage wells) that a regional authority whose jurisdiction is dominated by heavy industry would probably not include in their data base. Because of the varying needs of different data bases, no one list of well uses is likely to be sufficient. Therefore, provided below are a few lists of well uses for consideration. The lists vary by the type and level of detail of the well uses. These lists are provided merely to suggest possible examples of well use lists. Data providers or data users should modify these lists to meet their needs.

List 1 contains very broad categories of well uses with a description of more specific uses associated with that category.

List 1

Withdrawal of Water includes public water supply wells, community water supply wells, industrial water supply wells, irrigation wells, etc.

List 1 (continued)

Monitoring	includes RCRA monitoring wells, Superfund monitoring wells, observation wells, piezometer wells, test wells, etc.
Disposal	includes deep injection wells and shallow injection wells.
Unknown	the well use is unknown.

List 2 presents more specific well uses that includes wells that are primarily in a region dominated by agricultural communities and open range land.

List 2

Public Water Supply Wells
Community Water Supply Wells
Non-community Water Supply Wells
Irrigation Wells
Livestock Watering Wells
Irrigation Return Flow Wells (Class V Injection Wells)
Agricultural Drainage Wells (Class V Injection Wells)
Other Class V Injection Wells
Class II Injection Wells (Salt water disposal wells, enhanced oil recovery wells, and hydrocarbon storage wells)[20]
Class III Injection Wells (Salt and sulfur extraction wells and in situ leaching wells)[20]
Class IV Injection Wells (Hazardous and radioactive wastewater disposal wells located in or above underground sources of drinking water (USDWs))[20]
Geophysical Wells
Geothermal Wells
Oil and Gas Wells
Unknown

[20] For more information on describing injection wells and their classifications, see: U.S. Environmental Protection Agency and the Underground Injection Practices Council, Injection Wells - An Introduction to Their Use. Operation and Regulation, (undated).

List 3 presents a broader list of well uses that may be necessary for large data bases such as State data bases.

List 3

Public Water Supply Wells
Community Supply Wells
Non-community Supply Wells
Industrial Supply Wells
Recharge Wells
Irrigation Wells
RCRA Monitoring Wells
Superfund Monitoring Wells
Recovery Wells
Remediation Wells
Piezometer Wells
Class I Injection Wells (Hazardous, nonhazardous and municipal wastewater disposal wells located below USDWs)[21]
Class II Injection Wells (Salt water disposal wells, enhanced oil recovery wells and hydrocarbon storage wells)[21]
Class III Injection Wells (Salt and sulfur extraction wells and in situ leaching wells)[21]
Class IV Injection Wells (Hazardous and radioactive wastewater disposal wells located in or above underground sources of drinking water (USDWs))[21]
Class V Injection Wells (Injection wells not covered under the first four classes of injection wells)[21]
Geophysical Wells
Geothermal Wells
Oil and Gas Wells
Unknown

21 For more information on describing injection wells and their classifications, see: U.S. Environmental Protection Agency and the Underground Injection Practices Council, Injection Wells -An Introduction to Their Use, Operation and Regulation, (undated).

The naming convention for each well type shall be the choice of the data providers. The following examples suggest a few means of expressing a data convention for this element.

EXAMPLES: **A**
represents a Public Water Supply Well.

01
represents a Public Water Supply Well.

PWS
represents a Public Water Supply Well.

WELL DESCRIPTOR

13. TYPE OF LOG

DEFINITION: The type of record-keeping log(s) available for a well.

DISCUSSION: The purpose of this element is to provide data users with information on the types of logs that are available for a given well. Data users can use this information for a number of purposes. For example, knowing the types of logs available will help users decide whether examining the logs is worthwhile to them.

There may be a number of different logs that have been completed for a given well. For example, some well logs such as electrical logs and radioactive logs are often completed together at the same well. As a result, this element will be a repeating field.

Below is a list of common ground water well logs and one means of defining codes for each log type. The list includes general families of well logs (e.g., radioactive logs) as well as more specific log types (e.g., video logs). This list is provided to present examples of different types of record-keeping logs. Data managers or data providers may modify this list as they wish and present it as a look-up table. For example, data managers may want to provide more specific types of radioactive logs such as gamma-gamma logs and gamma-ray logs. The only requirements are that data managers provide a means for indicating, in a logical manner, the types of logs available for ground water wells, and that they reference these logs in a consistent way. Examples of different types of logs include the following:

A = Acoustic - a graphical representation of the transit of an acoustical pulse through a length of material.

C = Caliper - a graphical record of the diameter of an uncased borehole at various depths.

D = Driller's - a description of the material penetrated during drilling, prepared by the drilling crew.

E = Electrical - a graphical representation of the resistivity to the flow of electric current or electrical potentials (voltages) through subsurface geologic formations.

G = Geologist's/Engineer's - a record prepared by a geologist or engineer that presents a description of the lithology of each formation penetrated by the well (e.g., sand, shale).

R = Radioactive - a graphical representation of the natural, induced, or isotope injection radioactivity of subsurface geologic formations.

T = Temperature - a continuous record of temperature in the borehole taken at various depths.

U = Unknown.

V = Video - a video tape record of the features of a well created by lowering a video camera into the well.

The following examples suggest two means of expressing a data convention for this element.

EXAMPLES: A
represents an acoustic log.

G
represents a geologist's log.

14. DEPTH OF WELL AT COMPLETION

DEFINITION: The depth of the completed well below the land surface or other measuring point, in feet or meters.

DISCUSSION: The purpose of this element is to provide well construction data that are useful in interpreting water quality data. The depth of the well at completion may indicate whether the well fully penetrates the aquifer. The measuring point used as a reference point to determine the depth of the well at completion is specified under the Altitude data element. If the measuring point is not level (e.g., the plastic well casing was cut unevenly), the measurement is usually taken from the lowest point on the measuring point. Because there are different margins of error associated with the various devices used to measure the depth of a well, data base managers may consider requesting that data providers indicate the measurement devices used. Note that this element is not referring necessarily to the depth of the original wellbore. In addition, note that this element is not applicable to springs. (For illustrations of Depth of Well at Completion, see Figures 3 and 4.)

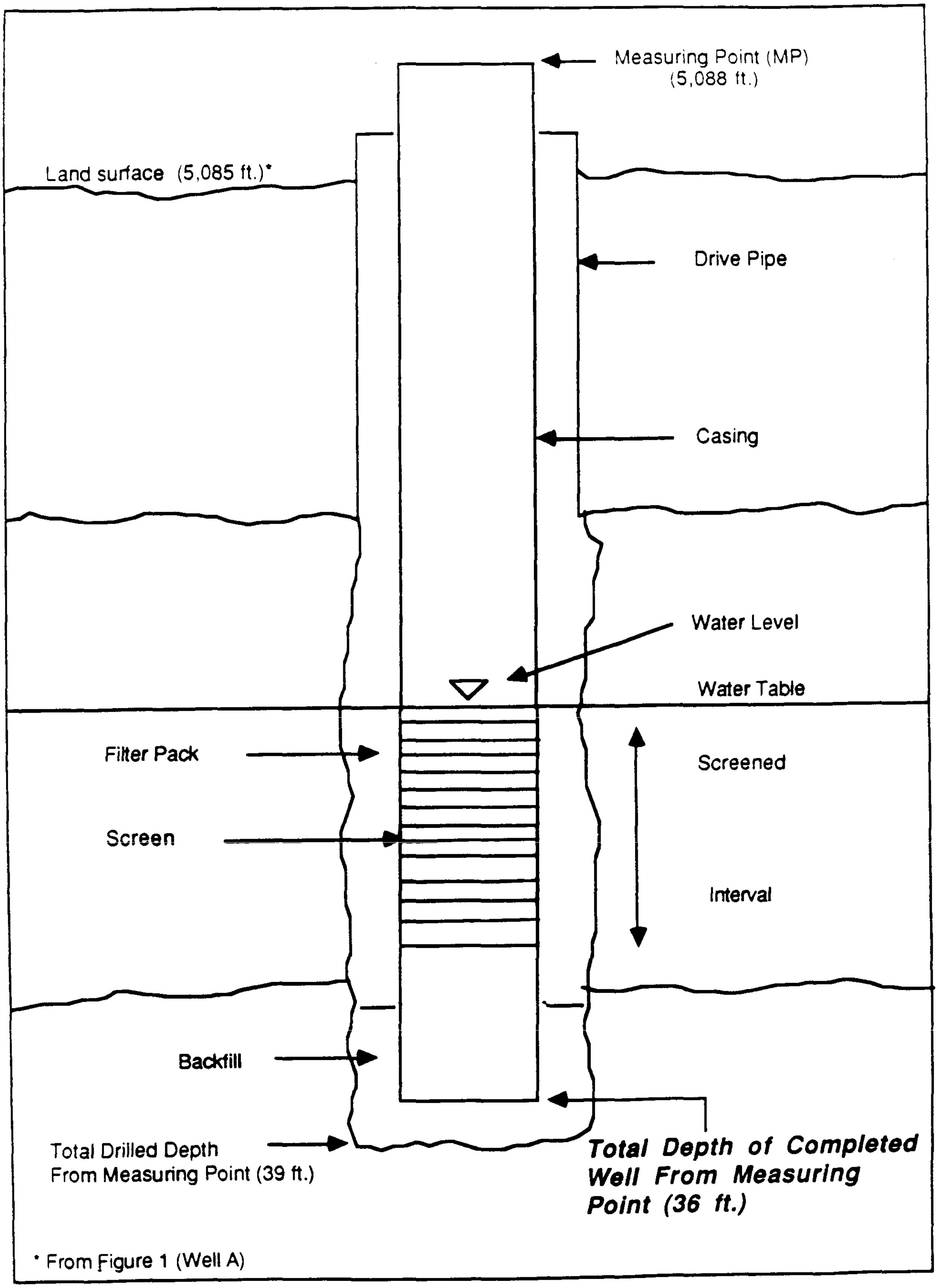
The following examples suggest ways of expressing a data convention for this element. Meters is the preferred unit of measurement within EPA systems.

EXAMPLES: **050**
M
represents the well is completed to a depth of 50 (050) meters (M) below the measuring point (defined under the Altitude element).

100
F
represents the well is completed to a depth of 100 (100) feet (F) below the measuring point (defined under the Altitude element).

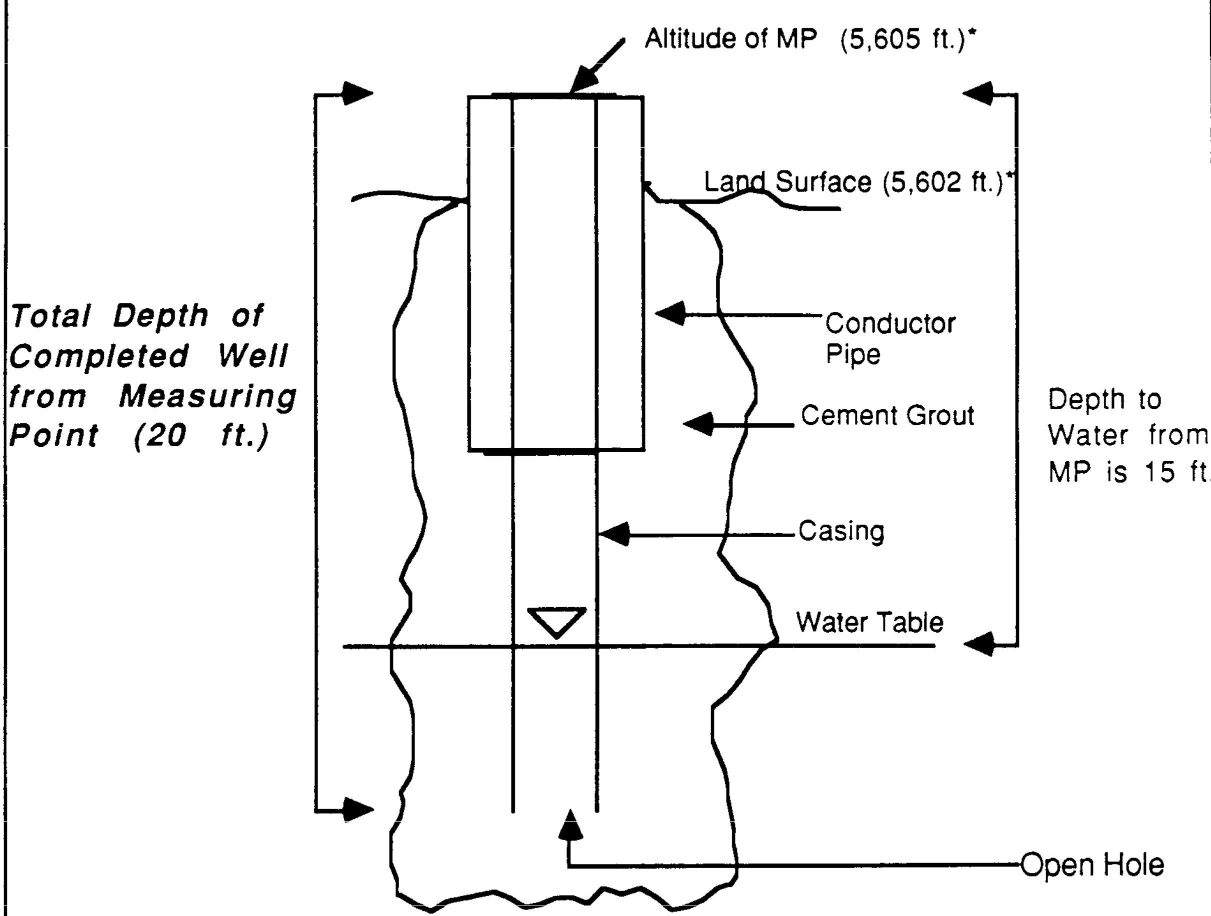
Figure 3

Diagram to Illustrate Depth of Well at Completion



Cross Section of a screened Water Well

Figure 4
Diagram to Illustrate Depth of Well at Completion



Explanation:
Depth to water table from land surface is 12 ft.
Depth to water table from measuring point is 15 ft.
Drilled depth is 20 ft.

*From Figure 1 (Well B)

Cross Section of an Open Hole Water Well

WELL DESCRIPTOR

15. SCREENED/OPEN INTERVAL

DEFINITION: The depth below the measuring point to the top and bottom of the open section in a well reported as an interval in feet or meters. The open section may be a well screen, perforated casing or open hole.

DISCUSSION: The purpose of this element is to report the depth of the hydrogeologic interval from which ground water is drawn. Recording this interval is also important in the event that the screened or perforated casing requires maintenance. The first value in this interval is the depth below the measuring point to the top of the open section. The measuring point is recorded under the Altitude data element. The second value in this interval is the depth below the measuring point to the bottom of the open section. The open section may be a well screen, open hole, or perforated casing. (For an illustration of Screened/Open Interval, see Figure 5.). Finally, since some wellbores may have multiple completions, and each well completion may have multiple screened, perforated, or open sections, this data element may be a repeating field. Note that this element is not applicable to springs.

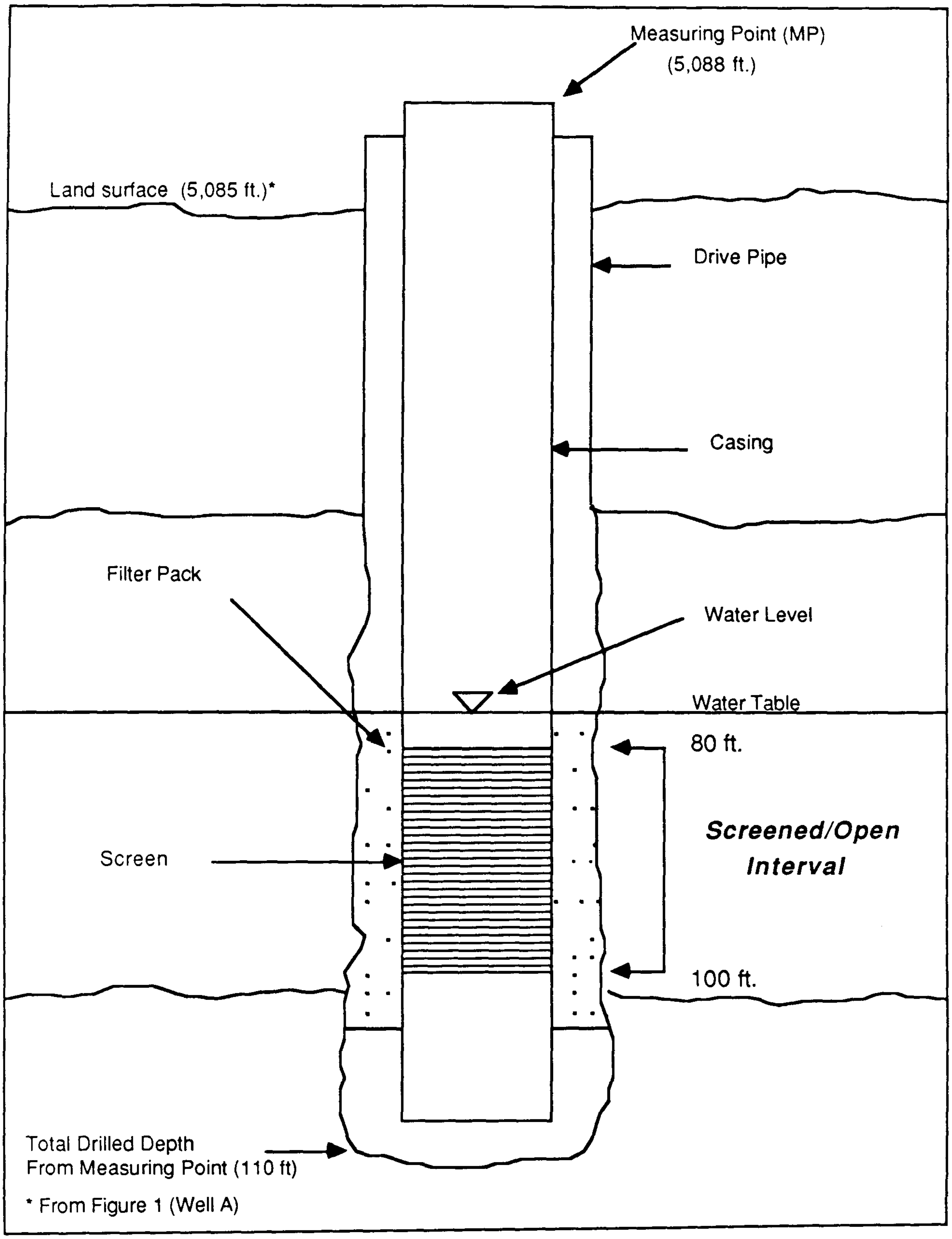
The following examples suggest two means of expressing a data convention for this element. Meters are the preferred unit of measurement within EPA systems.

EXAMPLES: **22.0**
25.5
M
represents a screened/open interval whereby the depth from the measuring point (defined under the Altitude element) to the top of the open section is 22 (22.0) meters (M) and the depth from the measuring point to the bottom of the open section is 25.5 (25.5) meters.

00075.5
00079
F
represents a screened/perforated interval whereby the depth from the measuring point (defined under the Altitude element) to the top of the open section is 75.5 (00075.5) feet (F) and the depth from the measuring point to the bottom of the open section is 79 (00079) feet.

Figure 5

Diagram to Illustrate Screened/Open Interval



Cross Section of a Screened Water Well

SAMPLE DESCRIPTORS

16. SAMPLE IDENTIFIER

DEFINITION: A unique number for each water quality sample collected at a well **(Sample Control Number)** which references the date **(Sample Date),** the depth at which each sample is taken reported in feet or meters **(Sample Depth)** and the time the sample is taken **(Sample Time).**

DISCUSSION: The purpose of this element is to provide critical supporting documentation for each water quality sample. The supporting documentation for the water quality samples include the following four components: (1) Sample Control Number, (2) Sample Date, (3) Sample Depth and (4) Sample Time. Each of these components is discussed below.

(1) Sample Control Number: the Sample Control Number is a unique number or series of codes that the data provider must assign to each sample collected at a well. The purpose of this Control Number is to provide a means of identifying the sample and linking it to corresponding water quality data for a particular well. Provisions may need to be made to account for the possibility that laboratories may split one sample into a number of different samples. If a sample is split, the newly created samples must be assigned unique Sample Control Numbers.

(2) Sample Date: the data provider also must record the date that water quality samples are taken. The Sample Date is necessary for tracking trends in ground water quality over time. The format for Sample Date is based on the Federal Information Processing Standard (FIPS) for date (i.e., yyyymmdd)[22].

(3) Sample Depth: The Sample Depth indicates the depth in the aquifer or aquifers (in case of multiple saturated zones) with respect to the measuring point (recorded under the Altitude data element) from which the water quality sample was taken and the units of measure used to report this measurement. Sample depth information can be referenced to hydrogeologic information which can help data users analyze water quality. Meters is the preferred unit of measure within EPA systems.

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[22] U S Department of Commerce, National Bureau of Standards, Representation for Calendar Date and Ordinal Date for Information Interchange, Federal Information Processing Standards (FIPS) Publication 4-1, January 27, 1988.

(4) Sample Time: The data provider must record the time each water quality sample is taken. The time must indicate a.m. or p.m. (either explicitly or through the use of the 24-hour clock) and the time zone. The time a sample was taken is an important piece of information. For example, two samples taken at the same well, at the same depth, on the same day but at different times may show a difference in the water quality analysis results. Data providers will need to consider normalizing the recorded time to account for differences between standard time and day-light savings time.

The following examples suggest a few means of expressing a data convention for this element. Each component of the Sample Identifier has its own "field" and as such data base managers may decompose the components to make any necessary corrections to their database, if needed.

EXAMPLES: 00101
19820430
026.5
M
1635
EDT
represents the unique Sample Control Number (00101), the Sample Date is April 30, 1982 (19820430), the Sample Depth is 26.5 (026.5) meters (M) and the Sample Time is 1635 (1635) eastern daylight time (EDT).

100262
19821204
1635EST
65F
represents the unique Sample Control Number (100262), the Sample Date is December 4, 1982 (19821204), the Sample Time is 4:35 p.m., eastern standard time (1635EST) and the Sample Depth is 65 (65) feet (F).

100262A
19821204
1635EST
65F
represents the unique Sample Control Number (100262A) that is a split sample from the sample identified directly above. The Sample Date is December 4, 1982 (19821204), the Sample Time is 4:35 p.m., eastern standard time (1635EST) and the Sample Depth is 65 (65) feet (F).

SAMPLE DESCRIPTOR

17. DEPTH TO WATER

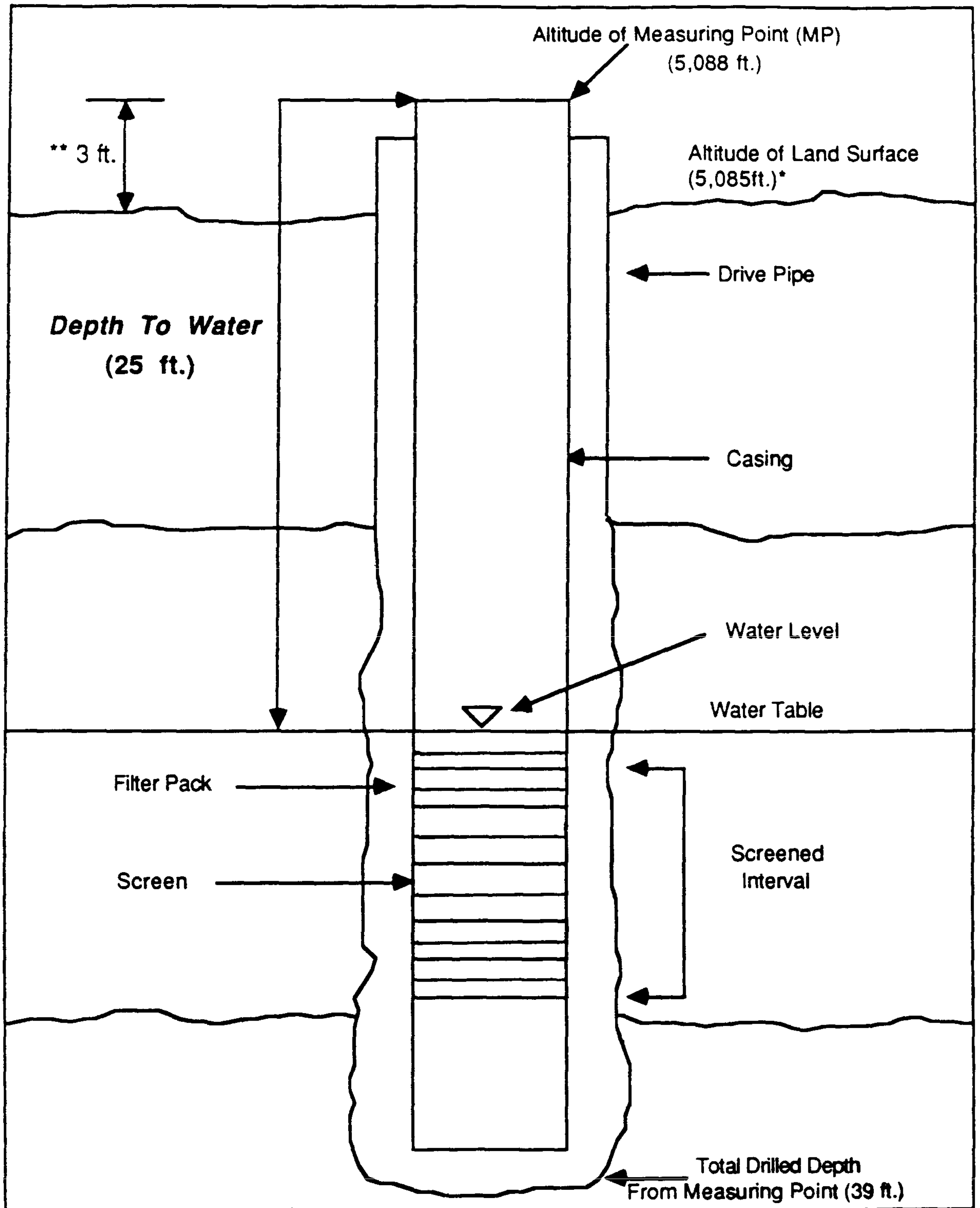
DEFINITION: The vertical distance between the measuring point and the water surface level at a well, corrected to land surface, where the measuring point is not the land surface. This distance should be reported in feet or meters **(Measurement Depth),** along with the date and time the measurement was taken **(Measurement Date** and **Measurement Time).**

DISCUSSION: The purpose of this element is to provide and track depth to water measurements that are necessary for the construction of potentiometric surface maps. The depth measurement must be corrected to the land surface when constructing the potentiometric maps. For an illustration of Depth to Water, see Figure 6. Since officials may take more than one depth to water measurement at a well, the field for this element will be a repeating field. Note that this element is not applicable to springs. The definition consists of the following three components: (1) Measurement Depth, (2) Measurement Date and (3) Measurement Time. Each component is described below.

(1) Measurement Depth: the Measurement Depth is typically the static water level obtained by measuring the distance between the measuring point to the water surface in a particular aquifer before the well is purged. This distance is corrected to the land surface. Static water level measurements, however, are not always possible especially at public water supply wells. The measuring point used as a reference point for this measurement is specified under the Altitude data element. If the measuring point is not level (e.g., the plastic well casing was cut unevenly), the measurement is usually taken from the lowest point on the measuring point. In most cases, the water surface will be below the measuring point, therefore, the depth to water measurement will be taken from below the measuring point. However, there are cases when the water surface will be above the measuring point (e.g., flowing artesian wells). To differentiate depth to water measurements in this case, the standard convention is to precede the depth to water value with a "**-**" (minus) sign if the water surface level is above the measuring point. Data providers will also need to specify the units of measure used to report the Measurement Depth value. EPA prefers the use of meters. Because there are different margins of error associated with various devices used to measure the depth to water, data base managers may consider requesting that data providers indicate the measurement devices used.

Figure 6

Diagram to Illustrate Depth to Water



Explanation: Depth to water table from land surface is 22 ft.
Depth to water table from measuring point is 25 ft.

*From Figure 1 (well A)
**Distance between measuring point and land surface is 3ft.

Cross Section of a screened Water Well

(2) Measurement Date: the Measurement Date is the date that the depth to water measurement was taken. This component is necessary since officials will take several depth to water measurements over time and will need to relate each measurement to when it was taken. The format for Measurement Date is based on the Federal Information Processing Standard (FIPS) for date (i.e., yyyymmdd)[23].

(3) Measurement Time: Officials may occasionally take more than one depth to water measurement in the same day. In this case, the time at which the measurements were taken must be recorded to differentiate the depth to water measurements. Data providers will need to consider normalizing the recorded time in their time zone to account for differences between standard time and day-light savings time. The time must indicate a.m. or p.m. (either explicitly or through the use of the 24-hour clock) and the time zone. Since officials may take more than one depth to water measurement at a well, the field for this element will be a repeating field.

The following examples suggest two means of expressing a data convention for this element. Meters is the preferred unit of measurement for EPA systems.

EXAMPLES: -000.25
M
19821204
04:35P
EDT

represents the Measurement Depth is 0.25 (-000.25) meters (M) above the measuring point, the Measurement Date is December 4, 1982 (19821204) and the Measurement Time is 4:35 (04:35) p.m. (P), eastern daylight time (EDT).

00125.F
19831230
1635
EST

represents the Measurement Depth is 125 (00125) feet (F) below the measuring point, the Measurement Date is December 30, 1983 (19831230) and the Measurement Time is 4:35 p.m. (1635), eastern standard time (EST).

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[23] U S Department of Commerce, National Bureau of Standards, Representation for Calendar Date and Ordinal Date for Information Interchange, Federal Information Processing Standards (FIPS) Publication 4-1. January 27, 1988.

SAMPLE DESCRIPTOR

18. CONSTITUENT OR PARAMETER MEASURED

DEFINITION: Measurement of a physical, chemical or biological component. The physical, chemical or biological components are referred to as constituents or parameters.

DISCUSSION: The purpose of this element is to provide a means of identifying the constituents or parameters that data providers measure in ground water samples. Constituent or parameter codes developed for U.S. EPA's data Storage and Retrieval system (STORET) are widely used by the U.S. EPA, U.S. Geological Survey, States and other agencies and organizations. However, States may have or prefer to use other constituent or parameter codes such as Chemical Abstract Service Registry Numbers (CAS Numbers). Data providers should use the constituent or parameter codes that they feel best meet their needs and note the source of the parameter codes. The following list presents suggested abbreviations for parameter code sources:

S = STORET parameter codes
C = CAS number
O = other

If data providers would like to use STORET Parameter Codes, a current online file of STORET codes can be obtained from the U.S. EPA Client Services Branch (1-800-424-9067 or 1-703-883-8861).

The following examples suggest two means of expressing a data convention for this element.

EXAMPLES: **39180**
S
represents the STORET parameter code (S) for trichloroethylene (whole water sample (39180).

79016
C
represents the CAS Number (C) for trichloroethylene (79016). Note: A CAS Number can have several STORET parameter codes.

SAMPLE DESCRIPTOR

19. CONCENTRATION/VALUE

DEFINITION: The analytical results value, the units of measure used **(Analytical Concentration/Value)** and the analytical method applied **(Analytical Method)** to samples collected.

DISCUSSION: The purpose of this element is to record the concentration or values of the parameters measured showing units of measurement and analytical methods used. The definition consists of the following two components: (1) Analytical Concentration/Value and (2) Analytical Method. Each component is described below.

(1) Analytical Concentration/Value: the Analytical Concentration/Value is the concentration or value of a particular ground water quality parameter obtained from laboratory and/or field analyses. Data providers may need to express Analytical Concentrations/Values in scientific notation. Data providers will need to specify the units of measure used to report the Analytical Concentration/Value. Since data providers are likely to have Analytical Concentrations/Values for multiple parameters, this element may be a repeating field.

(2) Analytical Method: the Analytical Method is the method of analysis applied to determine the Analytical Concentration/Value for a particular ground water quality parameter. Reference to the specific analytical method should include information on the minimum detection limit of that method and the units of measurement used. This element may be a repeating field. A comprehensive listing of analytical method codes and descriptions of the methods is available from the following publications:

U.S. EPA “Environmental Monitoring Methods Index (List of Lists - Catalog of Analytes and Methods),” Office of Water Regulations and Standards, September, 1990; and

U.S. EPA, “Test Methods for Evaluating Solid Waste,” Office of Solid Waste and Emergency Response, SW-846, November 1986.

The following examples suggest two means of expressing a data convention for this element.

EXAMPLES: 00002.07E-03
µg/l
8080

represents the Analytical Concentration/Value is 2.07 x 10^{-3} (00002.07E-03) measured in units of micrograms per liter (µg/l); the analytical method is EPA Analytical Method 8080 -- gas chromatographic analytical method for various organochlorine pesticides and PCB's (8080). This method specifies the minimum detection limit of the method and the units of measure for various types of organochlorine pesticides and PCB's (e.g., the minimum detection limit of this method for the pesticide Heptachlor is 0.003 µg/l).

00004 µg/l/8240

represents the Analytical Concentration/Value is 4 (00004) measured in units of micrograms per liter (µ g/l); the analytical method is EPA Analytical Method 8240 -- gas chromatography/mass spectrometry for volatile organic compounds (8240). This method specifies the minimum detection limit of the method and the unit of measure (e.g., the minimum detection limit of this method for 1,1,l-trichloroethane is 5 µ g/1).

20. ANALYTICAL RESULTS QUALIFIER

DEFINITION: Qualifying information that will assist in the interpretation of the concentration/value, such as whether the value is below the detectable limit or if the constituents (parameters) of interest are present but cannot be quantified.

DISCUSSION: The purpose of this element is to provide clarifying and/or supporting analytical results information. The analytical results qualifier, together with the analytical method recorded under the concentration/value element and the quality assurance information (see element 19--Quality Assurance Indicator) will help the data user to determine the reliability and usefulness of the analytical results data.

Different agencies and programs use various methods to present analytical results qualifiers. Some examples of analytical-results qualifiers are provided below:

ADL = Above Detection Limits
A suitable concentration exists for analysis and it is above the detection limit of the analytical method.

BDL = Below Detection Limits
The concentration of the constituent (parameter) in the sample did not exceed the lower detection limit in force at the time the analysis was performed. Concentration/Value, if present, is at best an approximate value.

BQL = Below Quantitation Limits
Concentration of the constituent or parameter was below the limit of analytical quantitation. Concentration/Value, if present, is at best an approximate value.

FPS = Failed Preliminary Screening
A preliminary screening of the sample for the subject parameter was conducted. The result of the screening indicated that determining the concentration of the parameter would not be useful.

NSA = Sample Not Suitable for Analysis
The sample was not suitable for analysis, i.e., there was not a sufficient quantity of the sample to conduct an analysis, there was an accident in the field or laboratory that rendered the sample unsuitable for analysis, or the sample was not preserved properly.

PNQ = Present But Not Quantified
The subject parameter was present in the sample but no quantifiable result could be determined.

If "above detection limit," "below detection limit" and "below quantitation limit" are included as analytical results qualifiers, then the data provider should also provide the values of those limits. Knowing the detection and quantitation limits is important for three reasons: (1) detection and quantitation limits can improve over time; (2) detection limits will vary depending on the analytical method used and the laboratory performing the analysis; and (3) knowing a concentration/value was below the detection and/or quantitation limit provides little information unless the actual limits are specified.

The following examples suggest three ways to express a data convention for this element.

EXAMPLES: BDL
1
μg/l
represents there was not a sufficient concentration of the constituent (parameter) in the sample to exceed the lower detection limit in force at the time the analysis was performed (1 microgram per liter (μg/1)). Concentration/Value, if present, is at best an approximate value.

ADL
represents there is a suitable concentration for analysis and it is above the detection limit of the analytical method.

BQL
2
μ g/l
represents the concentration of the parameter was below the limit of analytical quantitation (2 micrograms per liter (μg/l)). Concentration/Value, if present, is at best an approximate value.

SAMPLE DESCRIPTOR

21. QUALITY ASSURANCE INDICATOR

DEFINITION: The quality assurance of the field protocol plan and laboratory quality assurance/quality control (QA/QC) procedures.

DISCUSSION: The purpose of this element is to provide a means of reporting the level of reliability attached to the sample data. This element includes information on the degree of sophistication of both the field protocol plan and the laboratory QA/QC procedures in effect at the time of sampling. The following presents a suggested means of defining codes for the field protocol plan and laboratory QA/QC procedures:

Field Protocol Plan Codes:

A = Resource Conservation and Recovery Act (RCRA) Field QA/QC Program which includes (1) a reference to accepted sampling techniques, (2) procedures for documenting field actions contrary to the QA project plan, (3) documentation of pre-field activities (i.e., equipment calibrations and container preparation), field activities, and post-field activities (i.e., sample shipment and receipt, and team debriefing), (4) documentation of field measurement quality control data and (5) generation of quality control samples (i.e., trip and equipment blanks).

B = A detailed field sampling and preservation protocol plan that was developed by a certified laboratory or organization and approved by the responsible regulatory authority. Standard procedures and internal checks also exist.

C = A detailed field sampling and preservation protocol plan that contains standard procedures and internal checks but has not been approved by the responsible organization (State, EPA).

D = No detailed field sampling protocol plan exists.

U = Field sampling protocol information is unknown.

Laboratory QA/QC Procedures Codes:

1 = The laboratory is certified by a state for all parameters reported or has had a state or EPA approved QA/QC evaluation within the last two years with a satisfactory rating.

2 = Work conducted by an EPA Contract Laboratory Program lab.

3 = Laboratory has a detailed QA/QC plan with standard procedures and internal checks. Neither the state nor EPA has verified or evaluated the procedures, but the objectives of the plan have been reported as being met.

4 = Laboratory has a detailed QA/QC plan with standard procedures and internal checks, however, neither the state nor EPA has evaluated or verified the procedures.

5 = No detailed laboratory QA/QC plan exists.

6 = Laboratory QA/QC information is unknown.

The suggested codes for the field protocol plan and the laboratory QA/QC procedures provide a hierarchy of plans and procedures that range from the most to the least sophisticated. The RCRA field QA/QC program is at the top of the field protocol plan hierarchy since protocols used to enforce RCRA requirements are the most exacting. The following examples suggest ways of expressing a data convention for this element.

EXAMPLES: A
3
represents use of RCRA Field QA/QC Program guidelines (A) and use of a detailed laboratory QA/QC plan with standard procedures and internal checks, however, neither the State nor EPA has verified or evaluated the procedures, but the objectives of the plan have been reported as being met (3).

C5
represents use of a detailed field sampling and preservation protocol plan that contains standard procedures and internal checks but has not been approved by the responsible organization (C) and no detailed laboratory QA/QC Procedures exist (5).

APPENDICES

APPENDIX A

Key Issues Involved in the Implementation of the Minimum Set of Data Elements for Ground Water Quality

The Minimum Set of Data Elements for Ground Water Quality (MSDE) does not address issues related to actually designing or implementing a ground water quality data base. For example, the MSDE does not identify computer hardware specifications or logical design requirements. Instead the MSDE focuses on identifying and defining a list of data elements that, at a minimum, should be included in a ground water quality data base. EPA, however, has included this appendix that discusses key issues involved in the implementation of the MSDE.

This appendix identifies and describes a few fundamental data base design and implementation issues that some data base managers may find useful in developing or modifying a data base. Data base managers are likely to be well aware of these issues and may have already incorporated them into their data bases. By no means is this discussion of key implementation issues exhaustive. The purpose of this appendix is to identify and briefly discuss fundamental data base implementation issues that data base managers may want to consider. For more information, officials should contact the information systems specialists in their agency or department.

This appendix focuses on the following key MSDE implementation issues:

- Consistency in expressing data;
- Linking related data; and
- Storing data fields separately.

Consistency in Expressing Data

Designing data bases to consistently define parallel information contained in different elements is important. For example, several elements in the MSDE record depth information that require the unit of measurement to be identified (i.e., either feet or meters). Data bases should consistently use the same unit of measurement -- either feet or meters -- for all relevant data elements. EPA uses meters, which is becoming standard practice. If data are not expressed consistently, data base managers will need to develop conversion programs to make the data uniform. Such conversion programs can be complex and may fail to convert all data, resulting in errors.

Units of measure is just one example of the need to express data consistently. Other examples include the use of alphabetical and numerical representations for data and the number of spaces allowed after a decimal. Prescribing formats for each data element is not an objective of this document except where EPA policy or Federal standards specify formats (e.g., latitude and longitude). Therefore, it is the role of the data base developer and/or data base manager to consider ensuring, to the extent practicable, that data are expressed consistently.

Database developers and managers have an important incentive to ensure such consistency. Consistent data results in a data base that uses storage space efficiently and requires less maintenance. It should also lead to easier database enhancements that may be implemented in the future such as upgrading the complexity of the reports the data base is able to generate. These advantages ultimately save often scarce program dollars, making efforts to ensure data consistency a wise investment.

Linking Related Data

A critical factor in the design of any data base is deciding how to link data that are distinct but related. For one data record, each data element in the MSDE represents a distinct piece of information, but all are related by the fact that they represent attributes of the same well (e.g., the altitude, depth to water, and concentration/value of a constituent are all attributes of the same well). In order to save storage space and improve the efficiency of the data base, data base developers can group similar data elements into what are known as "entity" files. An entity can be defined as an object or event that is of concern to your data base. The following list identifies the three entities related to the MSDE:

(1) Wells and other ground water locations;
(2) Samples; and
(3) Analytical results.

Each data element in the MSDE can be grouped under one of these three entities and helps to define the attributes of that entity. For example, the general, geographic and well descriptors (elements 1 through 13) describe the attributes of a well (i.e., the well entity). Element 14 -- Sample Identifier -- and element 15 -- Depth to Water -- describe the attributes of a sample (i.e., the sample entity). And elements 16 through 19 describe the attributes of each sample analysis (i.e., the analytical results entity).

One entity relates to the next entity in what is referred to as a one-to-many relationship. That is, each well will have several samples that are taken from it, therefore there is a one-to-many relationship between wells and samples. Similarly, each sample will likely be analyzed for several constituents, therefore, there is a one-to-many relationship between samples and analytical results.

A less efficient way of linking all the data elements together is to repeat the well entity attributes and the sample entity attributes for each analytical result recorded. For example, if a well sample is analyzed for fifty separate constituents, then each of those fifty records would have to repeat all of the well entity and sample entity elements (i.e., elements 1 through 15). This method of linking data would result in a great deal of data repetition and, therefore, would not maximize the data storage capabilities of the data base.

In contrast, the most efficient way for database developers to link all the data elements together and avoid repeating data is to group the MSDE elements that define each entity into three separate entity files. Using the example from above, creating the three separate entity files will allow the storage of the fifty different analytical results without repeating the well and sample entity elements. Data from each entity file is linked to the corresponding data in other entity files by what is known as "primary keys." A primary key is a unique identifier created for each record in an entity file that is repeated for corresponding records in the other entity files thereby enabling the linking of these related data elements. To be more specific, primary keys allow information from each analytical result to be linked to its proper sample and each sample to be linked to its well to allow you to reconstruct all the data for a single well. The MSDE would need two primary keys to link the three entity files. Element 9 -- Well identifier -- can be used as the primary key to link the elements in the well entity file with the elements in the sample entity file. Element 14-- Sample Identifier, or more specifically, the Sample Control Number under this element -- can be used as the primary key to link the elements under the sample entity file with the elements under the analytical results entity file. See Figure 7 for an illustration of linking related data in this manner.

Storing Data Fields Separately

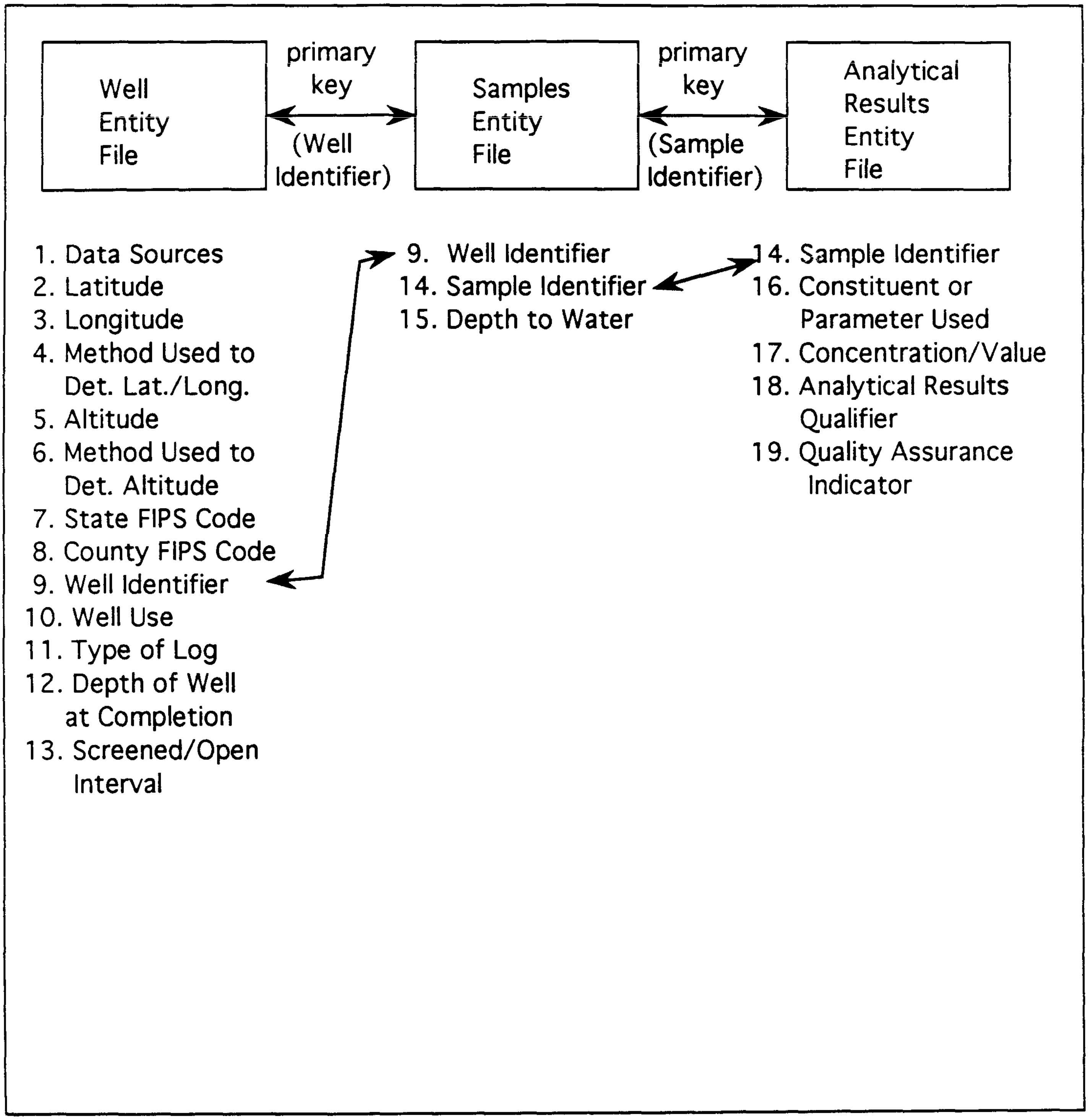
Data elements that contain two or more values representing distinct pieces of information can be stored separately in different fields to increase the flexibility of a data base. Separating data fields will make it easier for data base users to use the data and for data base managers to correct any data errors. These benefits are particularly apparent when a primary key contains data values in addition to a unique identifier. Because primary keys are critical to linking data, any error in a data value that is part of a primary key should be easy to correct.

An example of this issue is element 14 -- Sample Identifier. The Sample identifier is comprised of the date, time, and depth the sample was taken in addition to the unique sample control number. Storing sample date, sample time, sample depth, and sample control number separately makes it easy to correct errors and will result in minimal impact to tracking the sample and linking data. On the other hand, if sample date, time, depth, and control number were stored in one composite field, then a subsequent data correction would result in a new sample identification number that could lead to confusion in tracking the sample and linking its related data.

Another example of an MSDE data element that contains two values is element 13 -- Screened/Open interval. This data element consists of (1) depth below the measuring point to the top of the open section and (2) depth below the measuring point to the bottom of the open section. Data base managers may choose to store these values in separate fields as is suggested in the example for this element.

Figure 7.

Diagram to Illustrate Linking Related Data



Conclusion

The MSDE does not address issues involved in the implementation of the data set. Data base developers, however will need to consider many such issues including:

- Consistency in expressing data;
- Linking related data; and
- Storing data fields separately.

Considering these issues early in the planning process will help ensure that the data base stores data efficiently, data can be corrected easily, and the data base can accommodate future enhancements.

APPENDIX B

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These are the workgroup members involved with assisting in refining the element names and developing definitions for the data elements.

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