

User Manual

Hydrogeology Data Management

Database used for both Offline (desktop) GIS and Online (Web) GIS maps.

By: Shuaib Zarinkhail, GIS/MIS Adviser, NORPLAN

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Introduction

Data initially can be processed in spreadsheets (Microsoft Excel here) and then combined into databases to be used for below purposes:

1. Store data
2. Filter data
3. Sort data
4. Join and combine data
5. Query data
6. Represent data on GIS maps
 - Either live link
 - Or feeding exported data into other 2D formats

We used an MS Access database to store and export data to a Geodatabase used for the Desktop maps and to other specific formats used for the online maps. This database is called “Water Quality Feeder” database and has many versions. Up to date we are using version 36 of this file. The format from all versions needs to be the same, the difference is only in user data. By adding new records version number increases (we optionally may use a date stamp as well in the name of different versions of the feeder database). The feeder database can be called as the main tool for combining water quality data to be used by different GIS systems.

Below is a screen shot from the feeder database:

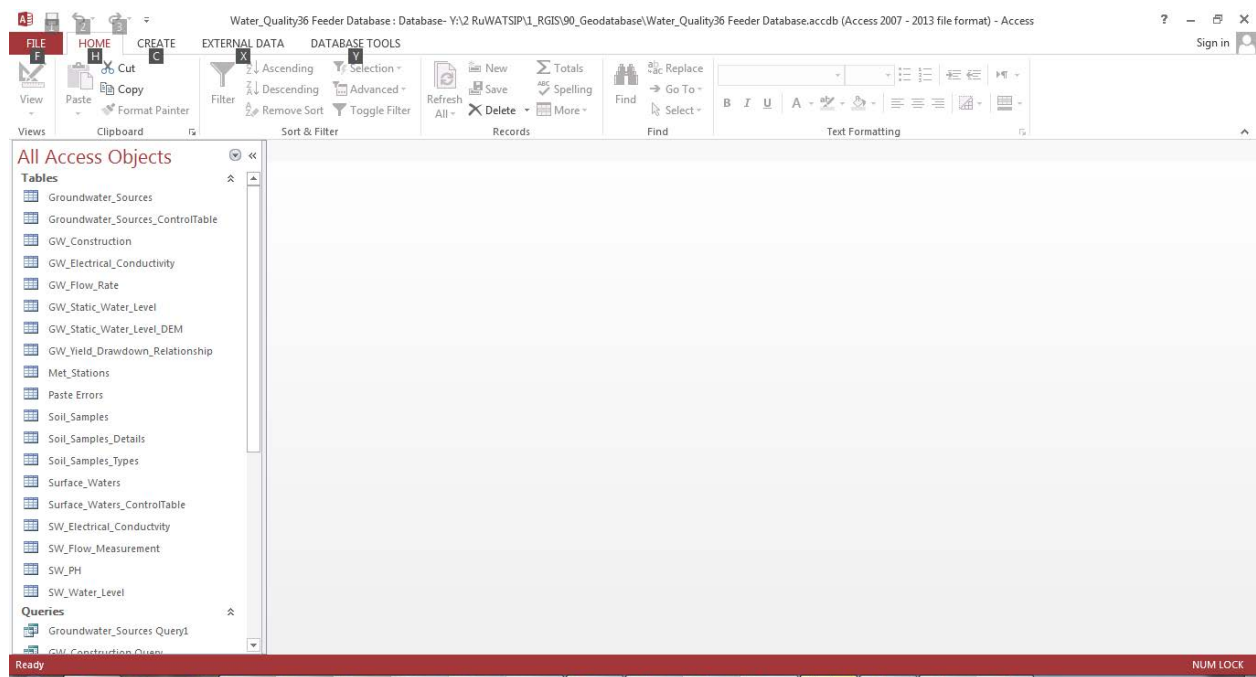


Figure 1: Feeder database window

Feeder Database Structure

The feeder database has many tables and relationships between tables. All tables categorized into groundwater, surface water, meteorological stations and soil samples. Data for all 4 categories can be stored in this database.

Groundwater Related Tables

Eight tables are included in this category.

1. Groundwater sources table

This is the master table recording most of details one time recorded for each waterpoint.

Groundwater Sources Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Type	Shows the type of waterpoint as "dug well", "spring", "karez" etc.
Name_of_feature	Name of waterpoint if related to a specific location or person
Village	Village name
District	District name
Province	Province name
Longitude	Longitude in decimal format
Latitude	Latitude in decimal format
Ground_elevation_meter_above_sea_level	Shows ground elevation from sea level
Ground_elevation_flag	Data source for above field
Year_constructed	Construction year with a logical value
Driller	In case of being drilled water point, name of driller
Implementing_agency	Who did implemented the project
Donor	Dono name
Data_supplied_by	Data source for above field
Use	Who use water; is it public?
Pump	Pump type
Aquifer	Aquifer type
Geological_construction_log_scanned	Yes/No field
Link_to_geological_construction_log	Link to document if above is yes

Depth_to_base_of_Quaternary_m	Depth to base of quaternary layer in meters
Depth_to_base_of_Neogene_m	Depth to base of neogene layer in meters
Geophysical_log_scanned	Yes/No field
Link_to_geophysical_log	Link to document if above is yes
Well_depth_m	Well depth in meters
Completed_diameter_at_top_mm	Completed diameter at the top of well in millimeters
Completed_diameter_at_bottom_mm	Completed diameter at the bottom of well in millimeters
Water_quality_analysis_available	Yes/No field
Link_to_water_quality_analysis	Link to document if above is yes
Problematic_water_quality_components	Water quality data showing problematic water
Additional_water_level_data_available	Yes/No field
Link_to_additional_water_level_data	Link to document if above is yes
Maximum_operational_yield_Liter_per_second	Maximum yield of water per second
Additional_pumping_test_data_available	Yes/No field
Link_to_additional_pumping_test_data	Link to document if above is yes
Comments	Comments part if there are
ft_Index	This fields is required for geodatabase
ft_Display	This fields is required for geodatabase

Table 1 Groundwater sources (the main table)

2. Groundwater sources control table

This table is used to prevent data duplication prior to entry. Checking point is the GPS coordinates and has the following structure:

Groundwater Sources Control Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Reference_File	Showing the source of data from previous stage (maybe Excel sheet)
Type	Shows the type of waterpoint as "dug well", "spring", "karez" etc.
Name_of_feature	Name of waterpoint if related to a specific location or person
Village	Village name
District	District name
Province	Province name
Longitude	Longitude in decimal format
Latitude	Latitude in decimal format

Table 2 Groundwater sources control table

3. Groundwater construction table

This table can/should have many records for every individual waterpoint where construction is done.

Groundwater Construction Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Lining_type	Materials used in construction of waterpoints. For each material a different record of data should be entered
From_m_bwt	Materials layer start from well top in meters
To_m_bwt	Materials layer end from well top in meters
Diameter_mm	Diameter of constructed layer in millimeters
Material	Type of materials. i.e. Concrete, steel, PVC, etc.

Table 3 Groundwater construction details table

4. Groundwater electrical conductivity (EC)

This table also can have many records for one groundwater point differentiated by date.

Groundwater Electrical Conductivity Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_EConductivity	Date of taking sample of water
Electrical_conductivity_mju_S_cm	Electrical conductivity after checking
Laboratory_L_or_Field_F	Type of check either "L" for laboratory or "F" for field
Corrected_to_C_Degree	Corrected to a specific temperature degree

Table 4 Groundwater EC recordings table

5. Groundwater flow rate

Groundwater Flow Rate Measurement Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_Flow_Rate	Date of checking flow rate of water productivity
Flow_or_discharge_L_per_s	Water production as liter per second
Estimated_or_gauged	This field can have either of 2 values: "estimated" or "gauged"

Table 5 Groundwater flow rate measurement recordings table

6. Groundwater static water level

This table records data from provided by individuals while the other table “Groundwater Static Water Level (using DEM)” stores data records using a different approach.

Groundwater Static Water Level Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_Static_Level	Date of measurement
Static_water_level_m	Water level in meters
Unit	Can be either from ground level or from well top, etc.
Elevation_DEM	Elevation value extracted from DEM (digital elevation model)
Static_water_level_m_asl	Water level above sea level in meters
Static_water_level_m_asl_Flag	Data source for above field

Table 6 Static water level data

7. Groundwater static water level (from DEM)

This table includes values automatically calculated from the existing data through the digital elevation model.

Groundwater Static Water Level (Using DEM) Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_Static_Level	Date of measurement
Static_water_level_m	Water level in meters
Unit	Can be either from ground level or from well top, etc.
Type	Shows the type of waterpoint as "dug well", "spring", "karez" etc.
Longitude	Longitude in decimal format
Latitude	Latitude in decimal format
Shape	This fields is required for geodatabase
RASTERVALU	Static water level extracted from DEM
Static_water_level_m_asl	Water level above sea level in meters
Static_water_level_m_asl_Flag	Data source for above field

Table 7 Static Water Level data using DEM

8. Groundwater yield drawdown relationship

Groundwater Yield Drawdown Data Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_Yield_Drawdown	Date of measurement
Yield_L_per_s	Water productivity liter per second
Drawdown_m	Drawdown of water while testing
Duration_hr	Duration of test

Table 8 Water productivity tests table

Surface water related tables

Six tables are related in this category and store surface waters related data.

1. Surface water sources table

This is the main table recording most of data covering one time entry information.

Surface Water Sources Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Type	Shows the type of waterpoint as "dug well", "spring", "karez" etc.
Name_of_feature	Name of waterpoint if related to a specific location or person
Name_of_River	River name
District	District name
Province	Province name
Longitude	Longitude in decimal format
Latitude	Latitude in decimal format
Year_data_commence	The year when data collection started
Year_data_cease	The year when data collection stopped
Agency_responsible	Responsible agency for data collection
Data_supplied_by	Data source for above field
Elevation_of_station_general_m_asl	Elevation of station location
Elevation_general_data_flag	Data source for above field
Typical_dry_season_flow_m3_per_second	Flow of water in dry season as m3 per second
Typical_wet_season_per_snowmelt_flow_m3_second	Flow of water in wet season as m3 per second
Typical_annual_avertage_flow_m3_second	Annual average flow of water as m3 per second
Additional_water_level_per_flow_data_available	Yes/No field
Link_to_additional_water_level_per_flow_data	Link to document if above is yes
Additional_water_quality_data_available	Yes/No field
Link_to_additional_water_quality_data	Link to document if above is yes
Problematic_water_quality_components	Water quality data showing problematic water
Comments_and_additional_information	Comments part if there are
ft_Index	This fields is required for geodatabase
ft_Display	This fields is required for geodatabase

Table 9 Surface water sources recording table

2. Surface water sources control table

Surface Water Sources Control Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Reference_File	Showing the source of data from previous stage (maybe Excel sheet)
Type	Shows the type of waterpoint as "dug well", "spring", "karez" etc.
Name_of_feature	Name of waterpoint if related to a specific location or person
Name_of_River	River name
District	District name
Province	Province name
Longitude	Longitude in decimal format
Latitude	Latitude in decimal format

Table 10 Surface water sources control table

3. Surface water electrical conductivity

Surface Water Electrical Conductivity Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_EConductivity	Date of taking sample of water
Temperature_C_degree	Temperature of water while collecting sample
Electrical_conductivity_mju_S_cm	Electrical conductivity after checking
Laboratory_L_or_Field_F	Type of check either "L" for laboratory or "F" for field
Corrected_to_C_Degree	Corrected to a specific temperature degree

Table 11 Surface water EC checking table

4. Surface water flow measurement table

Surface Water Flow Rate Measurement Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase

ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_flow_gauging	Date of checking flow rate of water productivity
Flow_measurement_m3_s	Water production as m3 per second
Method	What method of measurement is used? i.e. impeller/profile

Table 12 Surface water flow measurement table

5. Surface water pH recording table

Surface Water pH Recording Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_ph	Date of taking sample of water
pH	pH value
Laboratory_L_or_Field_F	Lab or Field (L or F)

Table 13 Surface water pH values recording table

6. Surface water level table

Surface Water Level Recording Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Date_water_level_measurement	Date of taking sample of water
Water_level_m_asl	Water level in meter above sea level

Method	Which method/equipment is used
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Table 14 Surface water level recording table

Meteorological stations table

There are some data on meteorological stations and their activities. We have only one table to store related data and is as follows:

1. Meteorological data table

Meteorological Centers Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Type	Shows the type of waterpoint as "dug well", "spring", "karez" etc.
Name_of_feature	Name of waterpoint if related to a specific location or person
District	District name
Province	Province name
Longitude	Longitude in decimal format
Latitude	Latitude in decimal format
Year_data_commence	The year when data collection started
Year_data_cease	The year when data collection stopped
Agency_responsible	Responsible agency for data collection
Data_supplied_by	Data source for above field
Elevation_general_m_asl	Elevation of location
Elevation_general_data_flag	Data source for above field
Annual_average_precipitation_mm	Annual average of precipitation in millimeters
Period_for_precipitation_atverage	Average period of precipitation
Annual_average_air_temperature_in_C_Degree	Annual average of temperature in C degree
Period_for_air_temperature_average	Period of air temperature average
Additional_precipitation_data_available	Yes/No field

Link_to_additional_precipitation_data	Link to document if above is yes
Additional_evapotranspiration_data_available	Yes/No field
Link_to_additional_evapotranspiration_data	Link to document if above is yes
Additional_temperature_data_available	Yes/No field
Link_to_additional_temperature_data	Link to document if above is yes
Additional_chemistry_per_isotope_data_available	Yes/No field
Link_to_additional_chemistry_per_isotope_data	Link to document if above is yes
Additional_other_data_available	Yes/No field
Type_of_other_data	Type of additional data if available
Link_to_additional_other_data	Link to document if above is yes
Comments_and_additional_information	Comments part if there are
ft_Index	This fields is required for geodatabase
ft_Display	This fields is required for geodatabase

Table 15 Meteorological Centers table

Soil samples tables

Soil samples data is recorded into three tables in this data. Details of each table is shown separately.

1. Soil samples table

This table includes the main data regarding soil samples.

Soil Samples Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Type	Shows the type of waterpoint as "dug well", "spring", "karez" etc.
Location_Village	Village name
District	District name
Province	Province name
Longitude	Longitude in decimal format
Latitude	Latitude in decimal format
Date_of_Sampling	Date of taking sample

Agency_Responsible	Responsible agency for data collection
Data_Supplied_By	Data source for above field
Ground_elevation_meter_above_sea_level	Elevation of station location
Ground_elevation_flag	Data source for above field
Underlying_geology	What is name of geology layer
Soil_Samples_Taken	Yes/No field
Comments	Comments part if there are
ft_Index	This fields is required for geodatabase
ft_Display	This fields is required for geodatabase

Table 16 Soil samples table

2. Soil sample details table

This table includes more details for soil samples.

Soil Sample Details Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase
ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Sample_Depth_cm	From how depth did the sample taken (in centimeters)
Sample_Number	Tag which is added in the field. i.e. NOR-MAY-SS-01-40a
Soil_Chemical_Analysis_Available	Yes/No field
Link_to_Chemical_Analsys	Link to document if above is yes
Soil_Grain_Size_Available	Yes/No field
Link_to_Grain_Size_Analysis	Link to document if above is yes
Other_Data_or_Photos_Available	Yes/No field
Link_to_Other_Data	Link to document if above is yes

Table 17 Soil sample details table

3. Soil sample types table

This table is used to record some types of information explaining soil sample types.

Soil Sample Types Table	
Field Name	Details
OBJECT_NULL	This fields is required for geodatabase

ID	Identification number for constructions of waterpoints starting
Grid_square	Shows the grid area for each waterpoint. Values for this field is extracted from the GPS coordinates and has 6+1 digits. i.e. from a coordinate 63.58523, 35.77679 the extracted value is 635-357 and it shows the square where this water point is located
Sequential_number	Is a number starting from 1 in each grid square
Depth_Range_cm	Depth of soil sample to be taken from ground in centimeter
Soil_Description	Description of soil from which sample is collected

Table 18 Soil sample types table

Relationship between above tables related to each category are show in below image.

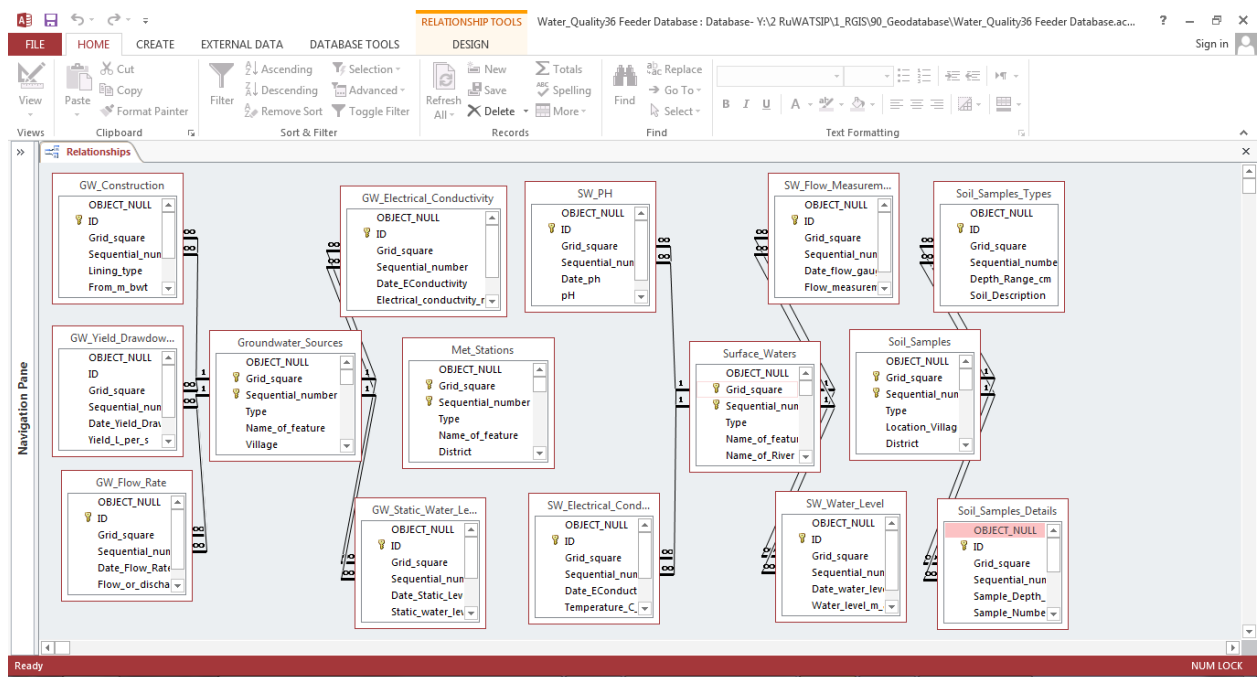


Figure 2 Relationship between feeder database objects (tables)

In relationships page tables related to every category are shown by lines of relationship. Groundwater related tables and surface water related parts both have two additional tables for controlling duplicate records before entry. They are not show in the relationships page.

Geodatabase Structure

A geodatabase is designed and linked to the project Desktop GIS. Maps present figures from the geodatabase originally fed from the feeder database explained earlier. A bundle of queries designed in the feeder database through which the updated data records are extracted and added to the geodatabase. In case to have recent data on the GIS maps, we have to query data from the feeder database and add to the geodatabase. All the required information for the geodatabase is included to the list of fields in queries in the feeder database.

List of queries in the feeder database which are using to feed the geodatabase is as follows:

List of Queries for Feeder DB to GeoDB		
No	Query Name	Details
1	Groundwater_Sources Query1	Shows all the groundwater points
2	GW_Construction Query	Shows all construction details plus GPS coordinates for every record (one water point may have more construction details)
3	GW_Electrical_Conductivity Query	Shows electrical conductivity for each water point with different dates and GPS coordinates
4	GW_Flow_Rate Query	Shows flow rate for each water point with different dates and GPS coordinates
5	GW_Static_Water_Level_Values_Frequency	Shows all static water level details plus GPS coordinates for every record (one water point may have more static_water_level_values details)
6	GW_Yield Drawdown_Relationship Query	Shows all yield and drawdown relationship figures and their related waterpoint's GPS coordinates
7	Met_Stations Query	Extracts details of all meteorological stations
8	Soil_Samples Query	Shows complete information from the soil samples table
9	Soil_Samples_Details Query	Shows all details plus GPS coordinates for every record
10	Soil_Samples_Types Query	Shows all types details plus GPS coordinates for every record
11	Surface_Waters Query	Shows all details for surface waters from the database
12	SW_Electrical_Conductivity Query	Shows electrical conductivity for each water point with different dates and GPS coordinates
13	SW_Flow_Measurement Query	Shows flow measurements for each water point with different dates and GPS coordinates
14	SW_PH Query	Shows all ph details plus GPS coordinates for every record (one water point may have more ph details)
15	SW_Water_Level Query	Shows water level for each water point with different dates and GPS coordinates

Table 19 List of queries by which data is extracted from feeder database and to be used in Geodatabase

In addition to the geodatabase required tables and structures, we have 15 tables in the project geodatabase. Every table is according to the queries from the above table. The database is linked to the project GIS and its data is in live link with all the project maps.

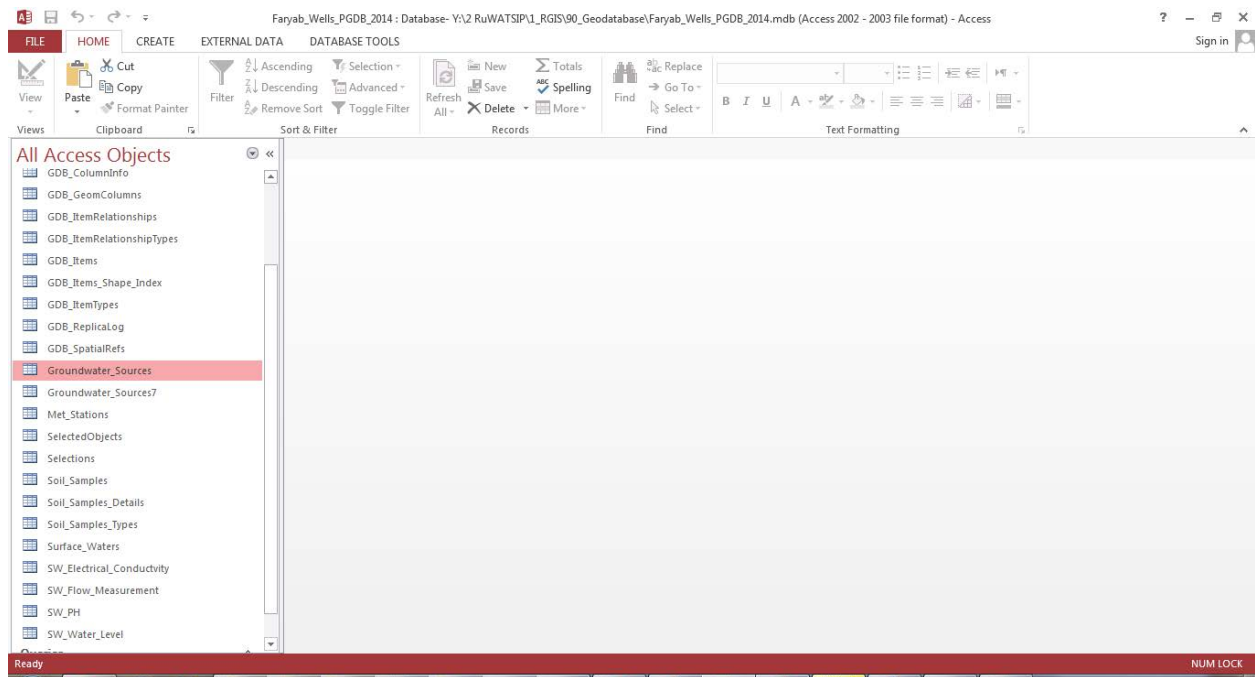


Figure 3 The geodatabase page

In the desktop GIS (ArcGIS), the geodatabase parts and tools are accessible. In the right side of below image, the structure of the geodatabase linked to the desktop GIS is visible and waterpoints are also shown on a sample map.

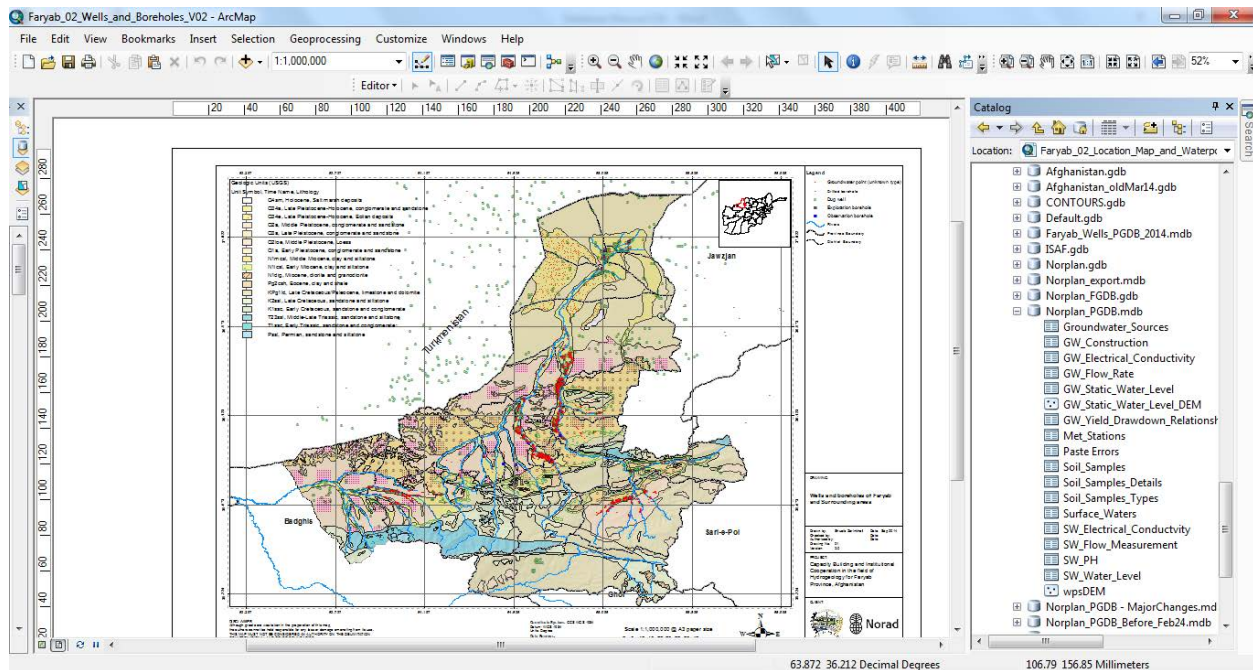


Figure 4 Desktop GIS (ArcGIS) view including Geodatabase structure

Conclusion

Hydrogeology data management system requires different steps/stages when data became available. Initial steps of data management from the technical perspective are taken using different software. Spreadsheets is a good alternative for technical data management. When the data is cleared from the hydrogeology technical point of view it comes to the system (database and GIS). First, data goes to the feeder database controlling duplication. Later it moves to the project geodatabase which has live link to the project desktop GIS maps. Maps can be exported in any format having any dimensions for presenting on digital and print formats.

At the end, I want to add a map presenting information from the project database.

