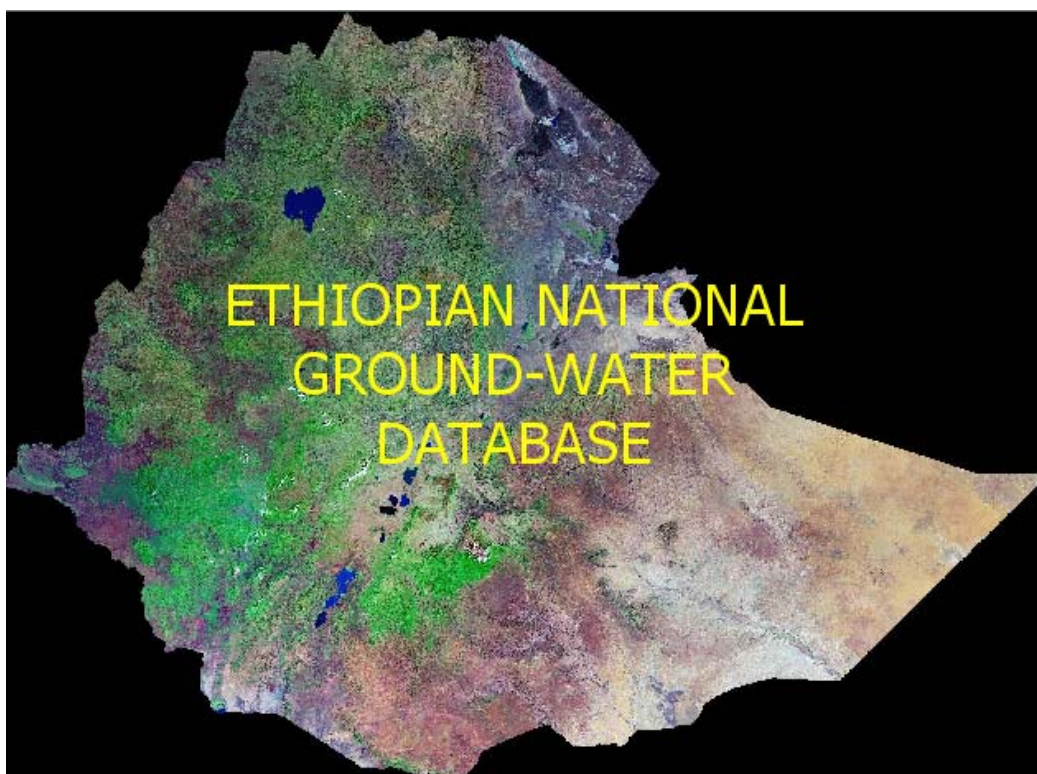




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DATABASE DICTIONARY FOR ETHIOPIAN NATIONAL GROUND-WATER DATABASE (ENGDA) DATA FIELDS

Open-File Report 2007–1099



**U.S. Department of the Interior
U.S. Geological Survey**

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By Eve L. Kuniansky, David W. Litke, and Patrick Tucci

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Reston, Virginia
2007

U.S. Department of the Interior
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U.S. Geological Survey
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Suggested citation:
Kuniansky, E.L., Litke, D.W., and Tucci, Patrick, 2007. Database dictionary for Ethiopian National Ground-
Water Database (ENGDA) data fields: <http://pubs.water.usgs.gov/ofr20071099>
U.S. Geological Survey Open-File Report 2007-1099, 131p. This publication is available from the internet
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Database Dictionary for Ethiopian National Ground-Water Database (ENGDA) Data Fields

By Eve L. Kuniansky, David W. Litke, and Patrick Tucci

INTRODUCTION

This document describes the data fields that are used for both field forms and the Ethiopian National Ground-water Database (ENGDA) tables associated with information stored about production wells, springs, test holes, test wells, and water level or water-quality observation wells. Several different words are used in this database dictionary and in the ENGDA database to describe a narrow shaft constructed in the ground. The most general term is **borehole**, which is applicable to any type of hole. A **well** is a borehole specifically constructed to extract water from the ground; however, for this data dictionary and for the ENGDA database, the words **well** and **borehole** are used interchangeably. A **production well** is defined as any well used for water supply and includes hand-dug wells, small-diameter bored wells equipped with hand pumps, or large-diameter bored wells equipped with large-capacity motorized pumps. **Test holes** are borings made to collect information about the subsurface with continuous core or non-continuous core and/or where geophysical logs are collected. Test holes are not converted into wells. A **test well** is a well constructed for hydraulic testing of an aquifer in order to plan a larger ground-water production system. A **water-level or water-quality observation well** is a well that is used to collect information about an aquifer and not used for water supply. A **spring** is any naturally flowing, local, ground-water discharge site.

The database dictionary is designed to help define all fields on both field data collection forms (provided in attachment 2 of this report) and for the ENGDA software screen entry forms (described in Litke, 2007). The data entered into each screen entry field are stored in relational database tables within the computer database. The organization of the database dictionary is designed based on field data collection and the field forms, because this is what the majority of people will use. After each field, however, the ENGDA database field name and relational database table is designated; along with the ENGDA screen entry form(s) and the ENGDA field form (attachment 2).

The database dictionary is separated into sections. The first section, *Basic Site Data Fields*, describes the basic site information that is similar for all of the different types of sites. The remaining sections may be applicable for only one type of site; for example, the *Well Drilling and Construction Data Fields* and *Lithologic Description Data Fields* are applicable to boreholes and not to springs. Attachment 1 contains a table for conversion from English to metric units. Attachment 2 contains selected field forms used in conjunction with ENGDA.

A separate document, "Users Reference Manual for the Ethiopian National Ground-Water Database (ENGDA)," by David W. Litke was developed as a users guide for the computer database and screen entry. This database dictionary serves as a reference for both the field forms and the computer database. Every effort has been made to have identical field names between the field forms and the screen entry forms in order to avoid confusion.

Acknowledgements

The data fields have been developed by members of the Ethiopian Ministry of Water Resources (MoWR), the Geological Survey of Ethiopia (GSE), the Addis Ababa Water and Sewer Authority (AAWSA), Addis Ababa University (AAU), and the U.S. Department of the Interior, Geological Survey (USGS). This database work group first began developing the database in October, 2000. The data fields were selected by using the best aspects of several existing ground-water databases used by members of the working group. The development of the field forms, documentation manuals, and the ENGDA database was supported by funding by the International Atomic Energy Agency (IAEA) and the USGS. The field forms have been tested by use in Ground-Water Field Methods classes taught at the MoWR/Japanese International Cooperative Association (JICA) ground-water training facility in Addis Ababa.

The databases most heavily borrowed from are the USGS Ground-Water Site Inventory database (Babcock and others, 2004; USGS, 1999, 2001), the Environmental Information System (USGS, 2003), and lithologic field definitions from a South African Database (Hodgson and others, 1993).

The database working group consisted of Eve L. Kuniansky, David W. Litke, and Patrick Tucci, USGS; Atakelte Teferie and Eyilachew Yitayew, MoWR; Yohannes Belete, Bisrat Lemma, and Shiferaw Ayele, GSE; Yirga Tadesse, AAWSA; and Dr. Tenalem Ayenew, AAU.

The Microsoft Access[®] database with Visual Basic forms developed for ENGDA was modified from the Environmental Information System (ENVIS) database developed for Cyprus by James A. Bisese and David W. Litke, USGS. The ENVIS database was funded by U.S. AID and the U.S. Department of State (U.S. Geological Survey, 2003).

The Ethiopian Science and Technology Agency (ESTA) helped coordinate the development of ENGDA, by coordinating with IAEA, MoWR, GSE, JICA, and AAU. During USGS missions to Ethiopia, Fanta Dismissie and Abebe Mekurio helped arrange transportation and coordination for the development of ENGDA. The authors wish to express gratitude for the assistance of Fanta Dismissie and to Ato Mulugeta Amha, the General Director of ESTA. The authors appreciate the support of Dr. Katema Tadesse, General Manager of GSE and Ato Mesfin Tegene, Vice Minister of MoWR and Ato Markos Tefera and Dr. Yuji Maruo, of the MoWR/JICA training facility.

Finally the authors would like to acknowledge the reviews of the manuscript by Linda Geiger and Keith McFadden of the USGS.

DATA ENTRY CONVENTIONS

This section describes standardized conventions for data entry into the ENGDA database.

Measurement Units

Units for measured quantities are in the metric system. Depths are recorded in meters, and generally are considered to have a maximum accuracy of 0.01 meters. Other units of length are recorded either in meters or centimeters. Volumes generally are recorded in liters, and pumping rates are recorded in m³/hr.

Dates and Times

Dates are recorded in the Julian calendar system. The format dd/mm/yyyy is the preferred format.

Times are recorded in the 24-hour format. When entering a combined date/time value, use a space between the date and the time and a colon between the hours and minutes:

Example: 22/06/1947 13:25

Dates and times may be entered very often in the ENGDA database for documenting when data were collected and measurements were made; however, the only situation where a date/time is required is for water level measurements. In some cases, only a partial date may be known. For example, it may be known that a water sample was collected in June 1965, but the day of the sampling may not be known. The ENDGA database requires that complete dates be entered (as dd/mm/yyyy), so that in this case, the user may decide not to enter a date, or may enter a surrogate date, using the following conventions:

- a) Date unknown; enter 1/1/9999 as a surrogate date
- b) Only the year is known; enter 15/6/yyyy where yyyy is the known year
- c) The year and month are known; enter 15/mm/yyyy where mm is the month and yyyy is the year
- d) The year, month, and day are known; enter dd/mm/yyyy where mm is the month, dd is the day, and yyyy is the year
- e) The year, month, day, and time are known; enter dd/mm/yyyy hh:mm where mm is the month, dd is the day, and yyyy is the year, hh is the hour, and mm is the minute

Surrogate dates are useful because known information is recorded, but they also are misleading because higher precision is implied. When using surrogate dates, use a comment field, if available, to indicate that the date is estimated.

Floating Point Numbers

For entering floating-point numbers, the English (American) system should be used. The English system is to use commas to separate groups of three digits and the dot is used to separate the whole number part from the fraction (1,124.46). The computer should be set for this style of data entry when entering data into the ENGDA database.

BASIC SITE DATA FIELDS

These data fields are necessary for describing borehole and spring site locations and basic attributes. Much of this information is recorded on the field forms named “Form for Record of Well Inventory” and “Form for Record of Spring Inventory” (Attachment 2) and is entered into ENGDA on the appropriate computer screen entry form, such as, Site Information Screen (“Borehole Site Information Screen” or Spring Site Information Screen”). Fields that must be entered into ENGDA are designated as “[REQUIRED]”. However, it is important to enter as much information as is known by the person locating the well or spring when completing the information on the field forms for Well Inventory or Spring Inventory (Attachment 2).

Well and spring inventories are conducted in order to gain an understanding of the groundwater resources in an area. The inventory consists of having trained people that go to a region to locate all of the wells and springs in the region and collect information about how each well is constructed, what type of pump is on the well, what the water level is in the well when the pump is turned off and any lithologic data that was collected during the drilling of the well. If available any pumping test information that was collected by the well driller in order to size the pump for the well, such as results of a specific capacity or step drawdown test should be recorded, also. Additionally, location information is obtained about springs, the spring discharge, topographic setting and any constructed improvements to the spring pool. A water-quality sample may be collected at the well or spring, depending on the study. However, water quality sampling procedures will not be covered in this manual.

In Ethiopia, many organizations both governmental and non-governmental are drilling wells, such as, the Ministry of Water Resources, the Ethiopian Orthodox Church, the Geological Survey of Ethiopia, and Regional Bureaus. Currently, no one agency is gathering information about the wells in Ethiopia. Springs, however, are sometimes indicated on topographic maps, but may not be entered into the ENGDA database.

The goal of the inventory is to collect as much information as possible about wells and springs in an area. Even records of unsuccessful well drilling efforts are important. The location and depth of dry or low water-yielding wells or wells with poor quality water is important information to collect. This information when combined with geologic mapping helps in determining what geologic formations are likely to provide or not provide ground water.

It is important to fill out the data fields for defining the method and accuracy of the location coordinate information obtained during a well or spring inventory.

Site Identification Fields

The following fields are used to help identify the sites. Fields such as the site identifier are generated by the database from the **Site Name** and **Locality** fields. Before conducting well or spring inventories in any region, a report of the existing sites in the database should be generated, so that duplicate sites are not accidentally created by completing new well inventory forms for existing wells.

Site Identifier [REQUIRED]

Description: This is the unique identifier for all sites. The **Site Identifier** is a combination of the **Site Name** and the **Locality**, separated by a space. When data are entered into ENGDA, this field will be filled out automatically based on the **Site Name** and the **Locality** that are entered. On field forms, fill out the **Site Name** field and the **Locality** field. Rules for filling out these fields are described below.

*NOTE: When a new site is established in ENGDA, an internal number is assigned to that site, and this internal number is the key upon which all data for that site is stored in the database. At a later date, a user may change the **Site Identifier** for the site by changing either the **Site Name** or the **Locality**, or both, but the internal site number will never change.*

Data Type: Text string, not to exceed 120 characters

Example: Site Identifier 39032313460801 ADDIS ABABA, WEREDA 03
Site Identifier Lost Springs Agilio, Dubti
Site Identifier SC-435 Unknown Village

ENGDA Database Table/Field: `site_nm` in the `geo_geography` table.

ENGDA Screen Data Entry: Created by ENGDA based on the **Site Name** and **Locality** when entering new site using the Create New Site form accessed through the Site Information form. The Site Identifier can be edited using the Site Information form.

ENGDA Field Form: none

Site Name [REQUIRED]

Description: A short text name (maximum of 50 characters) for the site. If the latitude and longitude of the site are known, the **Site Name** can consist of 14 characters that are the concatenation of latitude in degrees, minutes, and seconds (DMS), longitude in DMS, and a 2-digit sequence number. If latitude and longitude are not known, the **Site Name** can consist of a commonly used code for the site, or a commonly known name for the site.

Data Type: Text string, not to exceed 50 characters

Examples: Site Name 39032313460801
Site Name Lost Springs
Site Name SC-435

ENGDA Database Table/Field: `serial_nu_tx` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user for new site using the Create New Site screen form accessed through Borehole (or Spring) Site Information screen form. The Site Name can be edited using Borehole (or Spring) Site Information screen form.

ENGDA Field Form: Well and Spring Inventory forms. For most other field forms, the Site Name should be filled out in the office prior to visiting the site. The Site Name is included on all field forms.

Locality [REQUIRED]

Description: The village that the site is near. Because there are duplicate village names in Ethiopia, a distinct Locality name is made by combining the Village name with the District name. For filling out field forms, refer to a hard copy of the Locality table to determine the proper Locality name. When entering data into ENGDA, select a value for Locality using the list boxes on the computer forms. If the nearest Village name is not known, select 'Unknown Village' for the Locality.

Data Type: List, 6-digit (maximum) integer code

10001 ADDIS ABABA, WEREDA 03
(See the `com_village_cd_lut` table for a complete list of villages and their locations.)

ENGDA Database Table/Field: `village_id` in the `geo_geography` table. Links to the `com_village_cd_lut` where the locality name (`village_nm`) is stored. Each village is assigned a unique `village_id` that is calculated by multiplying the Region code by 10000 and then adding a sequence number, where the sequence number is a consecutive integer assigned by sorting the `com_village_cd_lut` table by Region-District-Zone-Village.

ENGDA Screen Data Entry: Selected by the user for a new site from a list on the Create New Site form accessed through the Site Information form. The Locality can be edited using the Site Information form. New villages can be added to the database by using the “Add Village” menu option in the ENGDA database.

ENGDA Field Form: Well and Spring Inventory forms. For most other field forms, the site name should be filled out in the office prior to visiting the site. The Site Name is on all forms, however not all of the other related data fields, such as Region or Zone, are on all of the forms.

Region

Description: The Ethiopian National Regional States as of 2000. A Region named ‘Unknown’ was added to the list so that a Region can be assigned to each site, even when the Region is not known (site location not known). Once a Locality has been assigned to a site, the Region-Zone-District for that village can be inferred by looking it up in the **com_village_cd_lut** table; therefore, this information does not have to be entered by the user. The Hagier-Awraja-Wereda (old administrative classification) for a village can also be looked up in the **com_village_cd_lut** table. Regions were assigned a Region ID as follows:

Data Type: List, 2-digit code

- 1 Addis Ababa
- 2 Afar
- 3 Amhara
- 4 Benishangul-Gumuz
- 5 Dire Dawa
- 6 Gambella
- 7 Harari
- 8 Oromia
- 9 SNNPR (Southern Nations, Nationalities and Peoples Republic)
- 10 Somali
- 11 Tigray
- 12 Unknown

ENGDA Database Table/Field: **district_cd** in the **geo_geography** table. (*NOTE: Pre-existing **district_cd** field used for Regions due to ENGDA programming constraints*). See the **com_village_cd_lut** table for a complete list of villages and their administrative assignments.

ENGDA Screen Data Entry: This field is automatically filled out by ENGDA on the Site Information form when the user selects a village from the **locality** list.

ENGDA Field Form: Well and Spring Inventory forms. For most other field forms for collecting data at an existing site in the database, the site name should be filled out in the office prior to visiting the site. The Site Name is on all forms, however not all of the other related data fields, such as Region or Zone, are on all of the forms.

Zone

Description: The administrative subunit of the regions.

Data Type: Text string, not to exceed 25 characters.

ENGDA Database Table/Field: **zone_tx** in the **com_village_cd_lut** table.

ENGDA Screen Data Entry: Value stored in the **com_village_cd_lut** table and determined based on village from the **locality** list.

ENGDA Field Form: Well and Spring Inventory forms. For most other field forms for collecting data at an existing site in the database, the site name should be filled out in the office prior to visiting the site. The Site Name is on all forms, however not all of the other related data fields, such as Region or Zone, are on all of the forms.

District

Description: The administrative subdivision name of a zone.

Data Type: Text string, not to exceed 25 characters.

ENGDA Database Table/Field: `district_tx` in the `com_village_cd_lut` table.

ENGDA Screen Data Entry: Value stored in the `com_village_cd_lut` table and determined based on village from the `locality` list.

ENGDA Field Form: Well and Spring Inventory forms. For most other field forms for collecting data at an existing site in the database, the site name should be filled out in the office prior to visiting the site. The Site Name is on all forms, however not all of the other related data fields, such as Region or Zone, are on all of the forms.

Village

Description: The local village and smallest organizational unit of government.

Data Type: Text string, not to exceed 25 characters.

ENGDA Database Table/Field: `village_tx` in the `com_village_cd_lut` table.

ENGDA Screen Data Entry: Entered by the user on the Site Information screen entry form.

ENGDA Field Form: Well and Spring Inventory forms. For most other field forms for collecting data at an existing site in the database, the site name should be filled out in the office prior to visiting the site. The Site Name is on all forms, however not all of the other related data fields, such as Region or Zone, are on all of the forms.

Borehole or Spring Location Fields

Site coordinate information is very important in a ground water database because the data are all dependent on the locations of wells. For this reason, coordinate information should be determined for all sites in the database.

The most common coordinate systems in Ethiopia are Geographic Coordinates (degrees-minutes-seconds) and UTM coordinates (meters easting and meters northing). Of these two systems, the Geographic Coordinate system should be used because there are three UTM Zones in Ethiopia (fig. 1, 36, 37, and 38), which complicates the use of the UTM system.

Geographic coordinates should be entered by the user in DMS format. Upon data entry, ENGDA will calculate the coordinates for the site in decimal degrees, because this format is more useful for GIS applications. Both the DMS value and the decimal degree format are stored in the database.

The datum of the coordinates must also be recorded for each site. The two most common datums in Ethiopia are the Adindan datum and WGS84 datum. Although these datums are very similar, they are different by about 100 meters ground distance, so recording the wrong datum may cause an apparent displacement in location of this magnitude.

While fields describing the method, accuracy, and datum are not designated required fields, it is important to fill out these data fields if known. If latitude and longitude is obtained from a Global Positions System unit, then it is not necessary to enter UTM easting and northing coordinates. However, if one has a GPS unit that can be switched from geographic coordinates (latitude and longitude) to UTM coordinates (northing and easting), it may be desirable to record both units on the field form. The site location information is on almost all of the field forms (Attachment 2) and should be entered on a well inventory form or any form where this is the first time the site is visited, such as a well construction or drilling form. For most other field forms, the Site Name and location coordinate information should be filled out in the office prior to visiting the site from the information in the database. The Site Name is on all forms, however not all of the other related data fields, such as coordinate method and datum, are on all of the forms. These do not need to be filled out unless a more exact site coordinate is obtained during a new visit to the site to collect a water quality sample or a water level.

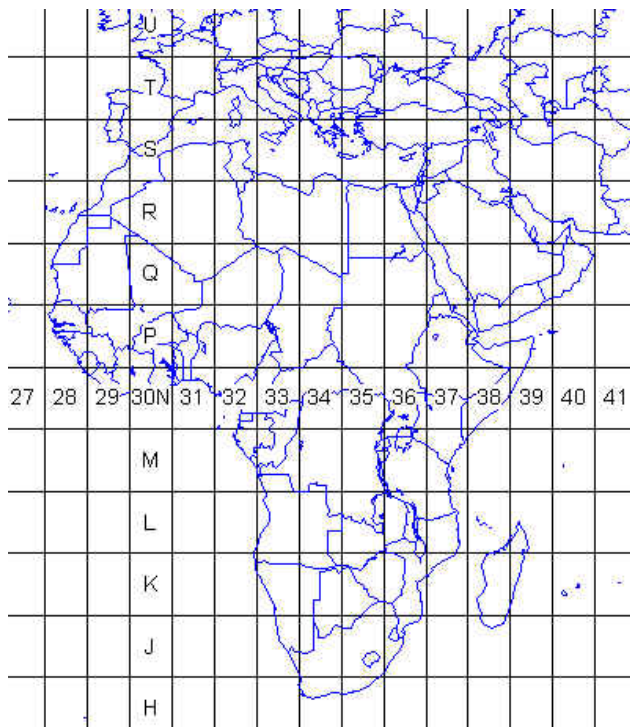


Figure 1.—UTM grid zones for Africa.

Handheld GPS units are probably the best way to determine the geographic position of wells or springs when doing a well or spring inventory. For work in Ethiopia, it is very important to purchase handheld GPS units that allow the switching between datums and include the Adindan datum as one of the datums that can be selected. Less expensive units will only use the WGS84 datum. If the GPS unit can only report latitude and longitude in the WGS84 datum, then record this correctly on the field form. However, you will not be able to use the latitude and longitude with WGS84 datum to locate yourself on the topographic maps of Ethiopia, because these use a different datum, the Adindan datum. For this reason, the field forms include fields for latitude and longitude, lat/lon datum and UTM northing and easting and UTM datum.

Even with an expensive handheld GPS unit, the accuracy of the position depends on both the number of satellites available and their positional geometry in the sky. Most GPS units will provide an estimate of the accuracy of the location at the time of the reading. Additionally, it is a good idea to hold the GPS unit over the site for several minutes. It is common for the position accuracy to be 4 to 15 meters with a handheld GPS unit.

Handheld GPS units will not provide accurate altitudes unless an expensive unit with an altimeter is purchased. More expensive units with altimeters, generally allow for converting position between any of the datums. If only three satellites are available, no altitude will be estimated by the GPS unit. An altitude can only be estimated if greater than four satellites

can be received at the time of the inventory. The accuracy of altitude determined with a handheld GPS unit is generally only 20 meters. The best method to obtain altitude data at a well or spring is to set the GPS datum to Adindan (the topographic map datum) and set units to UTM meters and plot the UTM northing and easting on the 1:50,000 scale topographic map and pick the altitude of the land surface or spring pool by interpolating between the topographic contours. However, if using a GPS unit that does not have any method of reporting the UTM coordinates in the Adindan datum, it still would be good to attempt to locate the well on the 1:50,000 map and estimate the altitude from the map. If an altimeter is available this could also be used for obtaining an altitude.

Latitude

Description: Geographic northing coordinate for longitude in degrees, minutes, seconds. Space for tenths and hundredths of seconds is available after the decimal point (DDMMSS.SS). If a more accurate latitude or longitude is obtained after the initial inventory, this field should be updated. Currently, maps of Ethiopia use the Adindan datum. Thus, these latitudes and longitudes should be in the Adindan datum. If field personnel are using a global positioning system (GPS) device, the device must be setup with the Adindan datum.

Data Type: Text string, not to exceed 9 characters.

Example: Latitude 090103.30

ENGDA Database Table/Field: `latitude_tx` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the latitude coordinate information should be entered on the form in the office prior to visiting the site from the information in the database.

Longitude

Description: Geographic easting coordinate for longitude in degrees, minutes, seconds. Space for tenths and hundredths of seconds is available after the decimal point (DDMMSS.SS). If a more accurate latitude or longitude is obtained after the initial inventory, this field should be updated in ENGDA by editing the field from the screen entry form. Currently, paper maps of Ethiopia use the Adindan datum. Thus, these latitudes and longitudes should be in the Adindan datum. If field personnel are using a global positioning system (GPS) device, the device must be setup with the Adindan datum.

Data Type: Text string not to exceed 9 characters.

Example: Longitude 384551.10

ENGDA Database Table/Field: `longitude_tx` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the longitude coordinate information should be entered on the form in the office prior to visiting the site from the information in the database.

Lat/Long Method

Description: A list of the methods used to obtain the latitude and longitude. This is related to the accuracy of the coordinate information.

Data Type: List, 1-character code

A Approximate
C Calculated from other coordinates
D GPS-Differential
G GPS
M 1:50,000 Map
N 1:250,000 Map
S Survey
U Unknown

ENGDA Database Table/Field: `coord_meth_cd` in the `geo_geography` table. Allowable values stored in `geo_coord_meth_lut` table.

ENGDA Screen Data Entry: Selected by the user on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the lat/long method information should be entered on the form in the office prior to visiting the site from the information in the database.

Lat/Long Datum

Description: The horizontal datum used for the geographic coordinates. Two common datums in Ethiopia are the Adindan datum, which is commonly used on printed maps, and the WGS84 datum, which is commonly the default datum used for GPS systems. However some GPS units allow the choice of many datums. Thus, if the GPS unit can be set to the Adindan Datum, this should be used in order to compare the latitude and longitude to the topographic map.

Data type: Text string, not to exceed 10 characters.

ENGDA Database Table/Field: `lat_long_datum_tx` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the lat/long datum information should be entered on the form in the office prior to visiting the site from the information in the database.

UTM Easting

Description: UTM easting coordinate in meters. If latitude and longitude is obtained from a Global Positions System unit, then you may not need to enter UTM coordinates.

Data Type: numeric (no set number of characters for field length)

ENGDA Database Table/Field: `east_wgs84_va` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: All, Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the UTM easting information should be entered on the form in the office prior to visiting the site from the information in the database.

UTM Northing

Description: UTM northing coordinate in meters. If latitude and longitude is obtained from a Global Positions System unit, then you may not need to enter UTM coordinates.

Data Type: numeric (no set number of characters for field length)

ENGDA Database Table/Field: `north_wgs84_va` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the UTM northing information should be entered on the form in the office prior to visiting the site from the information in the database.

UTM Method

Description: A list of the method for determining the UTM Easting and Northing coordinates. This is related to the accuracy of the coordinate information. If latitude and longitude is obtained from a Global Positions System unit, then you may not need to enter UTM coordinates.

Data Type: List, 1-character code

- A Approximate
- C Calculated from other coordinates
- D GPS-Differential
- G GPS
- M 1:50,000 Map
- N 1:250,000 Map
- S Survey
- U Unknown

ENGDA Database Table/Field: `UTM_method_cd` in the `geo_geography` table. Allowable values stored in `geo_coord_meth_lut` table

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the UTM method information should be entered on the form in the office prior to visiting the site from the information in the database.

UTM Datum

Description: The horizontal datum used for the geographic coordinates. This is usually the Adindan datum in Ethiopia. Data in WGS84 is more accurate than the Adindan datum and could also be used.

Data type: Text string, not to exceed 10 characters. This could be defined by a list of the most common datums. (?)

ENGDA Database Table/Field: UTM_datum_tx in the geo_geography table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the UTM datum information should be entered on the form in the office prior to visiting the site from the information in the database.

UTM Zone

Description: The UTM zone for the UTM coordinates. There are only 3 UTM zones in Ethiopia, UTM zones 36, 37, and 38.

Data Type: List, 2-digit code

36
37
38

ENGDA Database Table/Field: UTM_zone_tx in the geo_geography table. Allowable values coded on input form.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the UTM zone information should be entered on the form in the office prior to visiting the site from the information in the database.

Coordinate Method

Description: A list of the methods used to obtain the latitude and longitude or the UTM northing and easting. This is related to the accuracy of the information. This is used on many of the field forms rather than LAT/LONG METHOD or UTM METHOD. Many of the field forms allow the user to enter either Latitude and Longitude or UTM northing and easting. So on the field form the coordinate method will be for whichever type of data is entered for the location.

Data Type: List, 1-character code

A Approximate
C Calculated from other coordinates
D GPS-Differential
G GPS
M 1:50,000 Map
N 1:250,000 Map
S Survey
U Unknown

ENGDA Database Table/Field: coord_meth_cd or UTM_method_cd in the geo_geography table. Allowable values stored in geo_coord_meth_lut table.

ENGDA Screen Data Entry: Selected by the user on the Borehole Site Information form. User will select UTM_method_cd if UTM northing and easting on the field form or coord_meth_cd if Latitude and Longitude is entered on the field form.

ENGDA Field Form: For the Well and Spring Inventory forms these data should be filled out in the field at the time of the inventory. For most other field forms, the coordinate method information should be entered on the form in the office prior to visiting the site from the information in the database.

Map 1/50000 Sheet

Description: All 1:50,000 maps of Ethiopia have a defined text code and map name printed on each 1:50,000 scale map or orthophoto quad. This field is the map sheet name in which the borehole or spring is located.

Data Type: List, text code

0338-A1 MEGADO
0338-A2 MELBENA
0338-A4 SHENECHA
0338-B1 BOKU LUGOMA
(partial list)

ENGDA Database Table/Field: `sheet_nu` in the `geo_geography` table. Allowable values stored in `com_50k_maps_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: All forms. Fill out if known

Map 1/250000 Sheet

Description: Text code that refers to the 1:250,000 scale map in which the borehole is located (should be printed on each map).

Data Type: List, text code

NA37-2 SOLOLO
NA37-3 MOYALE
NB36-3 TORI
NB36-4 GECHA
(partial list)

ENGDA Database Table/Field: `plan_nu` in the `geo_geography` table. Allowable values stored in `com_250k_maps_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: All forms. Fill out if known.

Altitude

Description: The altitude above sea level of the land surface at the site. For springs, this is the pool altitude. *Note: GPS units are not very accurate for determination of altitude. It is very important to record the method for determination of the altitude.*

Data Type: Numeric field, in meters

ENGDA Database Table/Field: `alt_va` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Most forms.

Altitude Method

Description: This describes the method that was used to determine the land surface altitude at the well or borehole site or the pool altitude of the spring.

Data Type: List, 1-character code

- A Altimeter
- D Differential GPS
- G GPS
- M Estimated from topographic map
- N Calculation (Interpolated from digital elevation model)
- S Surveyed
- U Unknown

ENGDA Database Table/Field: `alt_meth_cd` in the `geo_geography` table. Allowable values coded on input form.

ENGDA Screen Data Entry: Selected by the user from a list on the Borehole Site Information form.

ENGDA Field Form: Most forms.

Altitude Accuracy

Description: This describes the accuracy of the land surface altitude or the spring pool altitude expressed in meters. The accuracy is dependent on the method used. An accuracy of +/- 0.1 meters would be entered as .1 on the form. Handheld GPS units tend to have poor altitude accuracy and may be only within 20 meters. The accuracy of GPS is variable depending on the number of satellites available at the time. Read the manual for the GPS used to determine the accuracy. Altimeters come with different accuracy specifications. Thus, if an altimeter is used, the accuracy of the specific altimeter should be recorded. If the location information from a GPS unit is used to plot the location on a topographic map and the land surface or pool altitude is interpolated from the topographic map, then the accuracy should be recorded as half the value of the contour interval. For example, if the altitude was interpolated from a topographic map with a 10 meter contour interval, the accuracy would be recorded as 5.

Data Type: Numeric, in meters.

ENGDA Database Table/Field: `alt_acc_nu` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Most forms.

Major River Basin

Description: There are 11 major river basins defined for Ethiopia.

Data Type: List, 2-digit code

- 1 Abey
- 2 Awash
- 3 Baro-Akobo
- 4 Danakil Depression
- 5 Genale-Dawa
- 6 Merebe
- 7 Ogaden
- 8 Omo
- 9 Rift Valley
- 10 Tekeze
- 11 Wabi Shebele

ENGDA Database Table/Field: `basin_tx` in the `geo_geography` table. Allowable values stored in `com_basin_id_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Most forms.

Borehole Attributes

Borehole attribute information consists primarily of information that describes or summarizes the characteristics of the borehole. Some of this information (for example, the borehole depth and diameter) is stored in more detail in the well construction tables of ENGDA, but is also included here as summary information about the borehole. It is the responsibility of the database user to ensure that the summary information entered here is consistent with the detailed borehole construction information.

Borehole Type

Description: This field indicates the type of borehole at the site.

Data Type: List, 2-character code

- TH test hole
- TW test well
- PW production well or water supply well
- HD hand-dug well
- OB observation well for water level or water quality data

ENGDA Database Table/Field: `well_type_cd` in the `geo_geography` table. Allowable values stored in the `geo_well_type_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form

Hole Depth

Description: The depth of the borehole, in meters. For boreholes where detailed borehole construction information is available, this number should agree with the deepest depth entered. For boreholes where detailed construction is not available, enter the depth of the borehole, if known.

Data Type: Floating point number

ENGDA Database Table/Field: `depth_va` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Form for Well Inventory

Hole Diameter

Description: The principal diameter of the hole as noted during a well inventory. This is usually the hole diameter at the surface; however, deep well may have smaller diameters with depth. For boreholes where detailed borehole construction information is available, this number should agree with the principal hole diameter entered. For boreholes where detailed construction is not available, enter the principal diameter of the borehole, if known. If the borehole is a hand-dug well, with an irregular shape, enter the diameter across the widest point and give the compass direction of the widest point. The diameter of the hand-dug well should be in units of meters not centimeters, which is the default unit on the form. Cross off “cm” on the form and endter “m”.

Data Type: character string

Examples: Hole Diameter: 15.2cm
Hole Diameter: 2.3 meters, oriented approximately north-south

ENGDA Database Table/Field: `hole_diameter_cd` in the `geo_geography` table. Allowable values stored in the `geo_borehole_diameters` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form

Year Constructed

Description: The year in which the well was constructed. For boreholes where detailed borehole construction information is available, this year should agree with the construction dates entered for the various construction activities. For boreholes where detailed construction is not available, enter the year the borehole was constructed, if known.

Data Type: 4-digit integer

Example: Year constructed 2001

ENGDA Database Table/Field: `year_nu` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form, Well Construction form

Site Use

Description: The use of water extracted from the well.

Data Type: List, 1-character code

I irrigation
H domestic
K mining
N industrial
W public supply
S stock watering
G geothermal
M mixed use
X unused
Z other

ENGDA Database Table/Field: well_use_cd in the geo_geography table. Allowable values stored in the geo_well_use_cd_lut table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form, Spring Inventory form, Water Use form

Site Status

Description: A general description of whether or not the site is in use

Data Type: List, 1-character code

A Abandoned (springs and wells)
F Filled (well sites only)
I In use (springs and wells)
O Unused-open (well sites only)
U Unused-cased (well sites only)
X Unused (spring sites only)

ENGDA Database Table/Field: site_status_cd in the geo_geography table. Allowable values stored in the geo_status_cd_lut table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form, Spring Inventory form

Project

Description: The name of the project that collected the information or funded the exploration or well drilling, if known.

Data Type: List, text string not to exceed 50 characters.

(Examples of names in list)
GSE Asosa Study

McKenzie Spring Survey
EGRAP Inventory

ENGDA Database Table/Field: `borehole_project_tx` in the `geo_geography` table. Existing values stored in `geo_borehole_project_lut` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form. Select a value from a list box or enter a new value. Extended information about projects can be added by using the “Manage Projects” menu option in the ENGDA database.

ENGDA Field Form: Well Inventory form, Spring Inventory form

Geologist Siting Borehole

Description: This field contains a code representing the name of the geologist who determined where the borehole should be installed, if known.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Examples of names in list)

DALI David Litke
DALI2 David Little
TETA Tesfaya Tadesse

ENGDA Database Table/Field: `site_well_party_id` in the `geo_geography` table. Allowable values stored in `geo_party_id_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form. New names can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Well Inventory form

Site Location Method

Description: Field indicating how the borehole or well site was located. This is mainly in reference to a site that was selected by a hydrogeologist and indicates the reason the borehole or well was drilled at this location.

Data Type: List, 2-character code

GE geological
GP geophysical
PH photograph
FS field survey
UN unknown
IN inventory

ENGDA Database Table/Field: `siting_method_cd` in the `geo_geography` table. Allowable values coded in the input form.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form, Spring Inventory form

Topographic Setting

Description: A description of the topography at the site selected from a list defined as follows (fig. 2; Babcock and others, 2004):

- (A) Alluvial fan refers to a low, outspread, relatively flat to gently sloping mass of loose rock material shaped like an open fan or a segment of a cone. It is deposited by a stream at a place where it issues from a narrow mountain valley upon a plain or broad valley.
- (B) Playa refers to a normally dry, vegetation-free, flat-floored area composed of thin, evenly stratified sheets of fine clay, silt or sand, and represents the bottom part of a shallow, completely closed or undrained desert lake basin in which water accumulates and is quickly evaporated, usually leaving deposits of soluble salts.
- (C) Stream channel refers to the bed in which a natural stream of water flows. It is the trench or depression washed or cut into the surface of the earth by the moving water that it periodically or continuously contains. This term includes intermittent or ephemeral streams, washes, arroyos, and coulees.
- (D) A local depression is an area that has no external surface drainage. Some depressions are small, but others may cover several square kilometers. Do not use this designation for small "interdune depressions" or those on an undulating surface (use undulating). Do not use for large, closed basins, such as Denakil Depression.
- (E) Dunes refer to mounds and ridges of windblown, or eolian sand. This term should not be used for an isolated mound unless it has a rather extensive area and is of hydrologic significance to the site.
- (F) A flat surface may be part of a larger feature, such as an upland flat, mesa or plateau, coastal plain, lake plain, or pediment terrace and valley flat, which are special varieties of flat surfaces, and are classified separately.
- (G) Flood plain refers to the surface or strip of relatively smooth land adjacent to a river channel, constructed by the present river in its existing regimen and covered with water when the river overflows its banks at times of high water.
- (H) A hilltop is the upper part of a hill or ridge above a well-defined break in slope. A site on the crest of an escarpment or top of a cuesta slope (see fig. 2) should be in this category. Use this category for hills of significant height above a generally flat area, but not for small "swells" a few meters high on an undulating surface such as a valley flat.
- (K) A sinkhole is a special type of depression that results from the dissolving of soluble rocks (salt, gypsum, limestone) and the subsequent collapse of the earth into the solution cavity. As such, it has special significance to the understanding of the hydrology in the vicinity of the site.
- (L) Lake refers to a body of inland water. However, this code also may be used for swampy or marshy areas where the ground may be saturated, or water may stand above the land surface for a significant period of time.
- (P) Pediment refers to a plain of combined erosion and deposition that forms at the foot of a mountain range.
- (S) A hillside is the sloping side of a hill--that is, the area between a hilltop and valley flat. The important factor is the general aspect of the site. The steepness of the slope or height of the hill is not significant.
- (T) An alluvial or marine terrace is generally a flat surface usually parallel to, but elevated above, a stream valley or coastline. Characteristically, steep slopes or escarpments separate the terrace from an adjacent upland on one side, and a lowland (coast or valley) on the other. Due to the effects of erosion, the terrace surface may not be as smooth as a valley flat, and within the general terrace area there may be undulating areas of dune sand or hill slopes.
- (U) Undulating topography is characteristic of areas which have many small depressions and low mounds. An undulating surface is primarily a depositional feature, not an erosional one. The term should not be misused for areas that have slightly irregular surfaces resulting from erosion.
- (V) A valley flat is a low flat area between valley walls and bordering a stream channel. It includes the flood plain, and generally is the flattest area in the valley. The surface may have a slight slope toward the main stream, toward the valley walls, or may be marked by valleys or smaller streams. Generally, the valley flat is separated from alluvial terraces, or from the upland, by a pronounced break in slope. Sometimes, however, the erosion of adjacent upland and the deposition of colluvium may make the outer edge of the alluvial flat. Use this code for sites in small valleys on a plain, if the site taps alluvium or the valley situation has hydrologic significance.
- (W) An upland draw is a small natural drainageway or depression, usually dry, on a hillside or upland.

Data Type: List, 1-character code

- A alluvial fan
- B playa
- C stream channel

- D depression
- E dunes
- F flat
- G floodplain
- H hilltop
- K sinkhole
- L lake or swamp
- P pediment
- S hillside
- T terrace
- U undulating
- V valley flat
- W upland draw

ENGDA Database Table/Field: `topo_setting_id` in the `geo_geography` table. Allowable values stored in the `com_topo_setting_id_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form, Spring Inventory form

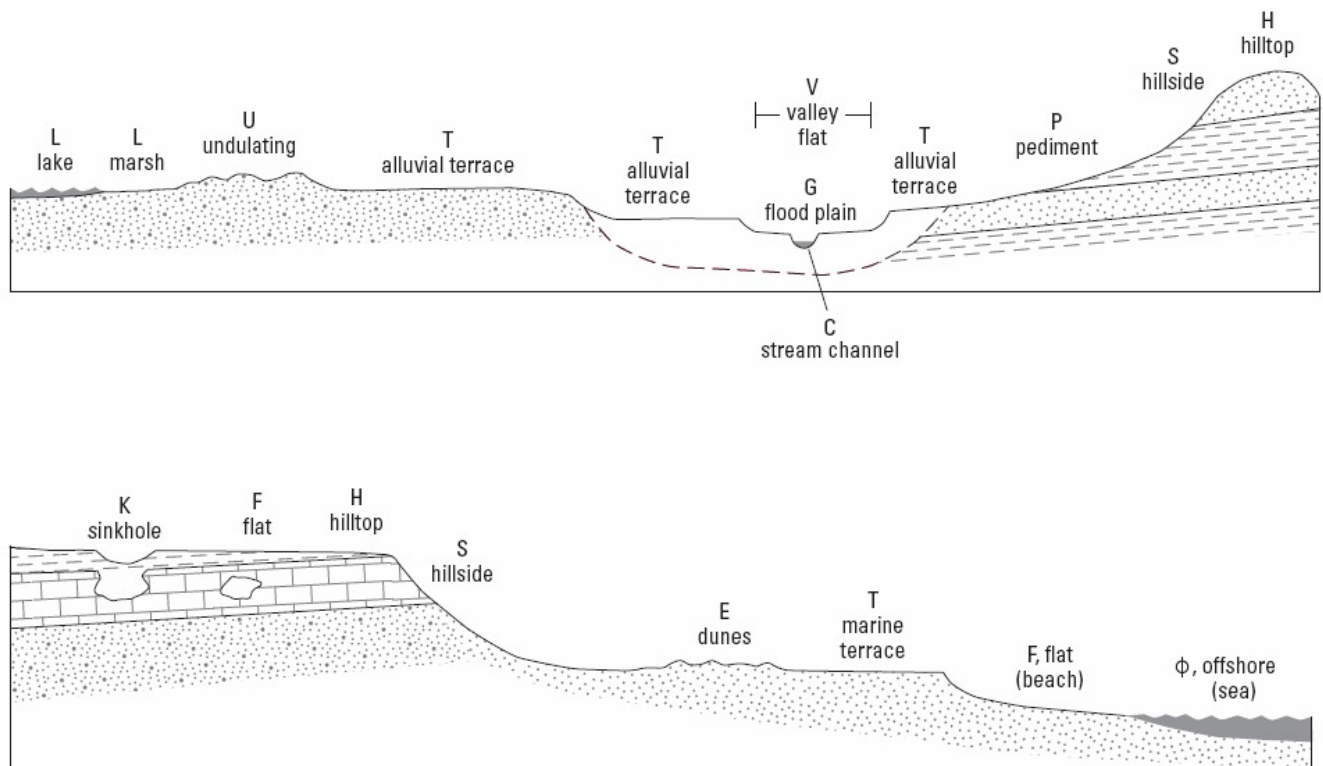


Figure 2. Topographic settings (from Babcock and other, 2004).

Principal Aquifer Lithology

Description: A general description of the aquifer lithology (rock type; Babcock and other, 2004).

Data Type: List, 1-character code

- C Consolidated porous sedimentary
- I Fractured igneous/metamorphic
- L Limestone/karstic
- O Other
- U Unconsolidated
- V Fractured volcanics
- X Unknown

ENGDA Database Table/Field: **rock_cd** in the **geo_geography** table. Allowable values stored in **geo_rock_type_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form, Spring Inventory form

Aquifer Type

Description: A general description of the aquifer type. Aquifers can be confined or unconfined, and wells can be drilled to intersect several different types of aquifers. An unconfined aquifer is one in which the aquifer water table is exposed to atmospheric pressure. Unconfined aquifers are usually fairly shallow or are the first water bearing formation below land surface. Confined aquifers are bounded above and below by relatively impermeable formations and are not exposed to atmospheric pressure (Babcock and others, 2004).

Data Type: List, 1-character code

- U Unconfined single aquifer
- N Unconfined multiple aquifers
- C Confined single aquifer
- M Confined multiple aquifer
- X Mixed (confined and unconfined multiple aquifers)
- Z Unknown

ENGDA Database Table: **aquifer_type_cd** in the **geo_geography** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form.

ENGDA Field Form: Well Inventory form, Spring Inventory form

Aquifer Name

Description: The named aquifer from which the well principally derives water

Data Type: List, integer code

- 0 Unknown
- 1 Rift Valley Aquifer

ENGDA Database Table/Field: **aquifer_id** in the **geo_geography** table. Values stored in the **com_aquifer_id** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form. User may add new value.

ENGDA Field Form: Well Inventory form, Spring Inventory form

Alternate Site Name

Description: A short text name (maximum of 50 characters) for the site. The **Alternate Site Name** can consist of a commonly-known name for the site. This field may contain an alternate site name for a borehole for those cases when agencies have named the same borehole by different names.

Data Type: Text string not to exceed 50 characters

Examples: Alternate Site Name St. Mariam church well
Alternate Site Name Tinish Springs
Alternate Site Name GSE#001-A

ENGDA Database Table/Field: hydrologic_nu in the geo_geography table.

ENGDA Screen Data Entry: Entered by the user on the Well and Spring Inventory form.

ENGDA Field Form: Well Inventory form, Spring Inventory form

Additional Borehole or Spring Attributes

Additional borehole attributes consist primarily of information about who owns the borehole and how to locate it and gain access to it, and about who conducted the borehole inventory.

Owner Name

Description: The owner of the site.

Data Type: Text string, not to exceed 50 characters.

Example: Owner Name: Abebe Tesfaye
Owner Name: Axum High School, Brahne Arefaine

ENGDA Database Table/Field: owner_nm in the geo_geography table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Form for Well Inventory, Form for Spring Inventory

Owner Address

Description: The mailing address of the owner.

Data Type: Text string not to exceed 150 characters.

Example: Address: Axum High School P.O. Box 14 Axum Tigray

ENGDA Database Table/Field: owner_add_tx in the geo_geography table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Form for Well Inventory, Form for Spring Inventory

Site Location Description

Description: The description of the location of the well or spring.

Data Type: Text string, not to exceed 250 characters.

Example: Site Loc Description Lalibella well-1 is located south of the Jordan River in the town of Lalibella along the road that passes the cemetery downhill from Bet Ibrahim.

ENGDA Database Table/Field: `site_loc_tx` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Form for Well Inventory, Form for Spring Inventory

Source of Data

Description: The Agency, Regional Bureau, person, or drilling company that supplied the data.

Data Type: List, text string code, not to exceed 10 characters

(Examples of agencies in list)

AAWSA	Addis Ababa Water and Sewerage Authority
ESTC	Ethiopian Science and Technology Commission
GSE	Geological Survey of Ethiopia
MU	Mekelle University
MWR	Ministry of Water Resources
PRIV	Private individual or organization
UNK	Unknown
WRB-BEN	Water Resources Bureau of Benishangule
WRB-ORO	Water Resources Bureau of Oromiya

ENGDA Database Table/Field: `data_source_cd` in the `geo_geography` table. Existing values stored in `com_department_lut` table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form. New data sources (agencies) can be added by the user by typing in a new agency name.

ENGDA Field Form: Form for Well Inventory, Form for Spring Inventory

Inventoried By

Description: This field contains a code representing the name of the person who inventoried the borehole.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)
DALI David Litke
DALI2 David Little
TETA Tesfaya Tadesse

ENGDA Database Table/Field: **inventory_party_id** in the **geo_geography** table. Allowable values stored in **geo_party_id_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Borehole Site Information form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Form for Well Inventory, Form for Spring Inventory

Date Inventoried

Description: This field will be blank if the data is not field verified during an inventory. The date should be entered using the international calendar.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Date Inventoried 22/01/1998

ENGDA Database Table/Field: **inventory_dt** in the **geo_geography** table.

ENGDA Screen Data Entry: Entered by the user on the Borehole Site Information form.

ENGDA Field Form: Form for Well Inventory, Form for Spring Inventory

Owner Permission

Description: This field indicates if the owner gives permission for access to the well or spring. The field form allows for entry of the name of the person who gave permission, but ENGDA only allows entry of whether or not permission was given (yes or no).

Data Type: List, 1-character code

Y yes
N no

ENGDA Database Table/Field: **owner_perm_cd** in the **geo_geography** table. Allowable values coded on input form.

ENGDA Screen Data Entry: Click on the check box on the Borehole Site Information form to indicate that permission is given.

ENGDA Field Form: Form for Well Inventory, Form for Spring Inventory

Spring Location

Spring location information is identical to that for boreholes, except that the altitude information refers to the spring pool altitude as discussed below in the spring attributes section.

Spring Altitude Information

This section of the data dictionary refers to information about spring pool altitude.

Pool Altitude

Description: The altitude of the spring pool or spring outlet if above a stream or pool, in meters above sea level.

Data Type: Numeric field in meters

ENGDA Database Table/Field: `alt_va` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Pool Altitude Method

Description: This describes the method that was used to determine the land surface altitude of the spring pool or spring outlet.

Data Type: List, 1-character code

- A Altimeter
- D Differential GPS
- G GPS
- M Estimated from topographic map
- N Calculation (Interpolated from digital elevation model)
- S Surveyed
- U Unknown

ENGDA Database Table/Field: `alt_meth_cd` in the `geo_geography` table. Allowable values stored in the `geo_coord_meth_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Pool Altitude Accuracy

Description: This describes the accuracy of the spring pool altitude expressed in meters. The accuracy is dependent on the method used. An accuracy of +/- 0.1 meters would be entered as .1 on the form. Handheld GPS units tend to have poor altitude accuracy and may be only within 20 meters. The accuracy of GPS is variable depending on the number of satellites available at the time. Read the manual for the GPS used to determine the accuracy. Altimeters come with different accuracy specifications. Thus, if an altimeter is used, the accuracy of the specific altimeter, should be recorded. If the location

information from a GPS unit is used to plot the location on a topographic map and the land surface or pool altitude is interpolated from the topographic map, then the accuracy should be recorded as half the value of the contour interval. For example, if the altitude was interpolated from a topographic map with a 10 meter contour interval, the accuracy would be recorded as 5.

Data Type: Numeric, in meters.

ENGDA Database Table/Field: `alt_acc_nu` in the `geo_geography` table.

ENGDA Screen Data Entry: Entered by the user on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Spring Attributes

Springs share some attributes with boreholes (Major River Basin, Status, Topographic Setting, Alternate Site Name, Water Use, Project); see the Borehole Attribute Information section of this database dictionary for a discussion of these common attributes. Attributes unique to springs are discussed below.

Spring Type

Description: This is a list field used to describe the mode of emergence of the spring or group of springs.

Data Type: List, 1-character code

- A Artesian-- a spring that discharges from an artesian aquifer, generally through a fault or some other geologic control. The spring flows because the head in the confined aquifer is above land surface.
- B Perched contact-- a spring that discharges from a perched water zone; that is a zone that is above the regional water table. The spring is located at the contact between a low permeability unit, which causes the perched water, and an overlying permeable unit.
- C Contact—a spring that is located at the contact between a low permeability unit, which causes the perched water, and an overlying permeable unit.
- D Depression—a spring that is located in a depression in the land surface that is below the regional water table.
- E Perched depression—a spring that is located in a depression in a perched zone, above the regional water table.
- F Fissures—a spring that is located in a fissure in a consolidated-rock aquifer.
- G Geyser—a spring that wither continuously or periodically erupts, causing water to be ejected onto the land surface.
- H Perched tubular—a spring that is located in a perched zone, above the regional water table, and is emerging from a tubular opening in the rock formation.
- J Artesian depression—a spring that is located in a depression in an artesian aquifer.
- K Artesian seepage—a spring that discharges at very low rates (seeps), from an artesian aquifer. The seepage usually is visible as a wet zone on the land surface, and the discharge may be very difficult to measure.
- L Fracture depression—a spring that discharges from a depression in a fractured-rock aquifer.
- M Multiple springs—more than one spring, usually closely spaced, at a site.
- P Perched—a spring that discharges from a zone that is above the regional water table
- Q Perched fracture—a spring that discharges from a fracture above the regional water table
- R Perched seepage—a spring that discharges, at a very low rate (seeps) from a perched zone that is above the regional water table.
- S Seepage filtration—a spring similar to a depression spring except that the spring discharges at very low rates (seeps) into the depression, which is below the regional water table.
- T Tubular cave—a spring that discharges from a tubular shaped opening in a cave
- Z Other—any other type of spring not mentioned in this list

ENGDA Database Table/Field: `spring_type_cd` in the `geo_geography` table. Allowable values stored in the `geo_spring_type_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Spring Development

Description: This field describes improvements made to the natural spring opening. *Note that the data entered for Spring Development, Development Possibility, and Year Developed should be mutually consistent (Babcock and others, 2004).*

Data Type: List, 1-character code

B boxed basin
C concrete basin
G gallery
H spring house
L lined
N none
P pond
R pipe
T trough
Z other

ENGDA Database Table/Field: **sp_dev_cd** in the **geo_geography** table. Allowable values stored in the **geo_spring_development_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Year Spring Developed

Description: The year in which the spring was developed.

Data Type: 4-digit integer

Example: Year developed 2001

ENGDA Database Table/Field: **year_nu** in the **geo_geography** table.

ENGDA Screen Data Entry: Entered by the user on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Spring Development Possibility

Description: The development possibility for water supply.

Data Type: List, 1-character code

Y yes

N no

ENGDA Database Table/Field: **sp_devpos_cd** in the **geo_geography** table. Allowable values coded in the input form.

ENGDA Screen Data Entry: Selected by the user using a check box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Spring Rock Type

Description: The major type of rock from which the spring emerges (Babcock and others, 2004).

Data Type: List, 1-character code

- C Consolidated porous sedimentary
- I Fractured igneous/metamorphic
- L Limestone/karstic
- O Other
- U Unconsolidated
- V Fractured volcanics
- X Unknown

ENGDA Database Table/Field: **sp_rock_cd** in the **geo_geography** table. Allowable values stored in the **geo_rock_type_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Spring Permanence

Description: The discharge of the spring as to if the spring flows continuously or seasonally (Babcock and others, 2004).

(P) Perennial refers to springs that discharge continuously.

(I) Intermittent refers to springs that discharge only during certain periods but at other times are dry. Although all springs may be considered to be either perennial or intermittent, more descriptive detail can be included if it is available. The following characteristics describe special types of intermittent springs that may be coded:

(R) Response to precipitation refers to springs that exist only after periods of rainfall.

(S) Seasonal refers to springs that exist only during periods of high water levels.

(G) Geyser refers to springs that discharge at more or less regular intervals. Discharge is caused by expansive force of highly heated steam.

(E) Periodic - ebb and flow refers to springs that normally have periods of relatively greater discharge at regular and frequent intervals. Periodic springs may be perennial or intermittent. Periodic springs resemble geysers somewhat in their rhythmic action, but discharge is not caused by a geothermal heat source.

Data Type: List

- E ebb and flow
- G geyser
- I intermittent
- P perennial

R precipitation
S seasonal
Z other

ENGDA Database Table/Field: **sp_perm_cd** in the **geo_geography** table. Allowable values stored in the **geo_spring_permanence_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Spring Protection Condition

Description: A description of any protection at the spring.

Data Type: List, 1-character code

F fenced
N none
L locked fencing

ENGDA Database Table/Field: **sp_protect_cd** in the **geo_geography** table. Allowable values stored in the **geo_spring_protection_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

Spring Sanitary Condition

Description: The sanitary condition of the spring, good, Fair, or bad.

Good- The spring is well protected or at a safe distance from potential sources of contamination. For example, a sturdy fence surrounds the spring, so that the potential for contamination from animals grazing nearby is small.

Fair- The spring is somewhat protected or at a minimal distance from potential sources of contamination. For example, a fence may surround or partially surround the spring, but animals could occasionally get near the spring.

Bad- The spring has no protection or is immediately downgradient from a source of contamination. The spring may already be contaminated, or has visible signs of contamination (trash or other potential contaminants in the water, for example, animals wading in the spring pool).

Data Type: List, 1-character code

G Good
F Fair
B Bad

ENGDA Database Table/Field: **sp_san_cd** in the **geo_geography** table. Allowable values stored in the **geo_spring_sanitary_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Spring Site Information form.

ENGDA Field Form: Form for Spring Inventory

WELL DRILLING AND CONSTRUCTION DATA FIELDS

Detailed information about the construction of a well can be stored in ENGDA. These data are all related to construction events. Because wells sometimes are reconstructed, a well can have more than one construction event, each with its own set of construction information; however, most wells typically will have only one construction event. There are two field forms relating to well construction. If a borehole is drilled for purposes of collecting geophysical logs and is never turned into a well or a hole is drilled and there is no water, then the information about this site could be filled in on the form for the Record of Well Drilling; this form could also be used for open hole wells that are never cased. If the borehole is complete as a well, and casing is installed at the borehole, then the form for the Record of Well Construction should be completed.

Well Construction Event Fields

Each construction event has a few basic fields used to define the construction event:

Construction Event Number [REQUIRED]

Description: A sequence number defining the construction event; the first construction event number is 1.

Data Type: Short integer

ENGDA Database Table/Field: `cons_seq_nu` in the `geo_well_cons` table.

ENGDA Screen Data Entry: This number is assigned automatically by ENGDA when a user clicks the NEW button on the Drilling information form on the Borehole Details form.

ENGDA Field Form: none, generated by the database.

Construction Start Date [REQUIRED]

Description: The date on which construction started.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Construction Start Date: 22/01/1998

ENGDA Database Table/Field: `start_dt` in the `geo_well_cons` table.

ENGDA Screen Data Entry: Entered by the user on the New Construction Event form which is launched by clicking the New construction event button on the Drilling form of the Borehole Details form. Existing values can be edited by entering new values on any of the Construction data forms.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Construction End Date [REQUIRED]

Description: The date on which construction ended.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Construction End Date: 22/01/1998

ENGDA Database Table/Field: `end_dt` in the `geo_well_cons` table.

ENGDA Screen Data Entry: Entered by the user on the New Construction Event form which is launched by clicking the New construction event button on the Drilling form of the Borehole Details form. Existing values can be edited by entering new values on any of the Construction data forms.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Construction Supervisor

Description: This field contains a code representing the name of the person who supervised the well construction.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI	David Litke
DALI2	David Little
TETA	Tesfaya Tadesse
EVKU	Eve Kuniansky
PATU	Patrick Tucci

ENGDA Database Table/Field: `geologist_party_id` in the `geo_well_cons` table. Allowable values stored in `geo_party_id_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the New Construction Event form which is launched by clicking the New construction event button on the Drilling form of the Borehole Details form. Existing values can be edited by entering new values on any of the Construction data forms. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Construction Comment

Description: Any additional information relevant to the current well-construction event.

Data Type: Text string not to exceed 150 characters.

ENGDA Database Table/Field: `comment_tx` in the `geo_well_cons` table.

ENGDA Screen Data Entry: Entered by the user on the New Construction Event form which is launched by clicking the New construction event button on the Drilling form of the Borehole Details form. Existing values can be edited by entering new values on any of the Construction data forms.

ENGDA Field Form: Form for Record of Well Construction

Drilling Data Fields

Drilling data describes in detail the process by which the borehole was drilled. It is intended to be used as an operational log of how various drill rigs/bits performed and how long it took to drill through various rock types. Data can be entered for multiple depth intervals within the well, and by time period.

For many boreholes, there may be no detailed data about the drilling process; for these boreholes, data may instead be entered as available in data fields concerning Hole, Water Struck, Casing, Packing, Lithology, and Development information.

Start Date [REQUIRED]

Description: Date drilling started for specified depth interval.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Start 20010820 08:30

ENGDA Database Table/Field: **start_dt** in the **geo_well_drilling** table.

ENGDA Screen Data Entry: Entered by the user in the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

End Date [REQUIRED]

Description: Date drilling ended for specified depth interval.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Finish 20010820 10:12.

ENGDA Database Table/Field: **end_dt** in the **geo_well_drilling** table.

ENGDA Screen Data Entry: Entered by the user in the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Interval Top [REQUIRED]

Description: Depth from the surface to the top of the interval, in meters.

Data Type: Numeric, units meters

Example: Interval Top 100.25

ENGDA Database Table/Field: **hole_top_va** in the **geo_well_drilling** table.

ENGDA Screen Data Entry: Entered by the user in the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Interval Bottom [REQUIRED]

Description: Depth from the surface to the bottom of the interval, in meters.

Data Type: Numeric, units meters

Example: Interval Bottom 120.25

ENGDA Database Table/Field: `hole_bottom_va` in the `geo_well_drilling` table.

ENGDA Screen Data Entry: Entered by the user in the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Diameter

Description: Diameter of the hole for the specified interval, in millimeters.

Data Type: numeric, units millimeters

Example: Diameter 50.8

ENGDA Database Table/Field: `hole_dia_va` in the `geo_well_drilling` table. Allowable values stored in `geo_borehole_diameters` table.

ENGDA Screen Data Entry: Selected by the user from a list on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

General Rock Type

Description: The type of rock that is being drilled.

Data Type: List, 1-character code

- 1 Unconsolidated
- 2 Sedimentary
- 3 Hard Rock

ENGDA Database Table/Field: `lithology_cd` in the `geo_well_drilling` table. Allowable values stored in the `geo_lith_group_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Drilling

Driller Name

Description: This field contains a code representing the name of the person who supervised the drilling event.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)
DALI David Litke
DALI2 David Little
TETA Tesfaya Tadesse

ENGDA Database Table/Field: party_id in the geo_well_drilling table. Allowable values stored in geo_party_id_lut table.

ENGDA Screen Data Entry: Selected by the user on the Drilling form of the Borehole Detail form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Drilling Method

Description: Indicates the method used to create the specified interval.

Data Type: List, 1-character code

A auger rig
C cable tool rig
D driven
G geoprobe
H hand dug well
M mud rotary
O other
P push point piezometer
R air rotary
T hammer tool
U unknown
V sonic vibration rig
X reverse rotary

ENGDA Database Table/Field: method_cd in the geo_well_drilling table. Allowable values stored in the geo_drilling_method_cd_lut table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Rig Number

Description: This field contains a code for the drill rig used.

Data Type: List, 6-character code

(Example of rigs in list)
1
GSE101

WD-101

ENGDA Database Table/Field: **equip_tx** in the **geo_well_drilling** table. Allowable values stored in the **geo_drill_rigs** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Drill Bit Number

Description: This field contains a code for the drill bit that was used.

Data Type: List, 6-character code

(Example of drill bits in list)

GSE12

GSE13

MOWR1

ENGDA Database Table/Field: **drill_bit_cd** in the **geo_well_drilling** table. Allowable values stored in the **geo_drill_bit_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Drilling

Hammer Number

Description: This field contains a code describing the hammer that was used

Data Type: List, 6-character code

(Example of hammers in list)

GSE1

GSE2

MOWR3

ENGDA Database Table/Field: **hammer_cd** in the **geo_well_drilling** table. Allowable values stored in the **geo_drill_hammer_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Drilling

Drilling Fluid

Description: The drilling fluid used in drilling this interval.

Data Type: List, 1-character code

- A Air
- B Bentonite
- F Foam
- W Water

ENGDA Database Table/Field: **process** in the **geo_well_drilling** table. Allowable values stored in the form.

ENGDA Screen Data Entry: Selected by the user from a list box on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Drilling

Comment

Description: Any additional comments about the drilling of the interval.

Data Type: 150 character text field

Example: Comment Rock is very brittle in this interval

ENGDA Database Table/Field: **comment_tx** in the **geo_well_drilling** table.

ENGDA Screen Data Entry: Entered by the user on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Hole Data Fields

Hole data describes the diameter of each open hole interval. Data can be entered for multiple depth intervals within the well. For some boreholes, detailed construction information may be available that may be entered into the drilling data fields; in this case hole information can be omitted or else it can be entered as a summary of the drilling data. For other boreholes, detailed drilling information may not be available, but some information about the hole diameters may be available; in this case the hole information may be entered using the hole data fields.

Interval Top [REQUIRED]

Description: Depth from the surface to the top of the interval, in meters.

Data Type: Numeric, units meters

Example: Interval Top 100.25

ENGDA Database Table/Field: **section_top_va** in the **geo_well_dia** table.

ENGDA Screen Data Entry: Entered by the user in the Hole form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Interval Bottom [REQUIRED]

Description: Depth from the surface to the bottom of the interval, in meters.

Data Type: Numeric, units meters

Example: Interval Bottom 120.25

ENGDA Database Table/Field: `section_end_va` in the `geo_well_dia` table.

ENGDA Screen Data Entry: Entered by the user in the Hole form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Diameter

Description: Diameter of the hole for the specified interval, in millimeters.

Data Type: numeric

Example: Diameter 50.8

ENGDA Database Table/Field: `section_dia_va` in the `geo_well_dia` table. Allowable values stored in `geo_borehole_diameters` table.

ENGDA Screen Data Entry: Selected by the user from a list on the Hole form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

WATER STRUCK DATA

Water struck data describes water encountered (“struck”) in the borehole during the drilling process. Several different intervals are allowed because water may be encountered at more than one level in the borehole, especially in fractured rocks or in complex aquifer systems.

Interval Top [REQUIRED]

Description: Depth from the surface to the top of the interval where water was encountered, in meters.

Data Type: Numeric, units meters

Example: Interval Top 100.25

ENGDA Database Table/Field: `depth_va` in the `geo_well_water_struck` table.

ENGDA Screen Data Entry: Entered by the user in the Water Struck form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Interval Bottom

Description: Depth from the surface to the bottom of the interval in which water was encountered, in meters.

Data Type: Numeric, units meters

Example: Interval Bottom 120.25

ENGDA Database Table/Field: `bottom_va` in the `geo_well_water_struck` table.

ENGDA Screen Data Entry: Entered by the user in the Water Struck form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Yield

Description: Yield (discharge) of the well, in liters per second, due to the water struck at this interval.

Data Type: numeric

Example: Yield 4.8

ENGDA Database Table/Field: `yield_va` in the `geo_well_water_struck` table.

ENGDA Screen Data Entry: Entered by the user in the Water Struck form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction; Form for Record of Well Drilling

Water Level

Description: Static water level in the borehole due to the water struck at this interval, in meters below the land surface.

Data Type: numeric

Example: Water Level 22.4

ENGDA Database Table/Field: `water_level` in the `geo_well_water_struck` table.

ENGDA Screen Data Entry: Entered by the user in the Water Struck form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Drilling

Date Struck

Description: Date on which the water was first encountered for this interval.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Date struck 20010820 10:12.

ENGDA Database Table/Field: `date_struck_dt` in the `geo_well_water_struck` table.

ENGDA Screen Data Entry: Entered by the user in the Water Struck form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Drilling

Casing/Screen Data

Casing/screen data describes the pipe sections that are installed in the hole. General information (Casing Start Date, Casing End Date, Casing Rig Number, Casing Supervisor) can be entered about the casing installation, and detailed information (for example, Casing Type, Casing Diameter) can be entered about each casing interval.

Casing Start Date

Description: The date on which casing installation started.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Casing Start Date: 22/01/1998

ENGDA Database Table/Field: `casing_start_dt` in the `geo_well_cons` table.

ENGDA Screen Data Entry: Entered by the user on the Casing form of the Borehole Details form.

ENGDA Field Form: Form for Record of Well Construction

Casing End Date

Description: The date on which casing installation ended.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Casing End Date: 22/01/1998

ENGDA Database Table/Field: `casing_end_dt` in the `geo_well_cons` table.

ENGDA Screen Data Entry: Entered by the user on the Casing form of the Borehole Details form.

ENGDA Field Form: Form for Record of Well Construction

Casing Supervisor

Description: This field contains a code representing the name of the person who supervised the well casing installation.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI David Litke

DALI2 David Little

TETA Tesfaya Tadesse

ENGDA Database Table/Field: `casing_party_id` in the `geo_well_cons` table. Allowable values stored in `geo_party_id_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Casing form of the Borehole Details form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Form for Record of Well Construction

Casing Rig Number

Description: This field contains a code for the rig used to install the casing.

Data Type: List, 3-character code

1
2
WD

ENGDA Database Table/Field: **casing equip_tx** in the **geo_well_cons** table. Allowable values stored in the **geo_drill_rigs** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Drilling form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Interval Top [REQUIRED]

Description: Depth from the surface to the top of the casing interval, in meters.

Data Type: Numeric, units meters

Example: Interval Top 100.25

ENGDA Database Table/Field: **top_va** in the **geo_well_casing** table.

ENGDA Screen Data Entry: Entered by the user in the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Interval Bottom [REQUIRED]

Description: Depth from the surface to the bottom of the casing interval, in meters.

Data Type: Numeric, units meters

Example: Interval Bottom 120.25

ENGDA Database Table/Field: **end_va** in the **geo_well_casing** table.

ENGDA Screen Data Entry: Entered by the user in the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Material

Description: Type of casing material installed in the hole for the specified interval.

Data Type: List, 1-character code

A	ABS
B	Brass/Bronze
C	Concrete
E	PFTE
G	Galvanized Iron
I	Wrought Iron
K	PVC Threaded
M	Other Metal
N	PVC Glued
P	Plastic
Q	FEP
R	Stainless Steel
S	API Steel
U	Unknown
X	Steel Carbon
Y	Steel Galvanized
Z	Other

ENGDA Database Table/Field: **material_cd** in the **geo_well_casing** table. Allowable values stored in **geo_well_csng_material_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list on the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Casing Diameter

Description: Diameter of the casing for the specified interval, in millimeters.

Data Type: List

Example: Diameter 25.0

ENGDA Database Table/Field: **dia_va** in the **geo_well_casing** table. Allowable values stored in **geo_casing_diameters** table.

ENGDA Screen Data Entry: Selected by the user from a list on the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Material Thickness

Description: Thickness of the casing material installed in the hole for the specified interval, in millimeters.

Data Type: List, 2-digit integer

2
3
4
5
6
7
8
9
10

ENGDA Database Table/Field: **thick_va** in the **geo_well_casing** table.

ENGDA Screen Data Entry: Selected by the user from a list on the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Casing/Screen Type

Description: The type of casing or screening for the specified interval.

Data Type: List

D Drilling Pipe
H Perforated holes
M Mesh Screen
P Solid
S Slotted
U Open
V Vertical Perforated Slots
W Wire-wound screen
Y Horizontal Perforated Slots

ENGDA Database Table/Field: **type_cd** in the **geo_well_casing** table. Allowable values stored in **geo_well_csng_type_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list on the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Opening Length

Description: Length of the openings in the screen for the specified interval, in millimeters.

Data Type: numeric

Example: Opening length 15

ENGDA Database Table/Field: **open_len_va** in the **geo_well_casing** table.

ENGDA Screen Data Entry: Entered by the user on the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Opening Width

Description: Width of the openings in the screen for the specified interval, in millimeters.

Data Type: numeric

Example: Opening width 5

ENGDA Database Table/Field: `open_width_va` in the `geo_well_casing` table.

ENGDA Screen Data Entry: Entered by the user on the Casing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Packing/Filling Data Fields

Packing data describe how the annular space between the casing and borehole wall was filled. “Packing” refers to material installed that will allow transmission of water from the aquifer to the well. “Filling” refers to material installed that will prevent water from passing through a specified interval; such material is used to isolate individual aquifers or to prevent contaminants from moving vertically along the borehole to other water-producing intervals. General information (Packing Start Date, Packing End Date, Packing Rig Number, Packing Supervisor) can be entered about the packing procedure, and detailed information (for example, packing material used in the annular space) can be entered about each packing or filling interval.

Packing Start Date

Description: The date on which installation of packing or filling material started.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Packing Start Date: 22/01/1998

ENGDA Database Table/Field: `packing_start_dt` in the `geo_well_cons` table.

ENGDA Screen Data Entry: Entered by the user on the Packing form of the Borehole Details form.

ENGDA Field Form: Form for Record of Well Construction

Packing End Date

Description: The date on which installation of packing or filling ended.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Packing End Date: 22/01/1998

ENGDA Database Table/Field: `packing_end_dt` in the `geo_well_cons` table.

ENGDA Screen Data Entry: Entered by the user on the Packing form of the Borehole Details form.

ENGDA Field Form: Form for Record of Well Construction

Packing Supervisor

Description: This field contains a code representing the name of the person who supervised the packing installation.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI David Litke
DALI2 David Little
TETA Tesfaya Tadesse

ENGDA Database Table/Field: `packing_party_id` in the `geo_well_cons` table. Allowable values stored in `geo_party_id_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Packing form of the Borehole Details form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Form for Record of Well Construction

Packing Rig Number

Description: This field contains a code for the rig used to install the packing.

Data Type: List, 3-character code

1
2
WD

ENGDA Database Table/Field: `packing equip_tx` in the `geo_well_cons` table. Allowable values stored in the `geo_drill_rigs` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Interval Top [REQUIRED]

Description: Depth from the surface to the top of the packing or filling interval, in meters.

Data Type: Numeric, units meters

Example: Interval Top 100.25

ENGDA Database Table/Field: `pack_top_va` in the `geo_well_packing` table.

ENGDA Screen Data Entry: Entered by the user in the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Interval Bottom [REQUIRED]

Description: Depth from the surface to the bottom of the packing or filling interval, in meters.

Data Type: Numeric, units meters

Example: Interval Bottom 120.25

ENGDA Database Table/Field: `pack_end_va` in the `geo_well_packing` table.

ENGDA Screen Data Entry: Entered by the user in the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Filling Material

Description: Type of filling material installed in the hole for the specified interval.

Data Type: List, 2-character code

CL Clay
B Bentonite
CE Cement
O Other (such as drill cuttings)

ENGDA Database Table/Field: `pack_filling_cd` in the `geo_well_packing` table.

ENGDA Screen Data Entry: Selected by the user from a list on the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Packing Material

Description: Packing material installed in the hole for the specified interval.

Data Type: List, 1-character code

S sand
G gravel
O Other (such as drill cuttings)

ENGDA Database Table/Field: `pack_packing_cd` in the `geo_well_packing` table.

ENGDA Screen Data Entry: Selected by the user from a list on the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Grain Size

Description: Nominal grain size of the packing material, in millimeters.

Data Type: numeric

Example: Grain size 4

ENGDA Database Table/Field: **pack_dia_va** in the **geo_well_packing** table.

ENGDA Screen Data Entry: Entered by the user from a list on the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Quantity

Description: Quantity of filling/packing material installed in the hole for the specified interval, in cubic meters.

Data Type: numeric

Example: Quantity 4.2

ENGDA Database Table/Field: **pack_quant_va** in the **geo_well_packing** table.

ENGDA Screen Data Entry: Entered by the user on the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Comment

Description: Any comments about the filling or packing process for this interval.

Data Type:

Example: Comment Fractures in rock required additional packing.

ENGDA Database Table/Field: **pack_comment_tx** in the **geo_well_packing** table.

ENGDA Screen Data Entry: Entered by the user on the Packing form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction

Well Development Data Fields

Development data describe how a newly-constructed well was prepared for producing water. During the process of development, the progress of the development may be monitored by collecting data on water temperature, conductivity, pH, turbidity, and other parameters; these types of data may be recorded on the Well Construction field form, but they are not stored in the ENDGA database.

Start Date

Description: Date/time of start of well development.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Start Date 21/03/1989

ENGDA Database Table/Field: **start_dt** in the **geo_well_develop** table.

ENGDA Screen Data Entry: Entered by the user in the Development form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction, well development section

End Date

Description: Date/time of end of well development.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Start Date 22/12/2001.

ENGDA Database Table/Field: **end_dt** in the **geo_well_develop** table.

ENGDA Screen Data Entry: Entered by the user in the Development form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction, well development section

Development Contractor

Description: Name of the agency or company that developed the well

Data Type: Text string.

Example: Afar Drilling Company

ENGDA Database Table/Field: **Not stored in ENGDA database**

ENGDA Screen Data Entry: Not stored in ENGDA database

ENGDA Field Form: Form for Record of Well Construction, well development section

Developer Name

Description: This field contains a code representing the name of the person that developed the well or supervised the well development. The person responsible for completion of the well development.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI David Litke

DALI2 David Little
TETA Tesfaya Tadesse

ENGDA Database Table/Field: **party_id** in the **geo_well_develop** table. Allowable values stored in **geo_party_id_lut** table.

ENGDA Screen Data Entry: Selected by the user on the Development form of the Borehole Detail form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Form for Record of Well Construction, well development section

Developer Rig Number

Description: Name/number of drill rig that did the well development.

Data Type: List, 3-character code

Example: Drill Rig 12

ENGDA Database Table/Field: **drill_rig_id** in the **geo_well_develop** table. Allowable values stored in **geo_drill_rigs** table.

ENGDA Screen Data Entry: Selected by the user on the Development form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction, well development section

Duration of Development

Description: Time duration, in hours, of well development.

Data Type: Integer

Example: Duration 2

ENGDA Database Table/Field: **duration_va** in the **geo_well_develop** table.

ENGDA Screen Data Entry: Entered by the user in the Development form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction, well development section

Development Method

Description: Method used to develop the well.

Data Type: List, 1-character code

A Airlift
B Bailing
C Chemicals
D Direct injection
F Flushing

J Jetting with air
K Jetting with water
M Mechanical surging
P Pumping and backwashing
W Backwashing

Example: Development Method A

ENGDA Database Table/Field: **meth_cd** in the **geo_well_develop** table. Allowable values stored in **geo_develop_method_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user on the Development form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction, well development section

Pump Description

Description: Description of the type of pump used to develop the well. *Note this should be related to the method.* For example if the method of well development is Jetting or Backwashing, then no pump would be used. If a bailer was used to develop the well, then fill out the field form with the word bailer. Typical pumps that may be used for well development are: Bucket/Bailer; Centrifugal; Jet; Piston; Rotary; Submersible.

Data Type: Character, 50-character code

Example: Pump Description: none

ENGDA Database Table/Field: Not stored in ENGDA database.

ENGDA Screen Data Entry: Not stored in ENGDA database.

ENGDA Field Form: Form for Record of Well Construction, well development section

Pump Capacity

Description: Description of the capacity of the pump used for development. If no pump is used then leave blank.

Data Type: Numeric

Example: Pump Capacity: none

ENGDA Database Table/Field: Not stored in ENGDA database.

ENGDA Screen Data Entry: Not stored in ENGDA database.

ENGDA Field Form: Form for Record of Well Construction, well development section

Pump Position

Description: Depth below the top of casing that the pump is positioned, if a pump was used for development. If a pump is not used, leave blank. The depth is entered in units of meter.

Data Type: Numeric

Example: Pump Position: 5

ENGDA Database Table/Field: Not stored in ENGDA database.

ENGDA Screen Data Entry: Not stored in ENGDA database.

ENGDA Field Form: Form for Record of Well Construction, well development section.

Comments

Description: Any comments about well development.

Data Type: Text string not to exceed 150 characters

Example: Comment Water removed from well was very turbid

ENGDA Database Table/Field: **comment_tx** in the **geo_well_develop** table.

ENGDA Screen Data Entry: Entered by the user in the Development form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction, well development section

Additional Equipment

Description: Information about additional equipment (besides drill rig) used for well development.

Data Type: Text string not to exceed 100 characters

Example: Additional Equipment Gasoline generator used to power pressure pump

ENGDA Database Table/Field: **additional equip_tx** in the **geo_well_develop** table.

ENGDA Screen Data Entry: Entered by the user in the Development form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Well Construction, well development section

LITHOLOGIC DESCRIPTION DATA FIELDS

These fields will contain multiple records for the description of each interval at a site where core or cuttings samples were taken. This lithology description scheme was developed by South Africa (Hodgson et. al., 1993). The lithologic descriptions should be filled out by trained and experienced geologists or drillers. If cuttings or continuous wireline core is stored, this form could be filled in at a laboratory or core library by a trained and experienced geologist, provided the depth interval of the sample is recorded with the sample.

Fields for Determining Depth Interval

Interval Top [REQUIRED]

Description: Depth to top of sample interval in meters.

Data Type: numeric

Example: Interval Top 100.25

ENGDA Database Table/Field: **lith_top_va** in the **geo_well_hydrounits** table.

ENGDA Screen Data Entry: Entered by the user in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Interval Bottom [REQUIRED]

Description: Depth to bottom of sample interval in meters.

Data Type: numeric

Example: Interval Bottom 120.25

ENGDA Database Table/Field: **lith_end_va** in the **geo_well_hydrounits** table.

ENGDA Screen Data Entry: Entered by the user in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Fields for Defining Lithology of a Selected Interval

Lithology Code

Description: Lithologic description codes to describe the rock or sediment type at this interval as defined in the HydroCom database (Hodgson et.al., 1993).

Data Type: List, 4-character code

AOLN	Aeolian deposits	GRCL	Gravel and clay
AGLM	Agglomerate	GRDS	Gravel, sand and clay
ALVM	Alluvium	GRSC	Gravel, silt and clay
APBL	Amphibolite	GNST	Greenstone
ADST	Andesite	GRCK	Greywacke
ANDR	Anhydrite	GRIT	Grit
ANRS	Anorthosite	GPSM	Gypsum
ARKS	Arkose	HRDP	Hard pan
BDIS	Banded Ironstone	HZPG	Harzburgite
BSLT	Basalt	HNFL	Hornfels
BNTN	Bentonite	IGBR	Igimbrite
BLCL	Boulder clay	JSPR	Jasper
BLDR	Boulders	JPLT	Jaspillite
BLSD	Boulders and clay	KLNT	Kaolinite
BLSC	Boulders, silt and clay	KBLT	Kimberlite
BRCC	Breccia	LTRT	Laterite
BNZT	Bronzite	LAVA	Lava
CCTF	Calc tufa	LGNT	Lignite
CLCT	Calcite	LMSN	Limestone
CLCR	Calcrete	LMDM	Limestone and dolomite
CBNT	Carbonatite	LOAM	Loam
CHLK	Chalk	LOSS	Loess
CHRT	Chert	MGGB	Magnetite gabbro
CLAY	Clay	MRBL	Marble
CLSD	Clay and sand	MARL	Marl
CLSN	Claystone	MRLS	Marlstone
COAL	Coal	MCSC	Mica schist
COBB	Cobbles	MUD	Mud
COSD	Cobbles and sand	MDSN	Mudstone
COSC	Cobbles, silt and clay	MLNT	Mylonite
CLVM	Colluvium	NPHL	Nepheline
CLGM	Conglomerate	N.S.	No sample
DIBS	Diabase	NORT	Norite
DMCT	Diamictite	NRAR	Norite-anorthosite
DORT	Diorite	OVDR	Olivine diorite
DLRT	Dolerite	OTSH	Outwash
DLMT	Dolomite	OBDN	Overburden
DNSD	Dune sand	PEAT	Peat
ECGT	Eclogite	PGMT	Pegmatite
ELVM	Eluvium	PNLT	Phonolite
EVPR	Evaporite	PLLT	Phyllite
FULT	Fault	PPHY	Porphyry
FLST	Felsite	PDGP	Pseudogranophyre
FCRT	Ferricrete	QZPR	Quartz porphyry
FGSN	Flagstone	QZSC	Quartz schist
GBBR	Gabbro	QRTZ	Quartzite
GBNR	Gabbro-norite	RSDM	Residual
GLCL	Glacial	RYLT	Rhyolite
GNSS	Gneiss	RBBL	Rubble
GRNT	Granite	SAND	Sand
GRGN	Granite-gneiss	SDCL	Sand and clay
GDGS	Granitoid-gneiss	SDGL	Sand and gravel
GRDR	Granodiorite	SDST	Sand and silt
GNPR	Granophyre	SGVC	Sand, gravel and clay
GRVL	Gravel	SNDS	Sandstone

SDSL	Sandstone and shale
SCST	Schist
SCRE	Scree
SRPN	Serpentine
SPTC	Serpentine talc
SHLE	Shale
SHSL	Shale and siltstone
SLCT	Silcrete
SILT	Silt
STCL	Silt and clay
SLSN	Siltstone
SLSH	Siltstone and shale

SLTE	Slate
SOIL	Soil
SYNT	Syenite
SNGS	Syenite-gneiss
TALC	Talc
TLUS	Talus
TILL	Till
TLLT	Tillite
TRCT	Trachyte
TUFF	Tuff
VNQZ	Vein-quartz

ENGDA Database Table/Field: lithology_cd in the geo_well_hydrounits table. Allowable values stored in geo_lithology_cd_lut table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Primary Colours

Description: Colour of the rock sample in this interval as defined in the HydroCom database (Hodgson et. al., 1993). This is the main colour present in the rock or sediment.

Data Type: List , 1-character code

S	Black
C	Brown
B	Blue
G	Green
H	Grey
M	Purple
O	Orange
P	Pink
R	Red
W	White
Y	Yellow
0	No information

ENGDA Database Table/Field: primary_color_cd in the geo_well_hydrounits table. Allowable values stored in geo_primary_color_cd_lut table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Secondary Colours

Description: Colour of the rock sample in this interval as defined in the HydroCom database (Hodgson et. al., 1993). This is the second most prevalent colour present in the rock or sediment.

Data Type: List, 1-character code

B	Blue
C	Brown
D	Dark
G	Green
H	Grey
L	Light
M	Purple
O	Orange
P	Pink
R	Red

- V Olive
- Y Yellow
- 0 No information

ENGDA Database Table/Field: `secondary_color_cd` in the `geo_well_hydrounits` table. Allowable values stored in `geo_secondary_color_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Texture

Description: This list is for the description of the texture of the core or sample.

Data Type: List, 2-digit code

- 00 Crypto
- 01 Micro
- 11 Very fine
- 12 Very fine to fine
- 13 Very fine to medium
- 14 Very fine to coarse
- 15 Very fine to very coarse
- 21 Fine and very fine
- 22 Fine
- 23 Fine to medium
- 24 Fine to coarse
- 25 Fine to very coarse
- 31 Medium to very fine
- 32 Medium and fine
- 33 Medium
- 34 Medium to coarse
- 35 Medium to very coarse
- 41 Coarse and very fine
- 42 Coarse and fine
- 43 Coarse and medium
- 44 Coarse
- 45 Coarse to very coarse
- 51 Very coarse and very fine
- 52 Very coarse and fine
- 53 Very coarse and medium
- 54 Very coarse and coarse
- 55 Very coarse
- 99 No information

ENGDA Database Table/Field: `texture_cd` in the `geo_well_hydrounits` table. Allowable values stored in `geo_texture_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Primary and Secondary Features

Description: This list is for the description of the main features of the rock or sediment core or sample.

Data Type: List, 2-character code

AG	Argillaceous	IL	Interlaminated
AR	Arenaceous	JT	Jointed
BD	Banded	LM	Laminated
BE	Bedded	LS	Loose
BK	Baked	LT	Light
BR	Broken	LU	Lustrous
BT	Bright	MC	Micaceous
CA	Calcareous	MN	Mineralised
CB	Carbonaceous	MS	Massive
CE	Cemented	OO	Oolitic
CL	Chloritic	PB	Pebbly
CR	Cross-bedded	PO	Phosphoritic
CS	Consolidated	PR	Primary
CY	Clayey	PT	Peaty
DK	Dark	SC	Siliceous
DL	Dull	SD	Solid
FC	Fractured	SF	Soft
FE	Ferruginous	SH	Shelly
FR	Fresh	SI	Silicified
FS	Feldspathic	SL	Silty
GL	Glauconitic	SN	Sandy
GR	Gritty	SR	Secondary
GV	Gravel-bearing	UC	Unconsolidated
HD	Hard	WT	Weathered
HM	Heavy minerals		

ENGDA Database Table/Field: `prim_second_cd` in the `geo_well_hydrunits` table. Allowable values stored in `geo_prim_second_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Feature Attributes

Description: This field is a modifier for the feature described in the primary or secondary feature field.

Data Type: List, 1-character code

- + Very
- Slightly
- 0 No information

ENGDA Database Table/Field: `feature_att_cd` in the `geo_well_hydrunits` table. Allowable values stored in `geo_feature_att_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Sorting

Description: The sorting of sedimentary rock.

Data Type: List, 2-digit code

- 11 Unsorted
- 22 Poorly sorted
- 23 Poorly to moderately sorted
- 32 Moderately to poorly sorted
- 33 Moderately sorted
- 34 Moderately to well sorted
- 43 Well to moderately sorted
- 44 Well sorted
- 0 No Information

ENGDA Database Table/Field: **sorting_cd** in the **geo_well_hydrunits** table. Allowable values stored in **geo_sorting_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Roundness

Description: The shape of the sediments.

Data Type: List, 2-digit code

- 11 Angular
- 12 Angular to subangular
- 13 Angular to subrounded
- 14 Angular to rounded
- 22 Subangular
- 23 Subangular to subrounded
- 24 Subangular to rounded
- 33 Subrounded
- 34 Subrounded to rounded
- 44 Rounded
- 0 No information

ENGDA Database Table/Field: **roundness_cd** in the **geo_well_hydrunits** table. Allowable values stored in **geo_roundness_cd_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form.

ENGDA Field Form: Form for Record of Lithologic Description

Geologist

Description: This field contains a code representing the name of the person that described the lithology.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI	David Litke
DALI2	David Little
TETA	Tesfaya Tadesse

ENGDA Database Table/Field: **party_id** in the **geo_well_hydrounits** table. Allowable values stored in **geo_party_id_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Lithology form of the Borehole Detail form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Form for Record of Lithologic Description

AQUIFER TEST DATA FIELDS

One or more pumping tests can be conducted at each well. Aquifer tests (commonly referred to as pumping tests) can include types where a well is pumped and tests where a slug is introduced into the well. Aquifer test information is divided into several categories: General Aquifer Test Information, Observation Well Characteristics, Test Well Characteristics, Aquifer Test Characteristics, Slug Test Characteristics, Water Level and Discharge Data, and Aquifer Test Results.

General Aquifer Test Information

Multiple aquifer tests can be conducted at a well. Each aquifer test requires a sequence number, a starting date and an ending date. Additional information about the type and purpose of the aquifer test should also be documented.

Aquifer Test Number [REQUIRED]

Description: A sequence number defining the aquifer test; the first aquifer test number is 1.

Data Type: Short integer

ENGDA Database Table/Field: `seq_nu` in the `geo_pump_test` table.

ENGDA Screen Data Entry: This number is assigned automatically by ENGDA when a user clicks the NEW button on the Aquifer Test form on the Borehole Details form.

ENGDA Field Form: none, generated by the database

Aquifer Test Start Date [REQUIRED]

Description: The date on which the aquifer test started.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Aquifer Test Start Date 28/11/2002.

ENGDA Database Table/Field: `start_dt` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the New Pumping Test form which is launched by clicking the New pumping test button on the Pumping Test form of the Borehole Details form. Existing values can be edited by clicking on the pumping test number on the Pumping Test form and then entering new values.

ENGDA Field Form: Aquifer Test Field Form

Aquifer Test End Date [REQUIRED]

Description: The date on which the aquifer test ended.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Aquifer Test End Date 28/11/2002.

ENGDA Database Table/Field: `end_dt` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the New Pumping Test form which is launched by clicking the New pumping test button on the Pumping Test form of the Borehole Details form. Existing values can be edited by clicking on the aquifer test number on the Pumping Test form and then entering new values.

ENGDA Field Form: Aquifer Test Field Form

Duration of Aquifer Test

Description: The duration of the aquifer test, in hours.

Data Type: Floating point number

Example: Duration of Aquifer Test 45.5

ENGDA Database Table/Field: `duration_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form

Agency Conducting Test

Description: The name of the agency that conducted the aquifer test

Data Type: List, text string code not to exceed 10 characters

(Examples of agencies in list)

AAWSA	Addis Ababa Water and Sewerage Authority
ESTC	Ethiopian Science and Technology Commission
GSE	Geological Survey of Ethiopia

ENGDA Database Table/Field: `dept_cd` in the `geo_pump_test` table. Existing values stored in `com_department_lut` table.

ENGDA Screen Data Entry: Selected by the user on the Pumping Test form of the Boreholes Detail Form. New data sources (agencies) can be added by the user by typing in a new agency name.

ENGDA Field Form: Aquifer Test Field Form

Aquifer Test Type

Description: The type of the aquifer test.

Data Type: List, text string code not to exceed 50 characters

Flowing Artesian Well Test
Multiple Well Constant Rate
Multiple Well Step-Drawdown Test

Single Well Constant Rate Aquifer Test
Single Well Step-Drawdown Test
Slug Test

ENGDA Database Table/Field: `test_type_tx` in the `geo_pump_test` table. Existing values stored in `geo_pump_test_types` table.

ENGDA Screen Data Entry: Selected by the user from a list on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form

Aquifer Test Comment

Description: This field contains miscellaneous information about the aquifer test.

Data Type: Text string not to exceed 150 characters

Example: Aquifer Test Comment Test interrupted for 3 hours due to pump malfunction

ENGDA Database Table/Field: `comment_tx` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Observation Well Characteristics

Observation well data fields from the Aquifer Test Field Form (Appendix 2) are entered by clicking on the Observation Wells button in the Pumping Test form of the Borehole Details form in the ENGDA software. This brings up the Observation Wells Used in Pumping Test form. Here you can select existing wells in the database which were used as observation wells for the pumping test. For each observation well you must enter:

Observation Well Name [REQUIRED]

Description: The name of the observation well.

Data Type: List; select Site Name from a list and `site_id` is stored in database.

Example: Observation Well Name Test Site 1 Aba Ali, Kutaber

ENGDA Database Table/Field: `data_well_site_id` in the `geo_pump_test_wells` table.

ENGDA Screen Data Entry: Selected by the user from a list of existing wells Observation Wells Used in Pumping Test form.

ENGDA Field Form: Aquifer Test Field Form, Well Inventory Field Form

Observation Well Azimuth

Description: The azimuth (compass direction), in degrees, of the observation well from the pumped test well. If there is only one observation well it is not critical to the analysis of the aquifer test to have this value. However it should be recorded on the Aquifer Test Field Form and in the ENGDA database, but is not a required field.

Data Type: Floating point number

Example: Observation Well Azimuth 145.5

ENGDA Database Table/Field: **azimuth_va** in the **geo_pump_test_wells** table.

ENGDA Screen Data Entry: Entered by the user on the Observation Wells Used in Pumping Test form.

ENGDA Field Form: Aquifer Test Field Form

Observation Well Distance [REQUIRED]

Description: The radial distance in meters of the observation well from the pumped test well. It is critical to the analysis if the aquifer test that the radial distance of the observation well from the test well is known, which is why this is a required field in the ENGDA database.

Data Type: Floating point number

Example: Observation Well Distance 120.5

ENGDA Database Table/Field: **distance_va** in the **geo_pump_test_wells** table.

ENGDA Screen Data Entry: Entered by the user on the Observation Wells Used in Pumping Test form.

ENGDA Field Form: Aquifer Test Field Form

Test Well Characteristics

Selected information is required about the test well, in which water was pumped or a slug was used, in order to analyze the pumping test results. In some cases (for example, Depth to Aquifer Bottom) the hole characteristics may not be known and so must be estimated. In other cases (for example, Casing Diameter) the data may be stored in other parts of ENGDA. The data should be entered on the Pumping Test form, however, so that a record may be kept of the parameters used to analyze the pumping test data.

Casing Diameter

Description: Principal diameter of the casing in the test well, in centimeters. May be determined by examining the Well Casing information stored for the borehole in ENGDA; *note however that the casing diameter units in the Casing table are in millimeters, while the units used here are in centimeters.*

Data Type: Floating point number

Example: Casing Diameter 25.0

ENGDA Database Table/Field: **casing_dia_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form, Well Construction Form

Annulus Diameter

Description: Principal diameter of the borehole, in centimeters. May be determined by examining the Hole information stored for the borehole in ENGDA; *note however that the hole diameter units in the Hole table are in millimeters, while the units used here are in centimeters.*

Data Type: Floating point number

Example: Annulus Diameter 40.0

ENGDA Database Table/Field: **annulus_dia_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form, Well Construction Form

Screen Length

Description: Total length of the screened interval of the well, in meters. May be determined by examining the Well Casing information stored for the borehole in ENGDA; *note however that multiple screened intervals may need to be added or interpreted to determine the correct screen length to be used in the pumping test analysis.*

Data Type: Floating point number

Example: Screen Length 15.0

ENGDA Database Table/Field: **screen_length_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form, Well Construction Form

Depth to Screen Top

Description: Depth to the top of the screen from the land surface, in meters. May be determined by examining the Well Casing information stored for the borehole in ENGDA.

Data Type: Floating point number

Example: Depth to Screen Top 80.0

ENGDA Database Table/Field: **screen_top_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form, Well Construction Form

Fill Material

Description: Principal type of fill material throughout the screened interval of the well. May be determined by examining the Packing information stored for the borehole in ENGDA; *note however that packing information over several intervals may need to be interpreted to determine the best value for fill material to use for the pumping test analysis.*

Data Type: List, text string code not to exceed 50 characters

Coarse Sand
Fine Sand
Gravel
Medium Sand

ENGDA Database Table/Field: `fill_material_tx` in the `geo_pump_test` table. Existing values stored in `geo_pump_test_fill_material`.

ENGDA Screen Data Entry: Selected by the user from a list on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form, Well Construction Form

Packing Material

Description: Principal type of fill material throughout the screened interval of the well. May be determined by examining the Packing information stored for the borehole in ENGDA; *note however that packing information over several intervals may need to be interpreted to determine the best value for packing material to use for the pumping test analysis.*

Data Type: List, text string code not to exceed 50 characters

Backfill
Bentonite
Cement
Open Hole

ENGDA Database Table/Field: `pack_material_tx` in the `geo_pump_test` table. Allowable values stored in `geo_pump_test_pack_material`.

ENGDA Screen Data Entry: Selected by the user from a list on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form, Well Construction Form

Depth to Aquifer Top

Description: Depth to the top of the aquifer from the land surface, in meters. May be determined by examining the Drilling, Water Struck, Casing, and Lithology information stored for the borehole in ENGDA.

Data Type: Floating point number

Example: Depth to Screen Top 60.0

ENGDA Database Table/Field: `aquifer_top_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form

Depth to Aquifer Bottom

Description: Depth to the bottom of the aquifer from the land surface, in meters. May be determined by examining the Drilling, Water Struck, Casing, Hole, and Lithology information stored for the borehole in ENGDA.

Data Type: Floating point number

Example: Depth to Screen Top 60.0

ENGDA Database Table/Field: `aquifer_bottom_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form

Aquifer Material

Description: Principal type of aquifer material throughout the screened interval of the well. May be determined by examining the Lithology information stored for the borehole in ENGDA; *note however that lithology information over several intervals may need to be interpreted to determine the best value for aquifer material to use for the pumping test analysis.*

Data Type: List, text string code not to exceed 50 characters

Anhydrite
Basalt
Clay
Clay soils (surface)
Claystone
Coarse Sand
Fine Sand
Fine-Grained Sandstone
Fractured Igneous and Metamorphic Rock
Gravel
Karst
Limestone, Dolomite
Medium Sand
Medium-Grained Sandstone
Permeable Basalt
Sand and Gravel Mixes
Shale
Silt, Loess
Siltstone
Till
Unfractured Igneous and Metamorphic Rock
Unweathered Marine Clay
Weathered Gabbro
Weathered Granite

ENGDA Database Table/Field: `aquifer_tx` in the `geo_pump_test` table. Existing values stored in `geo_pump_test_aquifer_materials`.

ENGDA Screen Data Entry: Selected by the user from a list on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form

Static Water Level

Description: Static depth to water (just prior to the start of the pump) from the land surface, in meters.

Data Type: Floating point number

Example: Static Water Level 30.0

ENGDA Database Table/Field: `static_water_level_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form, Slug Test Field Form

Confining Layer Thickness

Description: Thickness of the confining layer over the tested aquifer, in meters. Applies only to specific aquifer test types.

Data Type: Floating point number

Example: Confining Layer Thickness 130.0

ENGDA Database Table/Field: `confine_thick_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Boreholes Detail Form.

ENGDA Field Form: Aquifer Test Field Form

Aquifer Test Characteristics

Selected characteristics of the aquifer test are required to analyze the pumping test results. Additional data fields may be for documentation purposes only, such that other methods of analysis can be applied later.

Safe Yield

Description: The aquifer test safe yield (pumping rate that can be sustained while maintaining a relatively static drawdown), in liters per second. Used for documentation purposes only.

Data Type: Floating point number

Example: Duration of Test 12.4

ENGDA Database Table/Field: `yield_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Pump Type

Description: The type of pump used in the pumping test. Used for documentation purposes only.

Data Type: List, 2-character code

AL Air lift
BL Bailer
CP Centrifugal pump
ES Electro-submersible
SP Sand pump
TR Turbine

ENGDA Database Table/Field: `method_pumped_cd` in the `geo_pump_test` table. Allowable values stored in the `geo_pump_methods` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Pump Suction

Description: The pump suction in meters. Used for documentation purposes only.

Data Type: Floating point number

Example: Pump suction 5.26

ENGDA Database Table/Field: `pump_suction_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Discharge Method

Description: Method used to determine the discharge at the pumped well. Used for documentation purposes only.

Data Type: List, 1-character code

C Current meter
E Estimated
F Flume
M Totaling meter
O Orifice meter
R Reported
U Venturi meter
V Volumetric measurement
W Wier

Z Other

ENGDA Database Table/Field: `discharge_method_cd` in the `geo_pump_test` table. Allowable values stored in `geo_well_yield_method_cd_lut`.

ENGDA Screen Data Entry: Selected by the user from a list on the Pumping Test form of the Borehole Detail form.

ENGDA Field Form: Aquifer Test Field Form, Discharge Measurement Field Form

Suction Depth

Description: The depth, in meters below land surface, of the intake mouth pump suction. Used for documentation purposes only.

Data Type: Floating point number

Example: Suction Depth 9.45

ENGDA Database Table/Field: `pump_suction_depth_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Working Water Level

Description: The depth, in meters below land surface, of the water at the end of the pumping test, right before the pump is turned off. This can be used to calculate specific capacity of the well. It is mainly stored for documentation purposes only.

Data Type: Floating point number

Example: Working Water Level 10.87

ENGDA Database Table/Field: `working_water_level_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Test Flow Rate

Description: The pumping flow rate, in liters per second (L/s), maintained throughout the aquifer test for Constant Rate or Flowing Artesian Well type pumping tests. Required for aquifer test analysis.

Data Type: Floating point number

Example: Test Flow Rate 10.5

ENGDA Database Table/Field: `rate_va` in the `geo_pump_test` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Constant Drawdown

Description: The difference, in meters, between the static head, and the head after opening the well, for an artesian well that is capped or has an above ground stand pipe. Required only for Jacob-Lohman Flowing Well pumping test analysis (Halford and Kuniatsky, 2002).

Data Type: Floating point number

Example: Constant Drawdown 10.87

ENGDA Database Table/Field: **drawdown_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Assumed Storage Coefficient

Description: Assumed storage coefficient (dimensionless) for the tested aquifer. Required only for Pumping Step-Drawdown and Cooper-Jacob with Efficiency pumping test analyses.

Data Type: Floating point number

Example: Assumed Storage Coefficient 0.0005

ENGDA Database Table/Field: **storage_coeff_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Aquifer Test Field Form

Slug Test Characteristics

Selected characteristics of the slug are required to analyze the slug-type aquifer test results.

Slug Type

Description: Type of slug introduced into tested well.

Data Type: List, text string not to exceed 10 characters

Air
Bailer
Poured

ENGDA Database Table/Field: **slug_type_tx** in the **geo_pump_test** table. Allowable values stored in **geo_pump_test_slug_types**.

ENGDA Screen Data Entry: Selected by the user from a list on the Pumping Test form of the Borehole Detail form.

ENGDA Field Form: Slug Test Field Form

Slug Length

Description: The length, in centimeters, of a bailer type slug.

Data Type: Floating point number

Example: Slug Length 50.0

ENGDA Database Table/Field: **slug_length_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Slug Test Field Form

Slug Diameter

Description: The diameter, in centimeters, of a bailer type slug.

Data Type: Floating point number

Example: Slug Length 8.0

ENGDA Database Table/Field: **slug_dia_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Slug Test Field Form

Slug Length (Air Slug)

Description: The length, in centimeters, of the column of water displaced using an air type slug.

Data Type: Floating point number

Example: Slug Length 50.0

ENGDA Database Table/Field: **slug_disp_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Slug Test Field Form

Slug Volume

Description: The volume, in liters, of a poured type slug.

Data Type: Floating point number

Example: Slug Volume 50.0

ENGDA Database Table/Field: **slug_vol_va** in the **geo_pump_test** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: Slug Test Field Form

Water Level and Discharge Data Fields

During aquifer tests, data are collected on the discharge rate of the pumped test well and on the water levels in the pumped test well and any observation wells. For the pumped test wells, data may also be collected on the water quality of the pumped water. These data are entered into ENGDA by clicking on the Water Level Data Input button in the Pumping Test form of the Borehole Details form. This brings up the Pumping Test Data Entry form, where the following data can be entered from the Aquifer Test or Slug Test Field Form.

NOTE: On field forms, water-level data includes Depth to Water from the Measuring Point, the Elevation of the Measuring Point, and the Depth to Water Below Land Surface; of these, only the Depth to Water Below Land Surface is entered into the database.

Water Level Date/Time [REQUIRED]

Description: The date/time at which a pumping test data measurement is made.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Water Level Date/Time: 28/11/2002 15:30

ENGDA Database Table/Field: `water_level_dt` in the `geo_pump_test_water_levels` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test or Slug Test Field Form

Water Level

Description: The water level in meters below the land surface or measuring point (which could be the top of casing).

Data Type: Floating point number

Example: Water Level 20.34

ENGDA Database Table/Field: `water_level_va` in the `geo_pump_test_water_levels` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test or Slug Test Field Form

Pump Discharge

Description: The pump discharge of the pumping well in liters per second.

Data Type: Floating point number

Example: Pump Discharge 1.34

ENGDA Database Table/Field: **discharge_va** in the **geo_pump_test_water_levels** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test Form

Water Temperature

Description: The water temperature in degree Celsius of the water pumped.

Data Type: Floating point number

Example: Water Temperature 20.3

ENGDA Database Table/Field: **water_temp_va** in the **geo_pump_test_water_levels** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test Form

Water Conductivity

Description: The conductivity in microsiemens per centimeter of the water pumped.

Data Type: Floating point number

Example: Water Conductivity 245

ENGDA Database Table/Field: **water_cond_va** in the **geo_pump_test_water_levels** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test Form

Turbidity

Description: The turbidity in NTU of the water pumped.

Data Type: Floating point number

Example: Turbidity 60

ENGDA Database Table/Field: **water_turbidity_va** in the **geo_pump_test_water_levels** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test Form

Appearance

Description: The appearance of the water pumped.

Data Type: Text string not to exceed 30 characters

Example: Appearance Cloudy

ENGDA Database Table/Field: **water_appearance_cd** in the **geo_pump_test_water_levels** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test Form

Comment

Description: A comment about the water-level measurement.

Data Type: Text string not to exceed 50 characters

Example: Comment No conductivity because meter broke

ENGDA Database Table/Field: **comment_tx** in the **geo_pump_test_water_levels** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Data Entry form.

ENGDA Field Form: Aquifer Test Form, Slug Test Field Form

Pumping Test Results

Aquifer properties that are estimated as a result of pumping tests can be stored in ENDGA. *Note that ENGDA has been set up to transfer data directly into aquifer test analysis spreadsheets (Halford and Kuniansky, 2002).*

Result Estimation Date

Description: The date on which the aquifer properties were estimated.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Result Estimation Date 28/11/2002.

ENGDA Database Table/Field: **result_dt** in the **geo_pump_test_results** table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Results form which is accessed by clicking on the Results button on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: none-Data is analyzed using graphical methods or software

Transmissivity

Description: The transmissivity of the aquifer in m²/day as calculated based on the pumping test at the site.

Data Type: Floating point number

Example: Transmissivity 3.0

ENGDA Database Table/Field: `transmissivity_va` in the `geo_pump_test_results` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Results form which is accessed by clicking on the Results button on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: none-Data is analyzed using graphical methods or software

Hydraulic Conductivity

Description: The hydraulic conductivity of the aquifer in m/day as calculated based on the pumping test at the site.

Data Type: Floating point number

Example: Hydraulic Conductivity 3.0

ENGDA Database Table/Field: `horiz_conduct_va` in the `geo_pump_test_results` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Results form which is accessed by clicking on the Results button on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: none-Data is analyzed using graphical methods or software

Specific Storage

Description: The specific storage of the aquifer in 1/ft as calculated based on the pumping test at the site. *Note this value can only be determined from a multi-well aquifer test.*

Data Type: Floating point number

Example: Specific Storage 3.0

ENGDA Database Table/Field: `spfc_storage_va` in the `geo_pump_test_results` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Results form which is accessed by clicking on the Results button on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: none-Data is analyzed using graphical methods or software

Storage Coefficient

Description: The storage coefficient of the aquifer (dimensionless) as calculated based on the pumping test at the site. The storage coefficient can sometimes be estimated from a single-well pumping test if wellbore storage effects are negligible and the well is very efficient. However, it is best to estimate from a multi-well aquifer test.

Data Type: Floating point number

Example: Storage Coefficient 3.0

ENGDA Database Table/Field: `storage_coeff_va` in the `geo_pump_test_results` table.

ENGDA Screen Data Entry: Entered by the user on the Pumping Test Results form which is accessed by clicking on the Results button on the Pumping Test form of the Borehole Details form.

ENGDA Field Form: none-Data is analyzed using graphical methods or software

WATER USE, DISCHARGE, AND WATER LEVEL DATA FIELDS

These fields are used for describing water use, discharge values at wells and springs, and water level measurements. These fields are either on their own form specific to water use, discharge, or water levels or are on several other forms, such as well inventory or well construction.

Water Use Data Fields

These are the fields used to describe the use of the water from a site. Water use can be reported by year or by month. Water-use quantities should be reported in cubic meters.

Water Use Year/Month [REQUIRED]

Description: The year or year and month for which water use is being reported.

Data Type: Text string not to exceed 6 characters.

Example: Water Use Year/Month 2000
Water Use Year/Month 200001

ENGDA Database Table/Field: wu_record_year_month_tx in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Domestic Use

Description: The amount of water used for domestic purposes, in cubic meters.

Data Type: Floating point number

Example: Domestic Use 12.34

ENGDA Database Table/Field: domestic_va in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Irrigation Use

Description: The amount of water used for irrigation purposes, in cubic meters.

Data Type: Floating point number

Example: Irrigation Use 12.34

ENGDA Database Table/Field: irrigation_va in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Mining Use

Description: The amount of water used for mining purposes, in cubic meters.

Data Type: Floating point number

Example: Mining Use 12.34

ENGDA Database Table/Field: **mining_va** in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Industrial Use

Description: The amount of water used for industrial purposes, in cubic meters.

Data Type: Floating point number

Example: Industrial Use 12.34

ENGDA Database Table/Field: **industrial_va** in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Public Supply Use

Description: The amount of water used for public supply purposes, in cubic meters.

Data Type: Floating point number

Example: Public Supply Use 12.34

ENGDA Database Table/Field: **public_supply_va** in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Stock Watering Use

Description: The amount of water used for stock watering purposes, in cubic meters.

Data Type: Floating point number

Example: Stock Watering Use 12.34

ENGDA Database Table/Field: **stock_va** in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Geothermal Use

Description: The amount of water used for geothermal purposes, in cubic meters.

Data Type: Floating point number

Example: Geothermal Use 12.34

ENGDA Database Table/Field: **geothermal_va** in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Mixed Use

Description: The amount of water used for multiple purposes, in cubic meters.

Data Type: Floating point number

Example: Mixed Use 12.34

ENGDA Database Table/Field: **other_va** in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Other Use

Description: The amount of water used for other purposes, in cubic meters.

Data Type: Floating point number

Example: Other Use 12.34

ENGDA Database Table/Field: **other_va** in the **geo_well_wateruse** table.

ENGDA Screen Data Entry: Entered by the user on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Data Source

Description: The entity type that provided the water use data

Data Type: List, 1-character code

O Owner
R Regional bureau
S Regulatory agency
Z Other

ENGDA Database Table/Field: `src_cd` in the `geo_well_wateruse` table. Allowable values stored in `geo_data_source_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list in the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Method

Description: Method used to determine the water use

Data Type: List, 1-character code

E Estimated
M Metered

ENGDA Database Table/Field: `remarks_tx` in the `geo_well_wateruse` table.

ENGDA Screen Data Entry: Selected by the user from a list on the Water Use form of the Borehole Detail form.

ENGDA Field Form: Water use

Discharge Data Fields

Well or spring discharge (yield) data are measurements of water that is flowing from a spring or water that can be pumped from a well while the pumping water level remains relatively static.

Date Discharge Measured [REQUIRED]

Description: The date of the discharge measurement.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Finish 28/11/2002 15:30

ENGDA Database Table/Field: `result_dt` in the `geo_well_discharge` table.

ENGDA Screen Data Entry: Entered by the user on the Yield form of the Borehole Detail form.

ENGDA Field Form: Discharge

Discharge

Description: The measured discharge of the well or spring, in liters per second.

Data Type: Real number

Example: Discharge 5.26

ENGDA Database Table/Field: **result_va** in the **geo_well_discharge** table.

ENGDA Screen Data Entry: Entered by the user on the Yield form of the Borehole Detail form.

ENGDA Field Form: Discharge

Measurement Method

Description: The method used to measure the discharge.

Data Type: List, 1-character code

C Current meter
E Estimated
F Flume
M Totaling meter
O Orifice wier
R Reported
U Venturi meter
V Volumetric measurement
W Wier
Z Other

ENGDA Database Table/Field: **method_cd** in the **geo_well_discharge** table. Allowable values stored in **geo_well_yield_method_cd** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Yield form of the Borehole Detail form.

ENGDA Field Form: Discharge

Type of Discharge

Description: Describe if the discharge is naturally flowing or, if by a pump, then describe the pumping status.

Data Type: List , 1-character code

P pumped
F flowing

ENGDA Database Table/Field: **status_cd** in the **geo_well_discharge** table. Allowable values stored in **geo_gw_level_status_cd** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Yield form of the Borehole Detail form.

ENGDA Field Form: Discharge

Measured By

Description: This field contains a code representing the name of the person that made the discharge measurement.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI	David Litke
DALI2	David Little
TETA	Tesfaya Tadesse

ENGDA Database Table/Field: **party_id** in the **geo_well_discharge** table. Allowable values stored in **geo_party_id_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Yield form of the Borehole Detail form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Form: Discharge

Comment

Description: A comment about the discharge measurement.

Data Type: Text string not to exceed 100 characters.

Example: Comment Measurement made twice and average taken

ENGDA Database Table/Field: **remark_tx** in the **geo_well_discharge** table.

ENGDA Screen Data Entry: Entered by the user in the Yield form of the Borehole Detail form.

ENGDA Field Form: Discharge

Water Level Data Fields

These fields are used to describe instantaneous water levels measured at sites. Some of the data required on the Water Level Field Form, such as land surface altitude, site location information, have been discussed in previous sections of the data dictionary (Site Location Information and Well Inventory Information).

NOTE: Water-level data field forms include data (Held position, Cut position and Depth to Water from the Measuring Point) needed to calculate the Depth to Water Below Land Surface; these data are not entered into ENGDA. The final result (Depth to Water Below Land Surface) is entered into the database. This is a calculated value.

Date/Time Water Level Measured [REQUIRED]

Description: The date or date/time of the water level measurement.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Date/Time Water Level Measured 20/08/2001 13:00

ENGDA Database Table/Field: **result_dt** in the **geo_gw_level** table.

ENGDA Screen Data Entry: Entered by the user on the Water Level form of the Borehole Detail form.

ENGDA Field Forms: Well Inventory, Water Level Measurement, Aquifer Test, Slug Test

Held

Description: When using a steel tape to measure the depth to water below a measuring point one holds a fixed mark in meters at the measuring point. This number is the held number used with the cut value in computation of depth to water below measuring point (held minus cut equals depth to water below MP). If an electric tape is used the held is the mark read off of the tape in decimal meters for when the device sounds or lights up indicating the water level has been reached.

Data Type: Real number

Example: Held 5.26

ENGDA Database Table/Field: none

ENGDA Screen Data Entry: none

ENGDA Field Forms: Well Inventory, Water Level Measurement, Aquifer Test, Slug Test

Cut

Description: When using a steel tape to measure the depth to water below a measuring point one holds a fixed mark in meters at the measuring point. This is the held number. The cut is the measured value in decimal meters where the line indicating the submerged part of the steel tape versus the dry part of the steel tape (held minus cut equals depth to water below MP). This field is not used for all methods.

Data Type: Real number

Example: Cut 5.26

ENGDA Database Table/Field: none

ENGDA Screen Data Entry: none

ENGDA Field Forms: Well Inventory, Water Level Measurement, Aquifer Test, Slug Test

Equipment ID

Description: Serial number of water level meter used or some other identification number on the equipment used for measuring the water level.

Data Type: character

Example: Equipment ID P29904

ENGDA Database Table/Field: none

ENGDA Screen Data Entry: none

ENGDA Field Forms: Well Inventory, Water Level Measurement, Aquifer Test, Slug Test

Water Level

Description: The measured water level of the well, in meter below the measuring point.

Data Type: Real number

Example: Water Level 5.26

ENGDA Database Table/Field: **result_va** in the **geo_gw_level** table.

ENGDA Screen Data Entry: Entered by the user on the Water Level form of the Borehole Detail form.

ENGDA Field Forms: Well Inventory, Water Level Measurement, Aquifer Test, Slug Test

Measurement Method

Description: The method used to measure the water level.

Data Type: List, 2-character code

- 0 Unknown
- 1 Steel Tape
- 2 Electric Tape
- 3 Pressure Gage
- 4 Timing the sound from dropping a stone
- 5 Reported
- 6 Estimated from the length of a string
- 7 Use of a sounder on the end of a string
- 8 Transducer
- 9 Recorder
- 10 Other

ENGDA Database Table/Field: **method_cd** in the **geo_gw_level** table. Allowable values stored in **geo_gw_level_method_cd** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Water Level form of the Borehole Detail form.

ENGDA Field Forms: Well Inventory, Water Level Measurement, Aquifer Test, Slug Test

Well Status

Description: Describe if the discharge is naturally flowing or, if by a pump, then describe the pumping status. For a water level measurement in an observation well, the status would be “Static Water Level” 1.

Data Type: List, 1-digit code

0	UNKNOWN	(Condition unknown)
1	STATIC	(Static water level)
2	PUMPING	(The site was being pumped)
3	RECENTLY PUMPED	(The site had been pumped recently)
4	NEARBY SITE PUMPING	(A nearby site that taps the same aquifer was being pumped)
5	DRY	(The site was dry-no water level is recorded)
6	OBSTRUCTED	(An obstruction was encountered-no water level is recorded).
7	OTHER	(Other conditions that would affect the measured water level)

ENGDA Database Table/Field: `status_cd` in the `geo_gw_level` table. Allowable values stored in `geo_gw_level_status_cd_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list in the Water Level form of the Borehole Detail form.

ENGDA Field Forms: Well Inventory, Water Level Measurement

Measuring Point Description

Description: A detailed description of the measuring point may be entered here. Up to 120 characters of remarks are allowed.

Data Type: Text string not to exceed 120 characters.

ENGDA Database Table/Field: `mp_location_tx` in the `geo_gw_level` table.

ENGDA Screen Data Entry: Entered by the user on the Water Level form of the Borehole Detail form.

ENGDA Field Forms: Well Inventory, Water Level Measurement

Measuring Point Height

Description: The height of the measuring point above or below the land surface, in meters. *If the measuring point is below the land surface, it is recorded as a negative value.* It is used to calculate the depth to water above or below land surface.

Data Type: Real number

Example: Measuring Point Height 5.26
Measuring Point Height -3.25

ENGDA Database Table/Field: `mp_height_va` in the `geo_gw_level` table.

ENGDA Screen Data Entry: Entered by the user on the Water Level form of the Borehole Detail form.

ENGDA Field Forms: Well Inventory, Water Level Measurement

Measured By

Description: This field contains a code representing the name of the person that made the water level measurement.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI	David Litke
DALI2	David Little
TETA	Tesfaya Tadesse
PAT1	Patrick Tucci

ENGDA Database Table/Field: **party_id** in the **geo_gw_level** table. Allowable values stored in **geo_party_id_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list in the Water Level form of the Borehole Detail form. New persons can be added to the database by using the “Edit/Create Borehole Staff” menu option in the ENGDA database.

ENGDA Field Forms: Well Inventory, Water Level Measurement

PUMP AND BOREHOLE GEOPHYSICAL LOGS DATA FIELDS

Data about the type of pumps installed on a well or geophysical logs that were collected at a well or borehole can be recorded in ENGDA or filled out on various field forms.

Data Fields for Each Pump Installation

Because pumps are sometimes changed, information can be stored about a history of pumps at the well, including the date each was installed and removed. Each installed pump is assigned a sequence number (maximum of 6). A record is entered into the database for all of the information about one pump installation and these data are associated with the sequence number (called pump number).

Pump Number [REQUIRED]

Description: A sequence number is automatically assigned to the pump; the first pump number is 1.

Data Type: Short integer

ENGDA Database Table/Field: `lift_seq_nu` in the `geo_well_lift` table.

ENGDA Screen Data Entry: This number is assigned automatically by ENGDA when a user clicks the NEW button on the Pump form on the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Pump Installation Contractor

Description: The person or company that installed the pump.

Data Type: character field

Example: Acme Water Wells Incorporated

ENGDA Database Table/Field:

ENGDA Field Forms: Form for record of pumps installed

Pump Installation Supervisor

Description: The person who supervised the pump installation.

Data Type: character field

Example: Eve Kuniansky

ENGDA Database Table/Field:

ENGDA Field Forms: Form for record of pumps installed

Pump Install Date

Description: The date on which the pump was installed.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Pump Install Date 28/11/2002.

ENGDA Database Table/Field: lift_start_dt in the geo_well_lift table.

ENGDA Screen Data Entry: Entered by the user on the Pump form on the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Pump Removal Date

Description: The date on which the pump was removed.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Pump Removal Date 28/11/2002.

ENGDA Database Table/Field: lift_end_dt in the geo_well_lift table.

ENGDA Screen Data Entry: Entered by the user on the Pump form on the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Pump Type

Description: The type of pump installed on the well. See the following descriptions (Babcock and others, 2004).

Bucket includes the familiar "rope and bucket," chain and bucket lifts, and the small bailer lifted by a rope or chain and pulley.

Centrifugal pumps have rotating impellers in a closed chamber that draw the water into the pump. The water is then discharged from the pump, commonly under great pressure, by centrifugal force. Such pumps have maximum lift of about 25 feet but can force water to considerable heights above the pump.

Jet pumps have two pipes extending from the pump into the well. One pipe forces water down the hole under pressure while the other pipe discharges water that has been forced to the surface by the action of the jet. Jet pumps are used principally for small water supplies, such as would be used for a suburban home, farm, or small commercial establishment.

Piston pumps include the familiar lift and pitcher pumps common in many rural areas. The old "reciprocating" pumps and the "deep-well with walking-beam jacks" are of the piston type.

Rotary pumps operate on the principle that direct pressure is created by squeezing the water between specially designed runners. A relatively high vacuum may be created on the intake side so the suction lift is comparable to that for centrifugal pumps.

A submersible pump is a special type of turbine in which an electric motor is connected directly to the impellers and submerged beneath the water. It can be recognized by the presence of insulated electric wire leading into the well and the absence of any pump or power unit at the surface.

Turbines are of several types and may be for a deep or shallow well. A series of impellers, placed below the surface of the water, are rotated by a vertical shaft connected to a power source at the land surface. These impellers "pick up" the water and force it to the surface through the pump column. Such pumps are commonly used to lift large amounts of water at high pressure. They are used in high-capacity wells for public, industrial, or irrigation supply.

Use unknown only if the site is equipped with a pump about which other data are available, but the type of pump cannot be identified.

Data Type: List, 1-character code

N None
B Bucket
C Centrifugal
J Jet
P Piston
R Rotary
S Submergible
T Turbines
U Unknown
Z Other

ENGDA Database Table/Field: lift_cd in the geo_well_lift table. Allowable values stored in geo_well_lift_cd_lut.

ENGDA Screen Data Entry: Selected by the user from a list box on the Pump form of the Borehole Detail form.

ENGDA Field Forms: Form for record of pumps installed

Intake Depth

Description: The depth, in meters below land surface, of the pump intake.

Data Type: Floating point number

Example: Intake Depth 9.45

ENGDA Database Table/Field: intake_depth_va in the geo_well_lift table.

ENGDA Screen Data Entry: Entered by the user on the Pump form of the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Pump Rating

Description: The rating of the pump as the volume of water lifted per unit of power consumed. The value should be expressed as cubic meters of water per kilowatt-hour of electricity, cubic foot of natural gas, or liter of liquid fuel, depending on how the pump is powered. This value is commonly used to estimate water pumped where water volumes are not recorded, by instead using records of power consumption combined with the pump rating.

Data Type: Floating point number

Example: Pump Rating 9.45

ENGDA Database Table/Field: **pump_rating_fc** in the **geo_well_lift** table.

ENGDA Screen Data Entry: Entered by the user on the Pump form of the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Power Type

Description: The type of power used to power the pump

Data Type: List, 1-character code

E Electric
M Manual
G Gas
A Animal
P Petroleum

ENGDA Database Table/Field: **power_cd** in the **geo_well_lift** table. Allowable values stored in the form.

ENGDA Screen Data Entry: Selected by the user from a list box on the Pump form of the Borehole Detail form.

ENGDA Field Forms: Form for record of pumps installed

Pump Horsepower

Description: The horsepower rating of the primary power source (motor) for the pump.

Data Type: Floating point number

Example: Pump Horsepower 24.5

ENGDA Database Table/Field: **hp_va** in the **geo_well_lift** table.

ENGDA Screen Data Entry: Entered by the user on the Pump form of the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Pump Manufacturer

Description: The company that manufactured the pump.

Data Type: Text string not to exceed 50 characters.

(Example of names in list)

Armstrong
Blackstone
Bradford

ENGDA Database Table/Field: **manufacturer_nm** in the **geo_well_lift** table. Allowable values in **geo_pump_man_lut**.

ENGDA Screen Data Entry: Selected by the user from a list box on the Pump form of the Borehole Detail form. Select existing value from a list box or enter new value.

ENGDA Field Forms: Form for record of pumps installed

Pump Serial Number

Description: The serial number of the pump.

Data Type: Text string not to exceed 12 characters.

Example: Pump Serial Number 2N3E2001

ENGDA Database Table/Field: **serial_no_va** in the **geo_well_lift** table.

ENGDA Screen Data Entry: Entered by the user on the Pump form of the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Pump Capacity

Description: The manufacturer's pump capacity rating in liters per second.

Data Type: Floating point number

Example: Pump Capacity 20.5

ENGDA Database Table/Field: **capacity_va** in the **geo_well_lift** table.

ENGDA Screen Data Entry: Entered by the user on the Pump form of the Borehole Details form.

ENGDA Field Forms: Form for record of pumps installed

Geophysical Logs Data Fields

Logs Data Fields are used to describe data about the types of down-hole logs available for a borehole. The actual logs can be viewed from ENDGA if they are available in a standard Windows electronic format (for example, text files, MS Word files, or MS Excel files) and are stored in the ENGDA log-storage directory (ENDGA/logs). Proprietary log formats would be in the log-storage directory maintained by the local database administrator, but would require software for that specific file format for viewing the log. Many of the borehole image logs are collected in proprietary formats.

Logging Date [REQUIRED]

Description: The date on which the borehole log was acquired.

Data Type: Date field in the format of dd/mm/yyyy.

Example: Logging Date: 28/11/2002

ENGDA Database Table/Field: `log_dt` in the `geo_well_logs` table.

ENGDA Screen Data Entry: Entered by the user on the Logs form of the Borehole Details form.

ENGDA Field Forms: None prepared. Geophysical logs are collected electronically with specific instrumentation. If geophysical logs are collected the digital files should have a header indicating the well or borehole and the electronic log file should be provided to the Ministry of Water Resources and the Geological Survey of Ethiopia for storage in the appropriate ENGDA database directory.

Log Type [REQUIRED]

Description: Type of log.

Data Type: List, 2-character code

CS Caliper, single
CT Caliper, three
ED Dipmeter
EE Electric
EF Focused resistivity
EL Long normal
EP SP
ER Resistance
ES Short normal
FC Fluid conductivity
FE EM flow
FF Fluid differential temp
FR Fluid resistivity
FT Fluid temp
FV Fluid velocity
NG Gamma
OR Other
OV Video
WC Casing collar
WD Deviation

ENGDA Database Table/Field: `logs_cd` in the `geo_well_logs` table. Allowable values stored in `geo_log_type_lut` table.

ENGDA Screen Data Entry: Selected by the user on the Logs form of the Borehole Detail form.

ENGDA Field Forms: None prepared. Geophysical logs are collected electronically with specific instrumentation. If geophysical logs are collected the digital files should have a header indicating the well or borehole and the electronic log file should be provided to the Ministry of Water Resources and the Geological Survey of Ethiopia for storage in the appropriate ENGDA database directory.

Logging Agency

Description: Name of organization, company, or laboratory that collected the log.

Data type: List, 4-character code

Example: Logging Agency Ministry of Water Resource
Logging Agency Geological Survey of Ethiopia

ENGDA Database Table/Field: `logs_src_cd` in the `geo_well_logs` table. Allowable values stored in `com_department_lut` table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Logs form of the Borehole Detail form. New Agencies can be added by typing in a new agency name.

ENGDA Field Forms: None prepared. Geophysical logs are collected electronically with specific instrumentation. If geophysical logs are collected the digital files should have a header indicating the well or borehole and the electronic log file should be provided to the Ministry of Water Resources and the Geological Survey of Ethiopia for storage in the appropriate ENGDA database directory.

Log File Name

Description: The name of the electronic file in which the log is stored. File types recognized by ENDGA include txt, doc, xls, pdf, jpg, and bmp files. For files to be viewed in ENDGA, they must be stored in the endga/log directory.

Data Type: Text string not to exceed 50 characters

Example: Log File Name SRC1 Addis Resistivity.xls

ENGDA Database Table/Field: `log_file_nm` in the `geo_well_logs` table.

ENGDA Screen Data Entry: Entered by the user on the Logs form of the Borehole Detail form.

ENGDA Field Forms: None prepared. Geophysical logs are collected electronically with specific instrumentation. If geophysical logs are collected the digital files should have a header indicating the well or borehole and the electronic log file should be provided to the Ministry of Water Resources and the Geological Survey of Ethiopia for storage in the appropriate ENGDA database directory.

HYDROCHEMISTRY DATA FIELDS

Hydrochemistry data include data about the sample that is collected, the lab that does the analysis, and the values of the parameters being measured. Not all of the data that is recorded on the “Form for Record for Water-Quality Sample at Well” is stored in ENGDA.

Sample Information

Sample information includes data about how the sample was collected, and various field measurements made at the time of sample collection.

Sample Date/Time [REQUIRED]

Description: Date and time of water-quality sample collection.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Sample Date/Time: 28/11/2002 15:30

ENGDA Database Table/Field: **sample_dt** in the **qw_sample** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sample Type

Description: The type of material that is collected. Generally, this is water, but occasionally rock, earth materials, or precipitation are collected at a site.

Data Type: List, integer code

- 1 Ground water
- 2 Spring water
- 3 Well cuttings
- 4 Sediment
- 5 Rain water

ENGDA Database Table/Field: **medium_cd** in the **qw_sample** table. Allowable values stored in **com_medium_cd**.

ENGDA Screen Data Entry: Selected by the user from a list box on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sampled By

Description: This field contains a code representing the name of the person that collected the water sample, or if a team collected the sample, the leader of the sampling team.

Data Type: List, 5 character code; code consists of first 2 letters of first name, first 2 letters of second name, followed by a sequential integer if the 4-letter codes are duplicated.

(Example of names in list)

DALI David Litke
DALI2 David Little
TETA Tesfaya Tadesse

ENGDA Database Table/Field: **party_id** in the **qw_sample** table. Allowable values stored in **qw_party_id_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Sample form of the Water-Quality Results form. New persons can be added to the database by using the “Edit/Create Water-Quality Staff” menu option in the ENGDA database.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sampling Agency

Description: Name of organization, company, or laboratory that collected the sample.

Data type: List, 4-character code

Example: Sampling Agency Ministry of Water Resource
Sampling Agency Geological Survey of Ethiopia

ENGDA Database Table/Field: **dept_cd** in the **qw_sample** table. Allowable values stored in **com_department_lut** table.

ENGDA Screen Data Entry: Selected by the user from a list box on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sampling Project

Description: Name of the project that funded the sample collection.

Data Type: Text string not to exceed 50 characters.

Example: Sampling Project EGWRAP

ENGDA Database Table/Field: **project_tx** in the **qw_sample** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sample Number

Description: An identification number assigned by the agency collecting the water sample; commonly this is a number or code written on the sample bottles in the field to identify them.

Data Type: Text string not to exceed 16 characters

Example: Sample Number 102030345213TH

ENGDA Database Table/Field: **department_sample_nu_tx** in the **qw_sample** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sampling Method

Description: Method of water sample collection, commonly the type of pump used.

Data Type: List, 1-character code

- A Air lift
- B Bailer
- D Dip
- E Existing Pump
- G Grundfos Pump
- H Geopump
- P Peristaltic Pump
- N No information
- O Other

ENGDA Database Table/Field: **sample_method_cd** in the **qw_sample** table. Allowable values coded in form.

ENGDA Screen Data Entry: Selected by the user from a list box on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Well Depth

Description: The depth of the sampled well in meters, as measured at the time the sample was taken.

Data Type: Floating point number

Example: Well Depth: 123

ENGDA Database Table/Field: **well_depth_va** parameter; results stored in the **qw_results** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Water Level

Description: The depth to water in meters below the land surface, as measured at the time the sample was taken.

Data Type: Floating point number

Example: Water Level: 43

ENGDA Database Table/Field: **water_depth_va** parameter; results stored in the **qw_results** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Purging Information

These fields are used for determining how much water was removed from the well prior to collecting the sample. Some sampling protocols require that 3 casing volumes be removed prior to collecting the sample from the well. For a production well, this may not be required if the well is in use. Other protocols require that a well be pumped through a flow-through container until field parameters become stable (no longer change).

Well Status

Description: The status of pumping at the well prior to the time the sample was taken.

Data Type: List, 1-digit code

0	UNKNOWN	(Condition unknown)
1	STATIC	(Static water level)
2	PUMPING	(The site was being pumped)
3	RECENTLY PUMPED	(The site had been pumped recently)
4	NEARBY SITE PUMPING	(A nearby site that taps the same aquifer was being pumped)
5	DRY	(The site was dry-no water level is recorded)
6	OBSTRUCTED	(An obstruction was encountered-no water level is recorded).
7	OTHER	(Other conditions that would affect the measured water level)

ENGDA Database Table/Field: **pump_status_cd** in the **qw_sample** table. Allowable values coded stored in **geo_gw_level_status_cd_lut**.

ENGDA Screen Data Entry: Selected by the user from a list box on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Pumping Rate

Description: The pumping rate, in liters per second, as measured at the time the sample was taken from a well, or the discharge rate of a flowing spring at the time the sample was collected.

Data Type: Floating point number

Example: Pump Rate: 1.0

ENGDA Database Table/Field: **flow_rate_va** parameter; results stored in the **qw_results** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Pump Time

Description: The pumping time, in seconds. This value is used to calculate the total volume of water removed from the well prior to sampling the well, commonly referred to as the purged volume.

Data Type: Floating point number

Example: Pump Time: 15

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Volume Pumped

Description: A calculated value for the total purge volume pumped in liters. Take the pumping rate in liters per second and multiply by the time in minutes times 60 seconds per minute to calculate the purge volume.

Data Type: Floating point number

Example: Volume Pumped : 900

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Height of Water

Description: This value is the total height of water in the well in meters. If the well depth was measured from the measuring point then this is that depth minus the depth to water from the same measuring point.

Data Type: Floating point number

Example: Height of Water: 92

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Casing Diameter

Description: Inner diameter of the well casing, in centimeters. This is measured in the field or written onto the field form prior to going into the field in order to be able to calculate the volume of water stored in the casing prior to collecting the sample.

Data Type: List

Example: Diameter 25.0

ENGDA Database Table/Field: `dia_va` in the `geo_well_casing` table. Allowable values stored in `geo_casing_diameters` table.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Casing Volume

Description: The casing volume in liters. This is calculated in the field by knowing the height of water in the well and the casing inner diameter of the well. The height of the water times the area of the well is equal to the volume of water in the well. The area of a circle is π times the radius squared.

Data Type: Floating point number

Example: Casing Volume 2.5

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Casing Volumes Purged

Description: The number of casing volumes that were purged before the sample was taken. This is calculated by dividing the total volume pumped by the casing volume.

Data Type: Floating point number

Example: Casing Volumes Purged 2.5

ENGDA Database Table/Field: casing_vol_va parameter; result stored in the qw_results table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Water Quality Field Measurements

After purging of the well is completed, samples may be obtained from the well. Record information related to the water-quality field parameters obtained for the sample.

Time

Description: Record the time that the sample was obtained from the well, in 24 hour-minute format.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Final Temperature

Description: Record the temperature of the water sample in degrees Celsius.

Data Type: Floating point number

Example: Final Temperature 10.5

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Final Conductivity

Description: Record the specific conductance of the sample, in microsiemens per centimeter at 25°C.

Data Type: Floating point number

Example: Final Conductivity: 40.5

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

DO

Description: Record the dissolved oxygen value, in milligrams per liter, of the sample.

Data Type: Floating point number

Example: DO 2.5

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

pH

Description: Record the pH value of the sample.

Data Type: Floating point number

Example: pH 6.5

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Bicarbonate

Description: Record the bicarbonate value of the sample, in milligrams per liter, as HCO_3^- .

Data Type: Floating point number

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Carbonate

Description: Record the carbonate value of the sample, in milligrams per liter, as CO_3^{2-} .

Data Type: Floating point number

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Alkalinity

Description: Record the alkalinity value of the sample, in milligrams per liter, as CaCO_3 .

Data Type: Floating point number

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Other Field Parameters

Description: For other parameters measured in the field, record the Parameter type, the Value obtained (including appropriate units), and the Method used to obtain the measurement.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sample Bottle Information

Bottle Number

Description: Record a unique number for each sample bottle, including the well name.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Bottle Type

Description: List the code for the type of bottle that will contain the sample, using the list provided at the bottom of the table.

FA-Filtered Acidified
FU-Filtered Untreated
RU-Unfiltered Untreated
FC-Filtered Chilled
RC-Raw Chilled
RA-Raw Acidified

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Filter Size

Description: If the sample was filtered, record the size of the openings of the filter.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Bottle Size

Description: Record the size of the bottle that contains the sample (for example, 1 liter).

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Acid Type

Description: If the sample bottle was acidified, record the type of acid used.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Laboratory

Description: List the laboratory that will analyze the sample, if known.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

QA Type

Description: If the sample bottle will contain a sample blank or a replicate sample that will be used for quality assurance purposes, record the appropriate code from the list provided at the bottom of the table.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Sample Remarks

Description: Remarks containing any additional information about the sample.

Data Type: Text string not to exceed 255 characters

Example: Sample Number Sample contains black metallic particles which may indicate contamination from casing.

ENGDA Database Table/Field: **remark_tx** in the **qw_remarks** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: Entered by the user on the Sample form of the Water-Quality Results form.

Laboratory Information

Various types of information about the analysis of the sample may be provided by the analytical laboratories. This information is available on laboratory forms and is not derived from field forms.

Note: At present ENGDA allows for data entry of various types of laboratory information which have not yet been formalized by the Database Work Group, and therefore do not yet appear in this database dictionary.

Filtration

Description: The level of filtration through which the sample passed in the laboratory, measured in microns.

Data Type: Text string not to exceed 12 characters

Example: Filtration 40 micron

ENGDA Database Table/Field: **filtration_va** in the **qw_sample** table.

ENGDA Field Form: none, data from laboratory.

Acidification

Description: A description of any acid that was added to the sample in the laboratory.

Data Type: Text string not to exceed 12 characters

Example: Acidification 2 ml HNO3

ENGDA Database Table/Field: **acidification_va** in the **qw_sample** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: =None, data from laboratory.

Date of Analyses

Description: The date the laboratory completed the analysis of the sample.

Data Type: Date field in the format of dd/mm/yyyy

Example: Date of Analysis 28/11/2002

ENGDA Database Table/Field: **analyst_dt** in the **qw_sample** table.

ENGDA Screen Data Entry: Entered by the user on the Sample form of the Water-Quality Results form.

ENGDA Field Form: none, data from laboratory.

Water-Quality Results

Analysis results are stored in a single **qw_results** table using a parameter code and a result value. New parameters can be added to the database parameter dictionary as needed. Parameters identified by the Database Work Group to be included at a minimum in ENGDA database are listed in the following table. Some water-quality results are results measured in the field, and therefore can be entered using the “Form for Record for Water-Quality Sample at Well” as a reference. Other water-quality results will be transmitted by various analytical laboratories, and can be entered manually using hardcopy lab reports as a reference, or can be entered in a batch mode using results provided by laboratories in electronic format.

Parameter Code

Description: A code used by the database to identify each parameter.

Data Type: Integer

Example: Parameter Code 25

ENGDA Database Table/Field: **parameter_cd** in the **qw_result** table. Allowable values stored in **qw_parameter_code_lut** table.

ENGDA Screen Data Entry: Hardcoded on various Sample forms on the Water-Quality Results form.

ENGDA Field Form: none, data from laboratory.

Result

Description: The numeric result measured for a parameter

Data Type: Text field not to exceed 12 characters.

Example: Result 25.5

ENGDA Database Table/Field: **result_tx** in the **qw_result** table.

ENGDA Screen Data Entry: Entered on various Sample forms on the Water-Quality Results form.

ENGDA Field Form: none, data from laboratory.

parameter_cd	Parameter Description	Units
10	Water Temperature	°C
58	Flow Rate	m³/hr
94	Field Conductivity	µS/cm
226	Laboratory Conductivity	µS/cm
227	Laboratory pH	PH units
228	Dissolved Oxygen	mg/l
236	Fluoride	mg/l
239	Silica	µg/l
355	Laboratory Temperature	oC
403	PH, WH, Laboratory	pH
452	Carbonate,DIS,IT,F	mg/l
453	Bicarbonate,DIS,IT,F	mg/l
500	Residue Solids	mg/l
501	Residue at 180C	mg/l
615	Nitrogen,Nitrite T.	mg/l
620	Nitrogen Nitrate T.	mg/l
625	NH3	µg/l
630	NH4	mg/l
900	Hardness Total	mg/l
901	Carbonate Hardness	mg/l
903	Calcium Hardness	mg/l
910	Calcium Total	mg/l
920	Magnesium	mg/l
937	Potassium Total	mg/l
940	Chloride Dissolved	mg/l
945	Sulfate Dissolved	mg/l
999	Boron	mg/l
1045	Iron	µg/l

parameter_cd	Parameter Description	Units
1055	Manganese	µg/l
1104	Aluminum	µg/l

SYSTEM DATA FIELDS

In addition to the borehole data fields described in this manual, several additional fields are stored for data-management purposes.

Fields for Site Identification and Creation

ID [REQUIRED]

Description: An integer code stored by the data base as an unchanging key field for each site. Once an ID has been assigned to a site, it can never be changed. All other attributes of the site (including the Site Name and the Site Locality) can be edited, but the ID cannot be edited. If a site is deleted from the database, the ID is retired with it, and cannot be reused.

The ID for a borehole is displayed in the upper right hand corner of the Borehole Site Information form and Spring Site Information form.

Each copy of the ENGDA database has a COPY number which is an integer assigned by the database administrator. The ID for a new site is assigned by the ENDGA software and is formed by multiplying the COPY value by 100,000 and adding to this the next available sequential integer value not already used. For example, the Ministry of Water Resources copy of ENGDA is assigned COPY = 1. Thus the first site added to the database will have an ID of $100,000 * 1 + 1 = 100001$, and the second site added to the database will have an ID of 100002.

Data Type: Long integer.

Example: ID: 100028
ID: 300156

ENGDA Database Table/Field: site_id occurs in many ENGDA Database Tables.

ENGDA Screen Data Entry: Assigned by ENDGA; not editable.

Record Created Date/Time [REQUIRED]

Description: Date and time on which a database record is first created.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Record Created Date/Time: 28/11/2002 15:30

ENGDA Database Table/Field: record_cr in many ENGDA Database Tables.

ENGDA Screen Data Entry: Assigned by ENDGA; not editable.

Fields for Tracking Modification of Records

Record Modified Date/Time [REQUIRED]

Description: Date and time on which a database record is modified. Always contains the most recent modified date.

Data Type: Date field in the format of dd/mm/yyyy hh:mm.

Example: Record Modified Date/Time: 28/11/2002 17:30

ENGDA Database Table/Field: record_md in many ENGDA Database Tables.

ENGDA Screen Data Entry: Assigned by ENDGA; not editable.

Record Created User Name [REQUIRED]

Description: The login user name of the person who created a new record.

Data Type: Text field, not to exceed 8 characters.

Example: Record Created User Name: etdba

ENGDA Database Table/Field: record_cn in many ENGDA Database Tables.

ENGDA Screen Data Entry: Assigned by ENDGA; not editable.

Record Modified User Name [REQUIRED]

Description: The login user name of the person who most recently modified an existing record.

Data Type: Text field, not to exceed 8 characters.

Example: Record Created User Name: etdba

ENGDA Database Table/Field: record_mn in many ENGDA Database Tables.

ENGDA Screen Data Entry: Assigned by ENDGA; not editable.

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- Ethiopian Ministry of Water Resources, 2001, Ground-Water Database
- Geological Survey of Ethiopia, 2001, Lithologic Database

ATTACHMENT 1. Conversion Factors

Abbreviation	From	Multiply by	To	Abbreviation
Length				
Inch or inches	Inches	2.54	centimeters	cm
ft	feet	30.48	centimeters	cm
ft	feet	0.3048	meters	m
yd	yards	0.9843	meters	m
mi	miles	1.609	kilometers	km
Area				
in ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.0929	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
mi ²	square miles	2.59	square kilometers	km ²
ac	acres	4,047	square meters	m ²
ac	acres	0.4	hectares	ha
Volume				
pt	pints(liquid)	0.4732	liters	L
qt	quarts	0.9463	liters	L
gal	gallons	3.785	liters	L
gal/min	gallons per minute	6.309 x 10 ⁻⁵	cubic meters per second	m ³ /s
ft ³	cubic feet	0.0283	cubic meters	m ³
yd ³	cubic yards	0.7646	cubic meters	m ³
ac-ft	acre-foot	1,233	cubic meter	m ³
ac-ft	acre-foot	0.001233	cubic hectometer	ha ³
Flow Rate				
cfs or ft ³ /s	cubic feet per second	0.0283	cubic meters per second	m ³ /s
cfs or ft ³ /s	cubic feet per second	0.6463	million gallons per day	Mgal/d
Mgal/d	million gallons per day	0.0438	cubic meters per second	m ³ /s
Mgal/d	million gallons per day	1.547	cubic feet per second	cfs or ft ³ /s
ac-ft/yr	acre-foot per year	1,233	cubic meter per year	m ³ /yr
ft/d	foot per day	0	meter per day	m/d
in/yr	inch per year	25.4	millimeter per year	mm/yr
Temperature				
°F	degrees Fahrenheit	5/9 (°F)-32	degrees Celsius	°C
Concentration				
ppm	parts per million	1	milligrams per liter	mg/L
Specific Conductance				
µS/cm	Microseimens per centimeter at 25 °C	0.55 to 0.75 ^a	milligrams per liter	mg/L

^a Range in multiplier is typical for natural waters (Hem, 1985)

ATTACHMENT 2. Selected Field Forms Designed for the ENGDA Database

Form for Record of Well Inventory

Form for Record of Spring Inventory

Water-Level Measurement Form

Form for Record of Borehole Lithology

Form for Record of Well Drilling

Form for Record of Well Construction

Form for Record of Pumps Installed in a Well

Form for Record of Water Use at a Well or Spring

Form for Record of Water Quality Sample at a Well

Form for Record of Discharge Measurement at a Well or Spring

Form for Record of Aquifer Test

Form for Record of Slug Test

Form For Record of Well Inventory (2 pages)
Ethiopian National Ground-water Database (ENGDA)

WELL SITE INFORMATION

Site Name _____ Locality (Village and District) _____

Alternate Site Name _____

Latitude _____ Longitude _____ Lat/Long Datum: (Adindan WGS84)

Lat/Long Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)

UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38)

UTM Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)

UTM Datum (Adindan WGS84) Land Altitude (m) _____ Altitude Accuracy (m) _____

Altitude Method (Altimeter DGPS GPS Map Survey Calculation Unknown)

Major River Basin:

(Abay Awash Baro-Akobo Denakil Depression Genale-Dawa Merebe Ogaden Omo-Gibe Tekeze Rift_Valley Wabi Shebele)

Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)

Borehole Type: (Test Hole Test Well Production Well Hand-Dug Well Observation Well)

Hole Depth (m) _____ Hole Diameter (cm) _____ Year Constructed _____

Well Water Use: (Irrigation Domestic Public Supply Stock Watering Geothermal Mixed Use Industrial Mining Unused Other)

Well Status: (In Use Unused-cased Unused-open hole Abandoned Filled)

Pump Type: (None Bucket Centrifugal Jet Piston Rotary Submersible Turbine Unknown)

Project that installed well and/or inventoried site _____

Geologist Selecting Well Site: _____

Site Selection Method: (Geological Geophysical Photograph Field Survey Inventory Unknown)

Topographic Setting (Alluvial Fan Playa Stream Channel Depression Dunes Flat Flood Plain Hill Top Sinkhole Lake or Swamp Pediment Hillside Terrace Undulating Valley Flat Upland Draw)

Principal Aquifer Lithology: (Unconsolidated Consolidated porous sedimentary Limestone/Karstic Fractured Volcanics Fractured igneous/metamorphic Other Unknown)

Aquifer Type: (Unconfined Single Unconfined Multiple Confined Single Confined Multiple Mixed Unknown)

Aquifer Name: _____

Owner Name _____ Owner Permission (Yes No) Given by: _____

Owner Address _____

Site Location Description _____

Inventoried By _____ Inventory Date _____

WATER LEVEL INFORMATION

Measuring Point (MP) Description: _____

Measurement Date/Time	Held	Cut	Depth to Water	MP Height	Depth to Water Below Land Surface	Measurement Method	Equipment ID	Well Status	Person Measuring Well

MP Height: Distance of MP above/below land surface (negative if below land surface)

Measurement Method: Unknown (0); Steel Tape (1); Electric Tape (2); Pressure Gage (3); Timing the sound from dropping a stone (4); Reported (5); Estimated from the length of a string (6); Use of a sounder on the end of a string (7); Transducer (8); Recorder (9); Other (10)

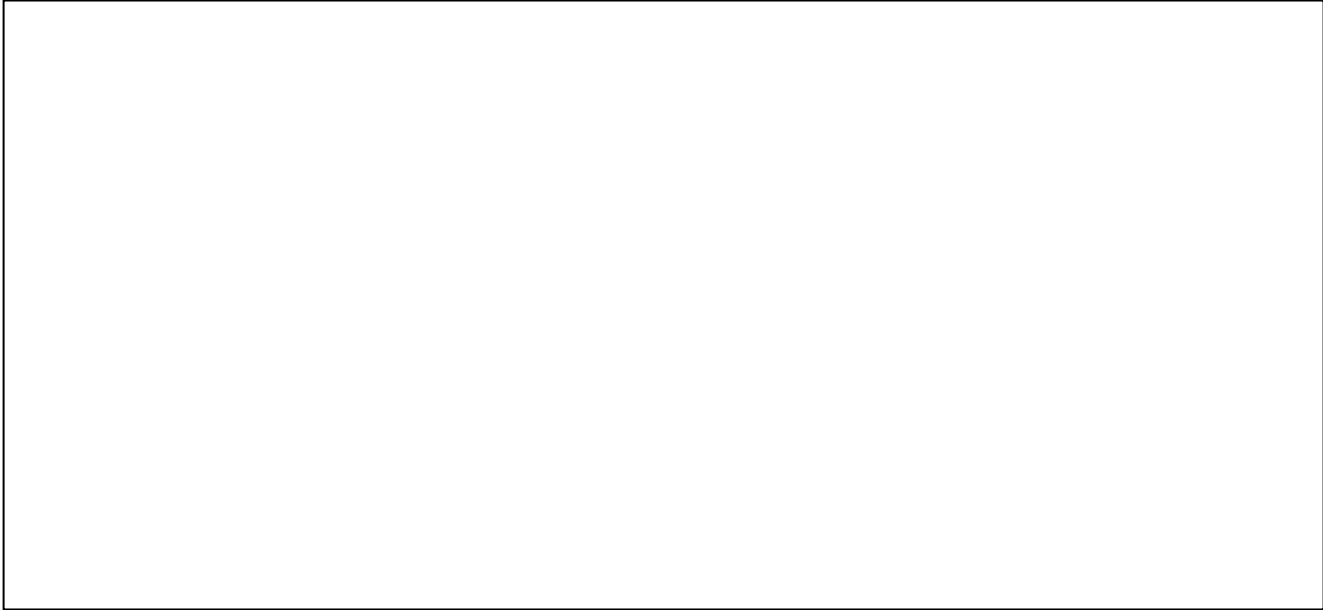
Well Status: Unknown (0); Static (1); Pumping (2); Pumped Recently (3); Nearby Well Pumping (4); Dry (5); Obstructed (6); Other (7)

(NOTE: FORM CONTINUED ON BACK OF PAGE)

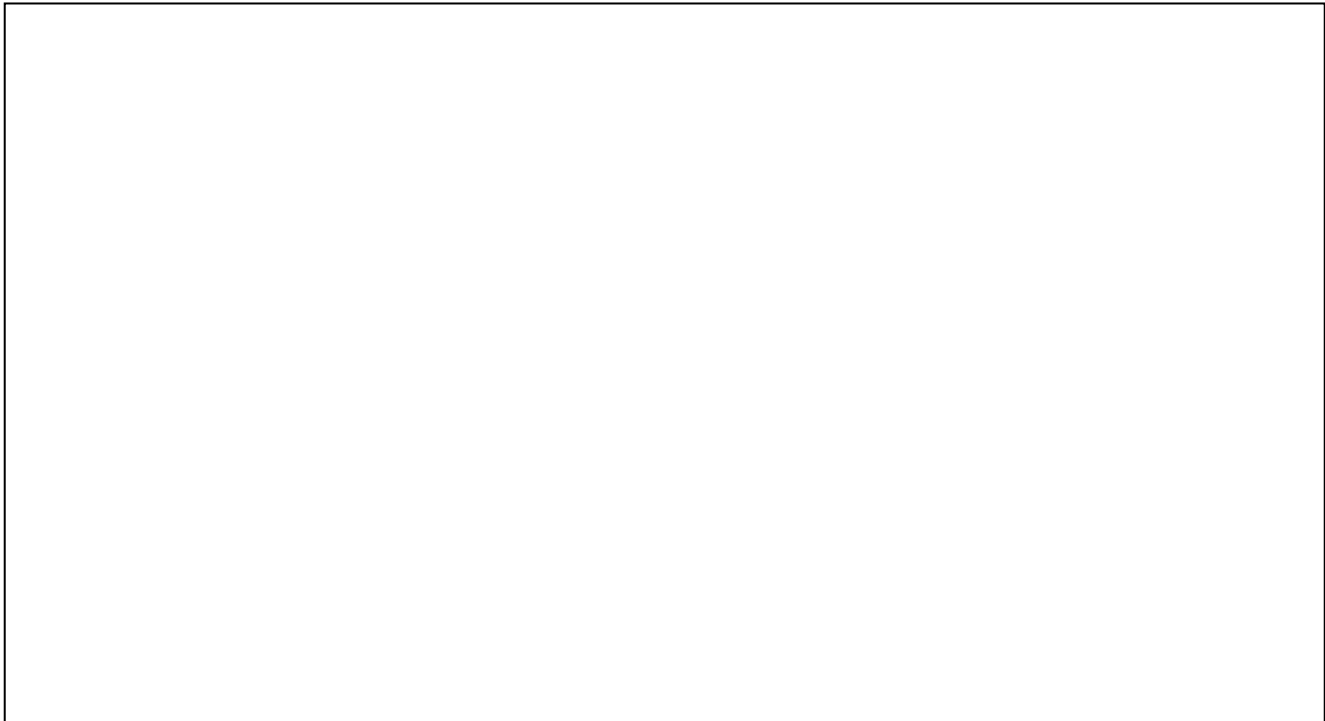
Form For Record of Well Inventory (2 pages)
Ethiopian National Ground-water DAtabase (ENGDA)

REMARKS _____

DIAGRAM OF WELL AND MEASURING POINT



PLAN VIEW MAP SKETCH OF WELL SITE



Instructions: Fill in information to the right of the data field name by printing neatly in underlined area. Circle correct choice in parenthesis to the right of the data field name. If possible, use the space above to sketch a local map to the well location and take a photograph of the well.

FORM FOR RECORD OF SPRING INVENTORY (2 pages)
Ethiopian National Ground-water Database (ENGDA)

SPRING SITE INFORMATION

Site Name _____ Locality (Village and District) _____

Alternate Site Name _____

Latitude _____ Longitude _____ Lat/Long Datum: (Adindan WGS84)

Lat/Long Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)

UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38)

UTM Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)

UTM Datum (Adindan WGS84)

Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)

Pool Altitude (m) _____ Altitude Method (Altimeter DGPS GPS Map Survey Calculation Unknown)

Altitude Accuracy (m) _____

Major River Basin:

(Abay Awash Baro-Akobo Denakil Depression Genale-Dawa Merebe Ogaden Omo-Gibe Tekeze Rift Valley Wabi Shebele)

Spring Type (Artesian Perched contact Contact Depression Perched depression Fissures Geyser Perched tubular
Artesian depression Artesian seepage Fracture depression Multiple springs Perched Perched fracture Perched seepage
Seepage filtration Tubular cave Other)

Spring Development (Boxed basin Concrete basin Gallery Spring house Lined None Pond Pipe Trough Other)

Spring Development Possibility (Yes No) Year Developed _____

Spring Water Use (Irrigation Domestic Water Supply Stock Watering Geothermal Mixed Use Mining Other)

Spring Status (In Use Unused Abandoned)

Project that inventoried spring _____

Topographic Setting (Alluvial Fan Playa Stream Channel Depression Dunes Flat Flood Plain Hill Top Sinkhole
Lake or Swamp Piedmont Hillside Terrace Undulating Valley Flat Upland Draw)

Spring Rock Type (Unconsolidated Consolidated porous sedimentary Limestone/Karstic Fractured Volcanics
Fractured igneous/metamorphic Other Unknown)

Spring Permanence (Ebb and flow Geyser Intermittent Perennial Precipitation Seasonal Other)

Spring Protection Condition (Fenced Locked fencing None)

Spring Sanitary Condition (Good Fair Bad)

Owner Name _____ Owner Permission (Yes No) Given by: _____

Owner Address _____

Site Location Description _____

Inventoried By _____ Inventory Date _____

SPRING DISCHARGE INFORMATION

Date/Time of discharge measurement (dd/mm/yyyy hh:mm) _____

Discharge _____ L/s

Discharge Measurement Method (Current meter Estimated Flume Totaling meter Orifice wier Reported Venturi meter
Volumetric measurement Wier Other)

Measured By _____

REMARKS _____

Instructions: Fill in information to the right of the data field name by printing neatly in underlined area. Circle correct choice in parenthesis to the right of the data field name. If possible, use the back of this form to sketch a local map to the spring location and take a photograph of the spring.

FORM FOR RECORD OF SPRING INVENTORY (2 pages)
Ethiopian National Ground-water Database (ENGDA)

PLAN VIEW MAP SKETCH OF SPRING LOCATION



FORM FOR RECORD OF BOREHOLE LITHOLOGY (2 pages)

Ethiopian National Ground-water DAtabase (ENGDA)

Sorting: Unsorted (11) Poorly sorted (22) Poorly to moderately sorted (23) Moderately to poorly sorted (32) Moderately sorted (33) Moderately to well sorted (34) Well to moderately sorted (43) Well sorted (44) No information (0)

Roundness: No information (0) Angular (11) Angular to subangular (12) Angular to subrounded (13) Angular to rounded (14) Subangular (22) Subangular to subrounded (23) Subangular to rounded (24) Subrounded (33) Subrounded to rounded (34) Rounded (44)

Lithology:

Andesite (ADST)	Greenstone (GNST)	Residual (RSDM)
Agglomerate (AGLM)	Gypsum (GPSM)	Rhyolite (RYLT)
Alluvium (ALVM)	Greywacke (GRCK)	Sand (SAND)
Anhydrite (ANDR)	Gravel and clay (GRCL)	Scree (SCRE)
Anorthosite (ANRS)	Granodiorite (GRDR)	Schist (SCST)
Aeolian deposits (AOLN)	Gravel, sand and clay (GRDS)	Sand and clay (SDCL)
Amphibolite (APBL)	Granite-gneiss (GRGN)	Sand and gravel (SDGL)
Arkose (ARKS)	Grit (GRIT)	Sandstone and shale (SDSL)
Banded Ironstone (BDIS)	Granite (GRNT)	Sand and silt (SDST)
Boulder clay (BLCL)	Gravel, silt and clay (GRSC)	Sand, gravel and clay (SGVC)
Boulders (BLDR)	Gravel (GRVL)	Shale (SHLE)
Boulders, silt and clay (BLSC)	Hornfels (HNFL)	Shale and siltstone (SHSL)
Boulders and clay (BLSD)	Hard pan (HRDP)	Silt (SILT)
Bentonite (BNTN)	Harzburgite (HZPG)	Silcrete (SLCT)
Bronzitite (BNZT)	Ignimbrite (IGBR)	Siltstone and shale (SLSH)
Breccia (BRCC)	Jaspillite (JPLT)	Siltstone (SLSN)
Basalt (BSLT)	Jasper (JSPR)	Slate (SLTE)
Carbonatite (CBNT)	Kimberlite (KBLT)	Sandstone (SNDS)
Calc tufa (CCTF)	Kaolinite (KLNT)	Syenite-gneiss (SNGS)
Chalk (CHLK)	Lava (LAVA)	Soil (SOIL)
Chert (CHRT)	Lignite (LGNT)	Serpentine talc (SPTC)
Clay (CLAY)	Limestone and dolomite (LMDM)	Serpentine (SRPN)
Calcrete (CLCR)	Limestone (LMSN)	Silt and clay (STCL)
Calcite (CLCT)	Loam (LOAM)	Syenite (SYNT)
Conglomerate (CLGM)	Loess (LOSS)	Talc (TALC)
Clay and sand (CLSD)	Laterite (LTRT)	Till (TILL)
Claystone (CLSN)	Marl (MARL)	Tillite (TLLT)
Colluvium (CLVM)	Mica schist (MCSC)	Talus (TLUS)
Coal (COAL)	Mudstone (MDSN)	Trachyte (TRCT)
Cobbles (COBB)	Magnetite gabbro (MGGB)	Tuff (TUFF)
Cobbles, silt and clay (COSC)	Mylonite (MLNT)	Vein-quartz (VNQZ)
Cobbles and sand (COSD)	Marble (MRBL)	
Diabase (DIBS)	Marlstone (MRLS)	
Dolomite (DLMT)	Mud (MUD)	
Dolerite (DLRT)	No sample (N.S.)	
Diamictite (DMCT)	Norite (NORT)	
Dune sand (DNSD)	Nepheline (NPHL)	
Diorite (DORT)	Norite-anorthosite (NRAR)	
Eclogite (ECGT)	Overburden (OBDN)	
Eluvium (ELVM)	Outwash (OTSH)	
Evaporite (EVPR)	Olivine diorite (OVDR)	
Ferricrete (FCRT)	Pseudogranophyre (PDGP)	
Flagstone (FGSN)	Peat (PEAT)	
Felsite (FLST)	Pegmatite (PGMT)	
Fault (FULT)	Phyllite (PLLT)	
Gabbro (GBBR)	Phonolite (PNLT)	
Gabbro-norite (GBNR)	Porphyry (PPHY)	
Granitoid-gneiss (GDGS)	Quartzite (QRTZ)	
Glacial (GLCL)	Quartz porphyry (QZPR)	
Granophyre (GNPR)	Quartz schist (QZSC)	
Gneiss (GNSS)	Rubble (RBBL)	

Form for Record of Well Drilling (2 pages)
Ethiopian National Ground-Water DAtabase (ENGDA)

SITE NAME: _____ **LOCALITY** (Village and district): _____
 Latitude _____ Longitude _____ Lat/Long Datum: (Adindan WGS84) Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)
 UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38) UTM Datum: (Adindan WGS84)
 Coordinate Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)
 Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)

CONSTRUCTION EVENT INFORMATION

Drilling Contractor _____ Driller Name _____ Start Date (dd/mm/yyyy) _____ Finish Date (dd/mm/yyyy) _____
 Construction Supervisor _____ Construction Event Number 1 2 3 Construction Comments _____

FINAL HOLE DIMENSIONS

Interval Top (m)	Interval Bottom (m)	Diameter (mm)

WATER STRUCK

Interval Top (m)	Interval Bottom (m)	Water Yield (L/s)	Water Level (m)	Date Struck (dd/mm/yyyy)

DETAILED DRILLING INFORMATION

Total Drilling Fluid Quantity _____ (L m³) Temporary casing used (Yes No) Temporary Casing Type and Size _____

Start Date (dd/mm/yyyy)	End Date (dd/mm/yyyy)	Interval Top (m)	Interval Bottom (m)	Dia- meter (mm)	General Rock Type	Driller Name	Drilling Method	Rig No.	Drill Bit No.	Ham -mer No.	Fluid Type	Comment

TABLE CONTINUED ON BACK OF FORM

Drilling Method: Auger (A) Cable Tool (C) Driven (D) Geoprobe (G) Hand Dug (H) Mud Rotary (M) Other (O) Air Rotary (R) Hammer Tool (T) Unknown (U) Reverse Rotary (X)
General Rock Type: Unconsolidated (1) Sedimentary (2) Hard Rock (3) Drilling Fluid Type: Foam (F) Bentonite (B) Water (W) Air (A)

FORM FOR RECORD OF WELL CONSTRUCTION (2 pages)

Ethiopian National Ground-Water DAtabase (ENGDA)

Site Name _____ Locality (Village and District) _____

Latitude _____ Longitude _____ Lat/Long Datum: Adindan WGS84)

UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38)

UTM Datum (Adindan WGS84) Land Altitude (m) _____ Altitude Accuracy (m) _____

Coordinate Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)

Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)

CONSTRUCTION EVENT INFORMATION

Construction Start Date (dd/mm/yyyy) _____ Construction Finish Date (dd/mm/yyyy) _____

Construction Supervisor _____ Construction Event Number 1 2 3

Construction Comments _____

CASING INFORMATION

Casing Start Date (dd/mm/yyyy) _____ Casing Finish Date (dd/mm/yyyy) _____

Casing Contractor _____ Casing Supervisor _____ Casing Rig Number _____

Interval Top (m)	Interval Bottom (m)	Casing Material	Diameter (mm)	Thickness (mm)	Casing/ Screen Type	Opening Length (mm)	Opening Width (mm)

Casing Material: ABS (A) Brass/Bronze (B) Concrete (C) PFTE (E) Galvanized Iron (G) Wrought Iron (I) PVC Threaded (K) Other Metal (M) PVC Glued (N) Plastic (P) FEP (Q) Stainless Steel (R) API Steel (S) Unknown (U) Steel Carbon (X) Steel Galvanized (Y) Other (Z)

Casing/Screen Type: Drilling pipes (D) Perforated Holes (H) Mesh Screen (M) Solid (P) Slotted (S) Open (U) Vertical Perforated slots (V) Wire-wound screen (W) Horizontal perforated slots (Y)

PACKING INFORMATION

Packing Start Date (dd/mm/yyyy) _____ Packing Finish Date (dd/mm/yyyy) _____

Packing Contractor _____ Packing Supervisor _____ Packing Rig Number _____

Interval Top (m)	Interval Bottom (m)	Packing Material	Filling Material	Grain Size (mm)	Quantity (m ³)	Comment

Packing Material: Sand (S) Gravel (G) Other (O) Filling Material: Clay (CL) Bentonite (B) Cement (CE) Other (O)

FORM FOR RECORD OF WELL CONSTRUCTION (2 pages)
 Ethiopian National Ground-Water DAtabase (ENGDA)

WELL DEVELOPMENT INFORMATION

Development Start Date (dd/mm/yyyy) _____ Finish Date (dd/mm/yyyy) _____

Developer Contractor _____ Developer Rig Number _____

Developer Name _____

Duration of development _____ hours

Development Method: Air Lift (A) Bailing (B) Mechanical Surging (M) Direct Injection (D) Backwashing (W) Pumping and backwashing (P)
 Jetting with air (J) Jetting with water (K) Flushing (F) Chemicals (C)

Pump Description _____ Pump Capacity _____ Pump Position _____

Additional Equipment _____

Time (minutes)	Temperature (°C)	Conductivity (µs/cm)	pH	Turbidity (NTU)	Pumping Rate (L/sec)	Comment

COMMENTS _____

Diagram of well location:

FORM FOR RECORD OF PUMPS INSTALLED IN A WELL (1page)
Ethiopian National Ground-Water DAtabase (ENGDA)

Site Name _____ Locality (Village and District) _____
Latitude _____ Longitude _____ Lat/Long Datum: (Adindan WGS84)
UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38)
UTM Datum (Adindan WGS84) Land Altitude (m) _____ Altitude Accuracy (m) _____
Coordinate Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)
Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)
COMMENTS _____

PUMP NUMBER 1

Pump Installation Contractor _____ Pump Installation Supervisor _____
Pump Install Date (dd/mm/yyyy) _____ Pump Removal Date (dd/mm/yyyy) _____
Pump Type (Bucket Centrifugal Jet Piston Rotary Submersible Turbine Unknown Other) Intake Depth (m) _____
Power Type (Electric Manual Gas Animal Petroleum) Pump Rating _____ Pump Capacity (L/s) _____
Pump Horsepower _____ Pump Manufacturer _____ Pump Serial Number _____

PUMP NUMBER 2

Pump Installation Contractor _____ Pump Installation Supervisor _____
Pump Install Date (dd/mm/yyyy) _____ Pump Removal Date (dd/mm/yyyy) _____
Pump Type (Bucket Centrifugal Jet Piston Rotary Submersible Turbine Unknown Other) Intake Depth (m) _____
Power Type (Electric Manual Gas Animal Petroleum) Pump Rating _____ Pump Capacity (L/s) _____
Pump Horsepower _____ Pump Manufacturer _____ Pump Serial Number _____

PUMP NUMBER 3

Pump Installation Contractor _____ Pump Installation Supervisor _____
Pump Install Date (dd/mm/yyyy) _____ Pump Removal Date (dd/mm/yyyy) _____
Pump Type (Bucket Centrifugal Jet Piston Rotary Submersible Turbine Unknown Other) Intake Depth (m) _____
Power Type (Electric Manual Gas Animal Petroleum) Pump Rating _____ Pump Capacity (L/s) _____
Pump Horsepower _____ Pump Manufacturer _____ Pump Serial Number _____

PUMP NUMBER 4

Pump Installation Contractor _____ Pump Installation Supervisor _____
Pump Install Date (dd/mm/yyyy) _____ Pump Removal Date (dd/mm/yyyy) _____
Pump Type (Bucket Centrifugal Jet Piston Rotary Submersible Turbine Unknown Other) Intake Depth (m) _____
Power Type (Electric Manual Gas Animal Petroleum) Pump Rating _____ Pump Capacity (L/s) _____
Pump Horsepower _____ Pump Manufacturer _____ Pump Serial Number _____

PUMP NUMBER 5

Pump Installation Contractor _____ Pump Installation Supervisor _____
Pump Install Date (dd/mm/yyyy) _____ Pump Removal Date (dd/mm/yyyy) _____
Pump Type (Bucket Centrifugal Jet Piston Rotary Submersible Turbine Unknown Other) Intake Depth (m) _____
Power Type (Electric Manual Gas Animal Petroleum) Pump Rating _____ Pump Capacity (L/s) _____
Pump Horsepower _____ Pump Manufacturer _____ Pump Serial Number _____

FORM FOR RECORD OF WATER-QUALITY SAMPLE AT WELL (2 pages)

Ethiopian National Ground-Water DATABASE (ENGDA)

WELL SITE INFORMATION

Site Name _____ Locality (Village and District) _____
Latitude _____ Longitude _____ Lat/Long Datum: (Adindan WGS84)
UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38)
UTM Datum (Adindan WGS84) Land Altitude (m) _____ Altitude Accuracy (m) _____
Coordinate Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)
Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)

SAMPLE INFORMATION

Sample Date/Time _____ Sample Type (Well Water Spring Water)
Field Sample Number _____ Sample Collected by: _____

WATER LEVEL and WELL DEPTH

Measurement Method: _____ Unknown (0); Steel Tape (1); Electric Tape (2); Pressure Gage (3); Timing the sound from dropping a stone (4); Reported (5); Estimated from the length of a string (6); Use of a sounder on the end of a string (7); Transducer (8); Recorder (9); Other (10)

Water Level Instrument ID: _____

Water Level			Well Depth	
	1	2		
Depth to water from measuring point (m)			Measuring point to bottom (m)	
Measuring point height above/below land surface (m)			Measuring point height (m)	
Depth to water below land surface (m)			Well depth below land surface (m)	

PURGING

Well Status: (Unknown Static Pumping Pumped Recently Nearby Well Pumping Dry)

Sampling Method (Pump Type): (Grunfos Geopump Bailer Existing Pump in well Air Lift)

Well diameter (cm) _____ Height of water column (m) _____ Casing volume (L) _____

Pump time (seconds) _____ Pump rate (L/s) _____ Volume pumped (L) _____

Time required to purge one casing volume (min) _____

Time	Temperature	Conductivity	Comments

DISCHARGE MEASUREMENT FIELD FORM FOR WELLS OR SPRINGS (1 page)

Ethiopian National Ground-water Database (ENGDA)

SITE NAME: _____ **LOCALITY (Village and District):** _____

Latitude _____ Longitude _____ Lat/Long Datum: (Adindan WGS84) Location map (sheet number) _____ Map Scale (1/50,000 1/250,000)

UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38) UTM Datum: (Adindan WGS84)

Coordinate Method (Approximate Calculated DGPS GPS 1:50,000 Map 1:250,000 Map Survey Unknown)

Measurement Date/Time (dd/mm/yyyy hh:mm)	Yield L/s	Measure- Ment Method	Discharge Type	Person Measuring Discharge	Comment

Measurement Method: Current meter (C) Estimated (E) Flume (F) Totaling meter (M) Orifice wier (O) Reported (R) Venturi meter (U) Volumetric (V) Wier (W) Other (Z)

Discharge Type: Flowing (F) Pumped (P)

FILL IN THIS PART OF THE FORM IF A WATER-LEVEL MEASUREMENT IS MADE AT THE SITE

Measurement Date/Time (dd/mm/yyyy hh:mm)	Held	Cut	Depth to Water	MP Height	Depth to Water Below Land Surface	Measure- ment Method	Equip- ment ID	Well Status	Measuring Point (MP) Description	Person Measuring Well

MP Height: Distance of MP above/below land surface (negative if below land surface)

Measurement Method: Unknown (0); Steel Tape (1); Electric Tape (2); Pressure Gage (3); Timing the sound from dropping a stone (4); Reported (5); Estimated from the length of a string (6); Use of a sounder on the end of a string (7); Transducer (8); Recorder (9 0; Other (10)

Well Status: Unknown (0); Static (1); Pumping (2); Pumped Recently (3); Nearby Well Pumping (4); Dry (5); Obstructed (6); Other (7)

COMMENTS:

Complete as much information as possible.

December, 2006

SLUG TEST FIELD FORM (2 pages)
Ethiopian National Ground-water DAtabase (ENGDA)

SLUG TEST WELL: Site Name: _____ Locality (Village and District): _____
 Latitude _____ Longitude _____ Lat/Long Datum: (Adindan WGS84) Location map (sheet number) _____ Map Scale (1:50,000 1:250,000)
 UTM Easting _____ m UTM Northing _____ m UTM Zone (36 37 38) UTM Datum: (Adindan WGS84)
 Coordinate Method (Approximate Calculated DGPS GPS 1:50,000 map 1:250,000 map Survey Unknown) Location map _____ Map Scale (1:50,000 1:250,000)
 Slug Test Start Date (dd/mm/yyyy) _____ Slug Test End Date (dd/mm/yyyy) _____ Slug Test Duration _____ hours
 Slug Test Type (Air Bailer Poured) Slug Length _____ cm Slug Diameter _____ cm Water Displaced _____ cm Slug Volume _____ L
 Agency Conducting Test _____ Slug Test Comments _____

SLUG TEST WELL CHARACTERISTICS: Fill out these information in the field, or before going to the field by examining existing well information.

Casing Diameter _____ cm Annulus Diameter _____ cm Screen Length _____ m Depth to Screen Top _____ m
 Depth to Aquifer Top _____ m Depth to Aquifer Bottom _____ m Confining Layer Thickness _____ m Assumed Storage Coeffecient _____

Aquifer Material (Anhydrite; Basalt; Clay; Clay soils (surface); Claystone; Coarse Sand; Fine Sand; Fine-Grained Sandstone; Fractured Igneous and Metamorphic Rock; Gravel; Karst Limestone/ Dolomite; Medium Sand; Medium-Grained Sandstone; Permeable Basalt; Sand and Gravel Mixes; Shale; Silt; Loess; Siltstone; Unfractured Igneous and Metamorphic Rock; Unweathered Marine Clay; Weathered Gabbro; Weathered Granite)

Fill Material (Coarse Sand Fine Sand Gravel Medium Sand) Packing Material (Backfill Bentonite Cement Open Hole)

Location of Measuring Point _____

Water Level Measurement Method: Unknown (0); Steel Tape (1); Electric Tape (2); Pressure Gage (3); Timing the sound from dropping a stone (4); Reported (5); Estimated from the length of a string (6); Use of a sounder on the end of a string (7); Transducer (8); Recorder (9); Other (10)

Persons Collecting Data _____

SLUG TEST WATER LEVEL DATA			
Measurement Date/Time (dd/mm/yyyy hh:mm)	Depth to Water (m)	MP Height (m)	Depth to Water Below Land Surface (m)

SLUG TEST WATER LEVEL DATA			
Measurement Date/Time (dd/mm/yyyy hh:mm)	Depth to Water (m)	MP Height (m)	Depth to Water Below Land Surface (m)

