MINISTRY OF AGRICULTURE, IRRIGATION AND WATER DEVELOPMENT

Standard Operating Procedure for Operation and Management of the National Groundwater Database

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1.0 GENERAL INFORMATION

1.1 Purpose

The purpose of this document is to describe the process for entering data and information into the National Groundwater Monitoring Network (NGWMN) WISH Database and managing the database. The NGWMN database is an electronic repository of data and information pertaining to the groundwater monitoring network.

The NGWMN Database provides useful data and information to support groundwater reporting activities, permitting activities, regulatory information and management activities.

1.2 Application

The procedures contained in this document are to be used by Groundwater Division Database personnel and any other officers/personnel concerned with groundwater development activities when entering groundwater data into the national Database and general maintenance and management of the database. In the event that the field personnel determine that any of the procedures described in this section are inappropriate, inadequate or impractical and that another procedure must be used for any aspect of data capturing and management, the variant procedure will be documented, along with a description of the circumstances requiring use of alternative procedure.

1.3 Scope

The GWMN database personnel shall enter, format, maintain and manage groundwater data in the national Database to produce various plots and reports for use by various groundwater stakeholders. NGWMN data and information stored in the database include groundwater levels, borehole location, water quality, quantity, geology and hydrogeology. Spatial data, from the GIS section, is an integral component of the groundwater database from which various maps, mainly topographic, drainage, aquifer distribution, borehole location and distribution and hydrochemistry maps, are produced for reporting.

Responsibilities of the database personnel are:

1) Ensuring the NGWMN database contains accessible, secure, and technically accurate data.
2) Keeping the database current, including capturing information generated by various groundwater stakeholders e.g. NGOs, research and consulting organizations.
3) Ensuring effective maintenance and management of the database.

4) Presenting groundwater data in various formats (plots and reports etc.)
5) Generating various spatial data plots.

1.4 Groundwater division SOPs

The following documents form part of the series of standard Operating Procedures for best management practices in groundwater management:

Document No.	**Title**
GW01/2012	Standard Operating Procedure: Drilling and Construction of National Monitoring Boreholes
GW02/2012	Standard Operating Procedure for Aquifer Pumping Tests
GW03/2012	Standard Operating Procedure for groundwater level monitoring
GW04/2012	Standard Operating Procedure for groundwater sampling
GW05/2012	**Standard Operating Procedure for operation and management of the national groundwater database**
GW06/2012	Standard Operating Procedures for Groundwater Use Permitting
GW07/2012	Standard Operating Procedure: Drilling and Construction of Production Boreholes

All official copies of the division's documents are kept, in electronic format and hard copies, by the office of the Deputy Director – Groundwater Resources.

1.5 Responsibilities

The Database Manager shall be responsible for groundwater database management. Special access to the database, updating and modifying the database shall be granted to delegated staff.

1.6 Definitions of terms

Ground elevation	The elevation of the ground surface of the borehole expressed in metres above mean sea level (mamsl).
Hydrogeologic	Factors that deal with subsurface waters and related geologic aspects of surface waters.
Hydrogeology	The subject dealing with the occurrence, characterization and movement of water below the earth's surface.
Raw data	Any electronic datalogger data, laboratory or field datasheets, records, notes, or exact copies, that are the result of original observations.
Water elevation	The elevation of the surface of the water in a borehole, expressed in metres above mean sea level (mamsl).
Water level	Depth to water in a borehole expressed in metres below ground level (mbgl) or metres above mean sea level (mamsl).

1.7 Health and safety

Proper safety precautions must be observed in the operation of the national groundwater database pertaining to the use of computers and office equipment. In particular the following issues apply:

1) use of anti-glare computer screens to reduce or minimise computer eye strain
2) proper set up of office chairs to reduce back pain
3) instructions on reducing back pain when sited in office chair for long periods e.g. standing up once in a while
4) use of power surge protectors to avoid cases of electric fire or blow-offs

2.0 EQUIPMENT LIST

The following equipment and tools must be available for entering data and information into the National Groundwater Monitoring Network.

1) Raw data or electronic data to be entered
2) Computer with Microsoft Excel and the Windows Information System for Hydrogeologists (WISH) installed
3) Power surge protectors for computers to avoid cases of electric fire or blow offs
4) Server for data back up and storage

3.0 PROCEDURES FOR DATA COMPILATION AND MANAGEMENT

3.1 General

1) All data collected for the NGWMN and related projects shall be collated, formatted and stored at the national database offices using HYDSTRA (groundwater module) and transferred into WISH database files for processing and presentation. HYDSTRA and WISH shall have the same data formats to allow sharing of data exported between the two programs. The following data types are available in WISH database files:

- Basic data.
- Chemistry data.
- Water level data.
- Discharge data.
- Rainfall data.
- Photos.
- Borehole geology data.
- Borehole construction data.
- Borehole fill data.
- Borehole parameters data.
- Borehole yield data.
- Pump test data.

Figure 1 shows the EXCEL data sheets for the WISH database.

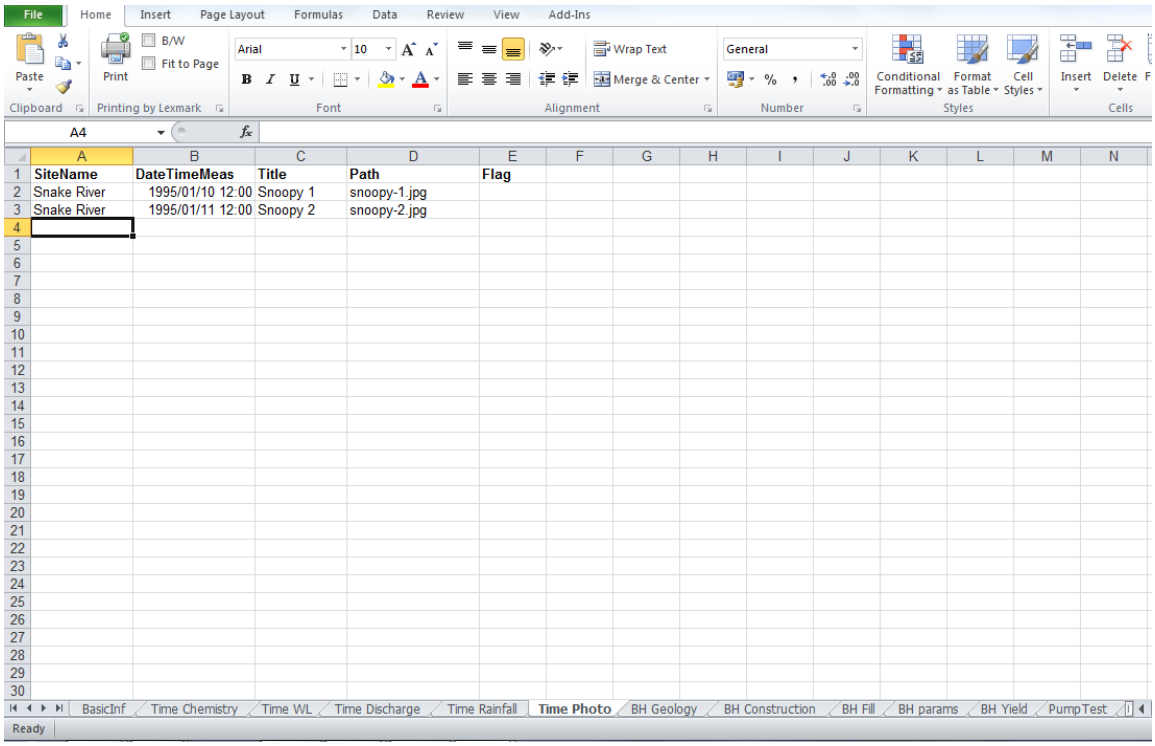

Figure 1 EXCEL spread sheets for WISH database

2) Server protocols for data access and modification to be observed as defined by the Groundwater Division (or Ministry)
3) All data or information request by groundwater stakeholders to be handled by the Database Manager.
4) All changes or updates to the database shall be saved and stored on the Server for back up and storage.

3.2 Water level measurements

1) Use “Basic data” and “Water level data” WISH’s EXCEL spread sheets for all water level measurements.

2) Record borehole location data i.e. surveyed X, Y and Z coordinates (UTM zone 36S, WGS 84 format) for each borehole on the “Basic data” file. Use GPS coordinates instead if there is no surveyed data.

3) Record the collar height i.e. the height, in metres, of the measuring point above the ground on the same spread sheet.

4) Indicate the nature of the measuring point as borehole (B) on this spread sheet.

3.2.1 Manual groundwater level measurements

1) Transfer the raw data collected in the field to a desktop computer’s spread sheet program.
2) Save the data to the network server for more permanent storage.
3) Record field water level data as metres below ground level (mbgl) on the “Water level data” on WISH’s EXCEL spread sheet and using the same borehole name as the one entered in the “Basic data” spread sheet. The date of the measurement is also recorded on this sheet.
4) Close the database file when the data has been loaded or updated onto the spread sheet and open the database file using WISH software.
5) Generate a groundwater level time series plot in WISH to view the data and determine if there are any errors or any readings that appear to be wrong or strange. Correct any mistake from such readings or flag the readings and subsequent repeat measurements shall be made to verify the readings.

3.2.2 Automatic groundwater level measurements

1) Transfer field data (raw data) to a desktop computer’s EXCEL spread sheet program and save it to the network server for more permanent storage.

2) For each borehole site, determine the constant offset to be applied to each automatic reading based on manual readings taken at that site.
3) Convert automatic measurements at each borehole to mbgl by applying the constant offset determined above.
4) Record the reduced water level data on the “Water level data” spread sheet (WISH’s EXCEL sheet), using the same borehole name as the one entered in the “Basic data” spread sheet. The date and time of the measurement is also recorded on this sheet.
5) Close the database file when the data has been loaded or updated onto the spread sheet and open the database file using WISH software.
6) Generate a groundwater level time series plot in WISH to view the data and determine if there are any errors or any readings that appear to be wrong or strange. Correct any mistakes from such readings or flag the readings and subsequent repeat measurements shall be made to verify the readings.
7) If it is established that the data logger may be malfunctioning, the data logger will be sent for repair.

3.3 Hydrochemistry

1) All the basic data for water sampling points shall be recorded on the “Basic data” EXCEL spread sheet, as described above for water measurements. The type of measuring point, for the sampling points, shall be designated as:
    - W for a well.
    - B for Borehole.
    - N for Meteorological station.
    - P for Pan or dam.
    - R for River or stream.
    - S for Seepage pond.

    Other letters can be used for other sampling points not listed above and a description of the sampling point should be given in the “Basic data” spread sheet.
2) Record the collar height i.e. the height in metres, of the measuring point above the ground surface for each sampling point on the “Basic data” sheet.
3) Record laboratory water quality results on the “Time Chemistry” data sheet of the WISH database file following data entry instructions and formatting requirements from the WISH manual.

Plots generated from the hydrochemistry data when the data is input into WISH include time series for each measured parameter, Piper, Stiff and Durov plots. All these can be

compared to prescribed standard values e.g. WHO limits for drinking water or national standards.

3.4 Rainfall

1) All the basic data for rain gauge stations shall be recorded on the “Basic data” EXCEL spread sheet. The type of measuring point shall be designated “N”.
2) All rainfall readings, above 0, shall be recorded in mm according to the requirements of the WISH manual.

WISH generates rainfall time series when rainfall data is loaded into the processing software.

3.5 Other parameters

Test pumping and borehole drilling and construction details shall be entered and stored in the WISH database file, in accordance to the WISH manual for data entry, formatting and processing requirements. All the data and information on location and nature of data point is entered on the “Basic data” sheet while the measured data is recorded on the relevant parameter data sheet.

3.6 Checking if data entries are correct

1) Install and use the WISH project macro to check the validity of the entries in the EXCEL database file.
2) Run the macro after new data has been entered or when difficulties are experienced in setting up the WISH database correctly in Excel. The macro identifies and highlights suspect data from the database, as set out in Table 2.

Table 1 Identification of suspect data using WISH macro

Error fields in excel spread sheets	Colour identification
Leading and trailing spaces removed	Cyan
Text Field where a value is expected	Bright cyan
Error Fields such as wrong dates	Red
Zero values are unlikely and therefore colour-coded	Light magenta
Missing values, such as empty fields	Yellow
Logical errors of parameters such as pH and date	Orange

In addition to colour coding of suspect data, the macro also automatically adds a flag column to time series datasheets when the macro is run to allow suspect records to be flagged from within the time series analysis feature during processing.

3) Correct or reformat the data errors identified.

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

1) Check for entry errors by comparing latest database entries with the original data files or paper data sheets once each month.
2) Check the format and validity of the entries in the EXCEL database file using the WISH project macro.

5.0 REFERENCES

The following documents were consulted in the preparation of this SOP:

Eelco Lukas and Frank Hodgson. WISH (Windows Interpretation System for Hydrogeologists) version 2.0 manual. Institute for Groundwater Studies (IGS), South Africa

FONG, D. Y. T., 2001. Data Management And Quality Assurance, Drug Information Journal 0092-8615/2001, Vol. 35, pp. 839–844, USA

Hagedorn, S., 2010. Standard Operating Procedure: Procedure for GSI Zooplankton Database Data Entry, Data Quality Control and Database Management - Procedure No: GSI/SOP/G/RA/DM/1, Great Ships Initiative (GSI)

Ministry of Finance and Economic Development (Sierra Leone), 2009. Standard Operating Procedures for the Sierra Leone Development Assistance Database (DAD), URL: http://www.aideffectiveness.org/Country/Sierra-Leone/Standard-Operating-Procedures-for-the-Sierra-Leone-Development-Assistance-Database-DAD.html, retrieved on 8 February 2012.

Terakawa, A., 2003. World Meteorological Organization, Operational Hydrology Report No. 48 Hydrological Data Management: Present State and Trends, Secretariat of World Meteorological Organization, Geneva, Switzerland