



Pumped hydroelectric storage in post mined areas to support regional net-zero emission energy systems development

Work Package 1: Data collection on potential locations for the proposed energy storage technology

Deliverable D1.4

Database of selected mining and postmining areas

Technical University of Crete (TUC) : **Leader of the Task**

Contributing partners: CUT, POLT, VUHU, KOSD and UP



Co-funded by the
European Union



With the co-financing of Greece and the European Union

“This research was funded by the CETPartnership, under the Joint Call 2023. The CETPartnership’s research projects are co-funded by the European Commission (Grant Agreement No. 101069750) and the national funding organizations listed on the CETPartnership website.”

Summary

Deliverable D1.4 presents the development of the HYDROMINE database, created within Work Package 1 to support the identification of former mining sites suitable for Small Pumped Hydro Storage (SPHS) systems. The database compiles georeferenced technical, environmental, infrastructural, economic, and regulatory data to enable systematic comparison of candidate sites and support regional net-zero energy planning.

Currently containing data from 13 sites across Czechia, Germany, Greece, Poland, and Romania, the database integrates detailed information on site characteristics, upper and lower reservoir parameters, hydraulic connections, grid access, nearby renewable installations, and market and legal conditions.

The database is implemented in MySQL and normalized in Third Normal Form to ensure consistency and efficient querying. It is organized into seven interrelated tables centered on the “sites” entity. For spatial visualization, the database is mirrored into PostGIS and accessed through QGIS, where users can explore mapped reservoir locations, view attributes, and export data. Editing rights remain with the database administrators.

The second section of the deliverable provides a practical guide for accessing the HYDROMINE database through QGIS (version 3.40 LTR). Users are instructed to download the provided project file, connect to the online PostGIS database using authentication credentials, and establish predefined table relationships within the QGIS project. Once connected, reservoir locations appear as georeferenced points on the map, and users can employ tools such as “Identify Features” and “Open Attribute Table” to retrieve detailed site information. While QGIS enables navigation, visualization, and export of data, any modifications to the database must be performed by the responsible database management team (TUC).

Overall, the HYDROMINE database functions as a structured geospatial decision-support tool that facilitates the technical and strategic assessment of post-mining areas for pumped hydro energy storage deployment.

Contents

1.	Database overview.....	1
1.1	Database Structure	1
1.2	Database connection with QGIS-Access and uses.....	3
2.	Short guide on how to access Hydromine Database using QGIS	4
2.1	Software downloads	4
2.2	Initialization	4
2.3	Setting up Table Relationships.....	6
2.4	Navigating the map and reading the information of the data points.....	7

1. Database overview

The database created in Task 1.4 of WP1 of Hydromine project contains data of former mine sites collected in Task 1.1 and their capacities for pumped hydro storage (PHS) estimated in T1.3. Data is georeferenced and possible to be accessed and viewed via GIS.

The main goal of the developed database is to gather information for mine sites which are suitable locations for building Small Pumped Hydro Storage (SPHS) systems. It allows a comparison between different sites based on technical, infrastructural, and economic factors.

The HYDROMINE database is built on MySQL which is a high performance, open-source, relational DBMS (Database Management System). The HYDROMINE database currently contains data from 13 post mined sites from Czechia, Germany, Greece, Poland and Romania and is expected to be enriched until the project's completion. It also includes representative sections related to numerical geotechnical modelling.

An overview of data collection on the potential locations includes the following types of data.

- General location data: location, type of site, boundaries, water reservoir characteristic etc.
- Parameters of both lower and upper reservoir where PHS will be installed: area, elevation and water capacity of reservoirs, coordinates, distance and inclination angle between reservoirs, parameters of water, seasonal water level changes, etc.
- Infrastructure and electricity grid: access and proximity to the electricity grid, grid type and working voltage, existence and distance of renewable energy installations in the greater vicinity, working voltage and power of the installation and access road to site.
- Market, financial, legal and social issues (per country/region): region's energy demand, promotion of investment in energy storage units and particularly in PHS, social acceptance of activities related to energy production/storage, existence of regulations related to energy storage units and particularly for PHS, location of PHS in protected areas or in their vicinity, and lastly an estimation of the average industrial energy price: peak vs. Off-peak.

1.1 Database Structure

In the database created, every table was designed by means of describing one entity and the associated data which is necessary for describing that entity. Third Normal Form (3NF) normalization was used in order to eliminate or reduce redundancy in database tables and to improve the performance of queries. Thus, every table present on the database satisfies the specific criteria of this normal form, where non-primary key columns shouldn't depend on other non-primary key columns and there is absence of transitive functional dependencies. The database design is displayed in the Entity-Relationship Diagram as shown in Figure 1.1.

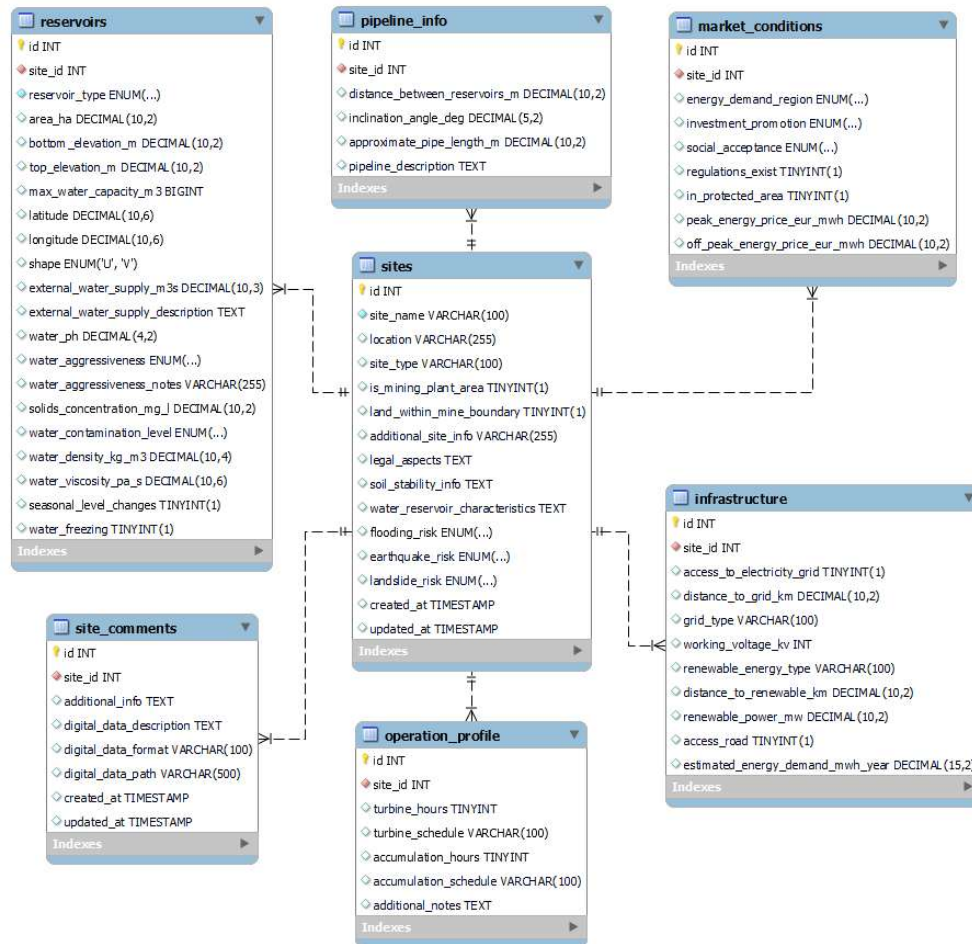


Figure 1.1: Entity-Relationship Diagram

The database schema achieves Third Normal Form across all seven following tables.

- Table **sites**: Central entity storing core site identification, classification, geotechnical assessment summaries, and risk evaluations. Serves as the parent table for all foreign key relationships.
- Table **reservoirs**: Stores physical dimensions, hydraulic characteristics, coordinates, and water quality parameters for both upper and lower reservoirs. Uses type-discriminated design pattern with `reservoir_type` field.
- Table **pipeline_info**: Captures hydraulic connection specifications between upper and lower reservoirs including distance, inclination, and pipe length.
- Table **operation_profile**: Records expected daily operating schedules for turbine generation and pump accumulation modes.
- Table **infrastructure**: Documents electrical grid connectivity, nearby renewable energy installations, and site accessibility.
- Table **market_conditions**: Captures regional market factors, regulatory environment, social acceptance, and energy pricing relevant to project viability.
- Table **site_comments**: Stores supplementary information and references to digital assets (e.g. maps, 3D models, satellite imagery) not captured in structured fields.

1.2 Database connection with QGIS-Access and uses

The core relational database was initially implemented in MySQL, which is used by the project team as the primary environment for data entry, maintenance, and structural development. MySQL was selected at this stage because it is well suited to iterative database design and testing.

To enable integration in QGIS, the database is mirrored into a PostGIS database. This transfer is handled automatically through scripts and preserves the structure of the data, allowing all tables associated with a given site to remain linked (see Figure 1.2). QGIS connects directly to the PostGIS database and therefore reservoir records and site information are displayed through clickable map features (see Figure 1.3). QGIS acts as a visualization tool that is also able to export the tables.

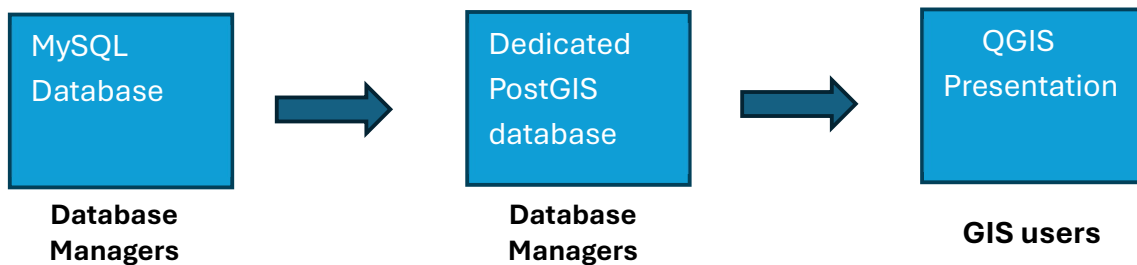


Figure 1.2: Flowchart of the procedure corresponding to the databases, managers and GIS users

End users interact only with QGIS, without needing to manipulate the underlying databases. Database managers are able to perform complex SQL queries through the MySQL database to filter and export information.

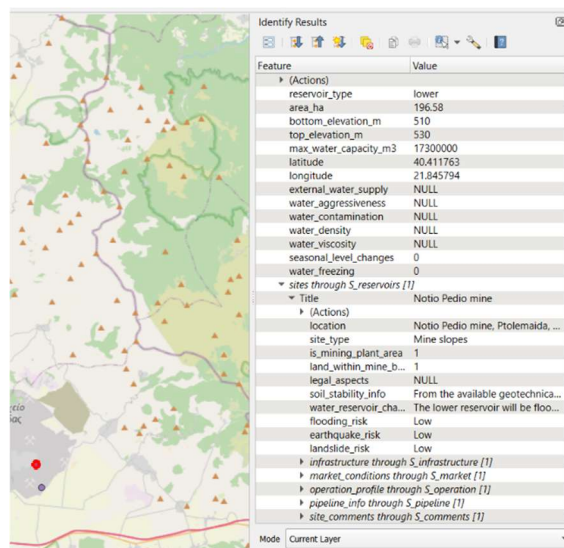


Figure 1.3: QGIS-accessed data of a potential site for PHS installation

2. Short guide on how to access Hydromine Database using QGIS

2.1 Software downloads

Firstly, the QGIS user should download the software version 3.40 Bratislava (Long Term Release-LTR) through the link: <https://qgis.org/download/> and install it on his computer. Secondly, the user should download and save the provided QGIS project named **Hydromine.qgz** which is stored in [project cloud](#).

2.2 Initialization

Once the user enters QGIS, the following steps are required. First, the user should open the database file in QGIS through the menu **Project -> Open-> choose the saved Hydromine.qgz file-> Open** (Fig. 2.1).

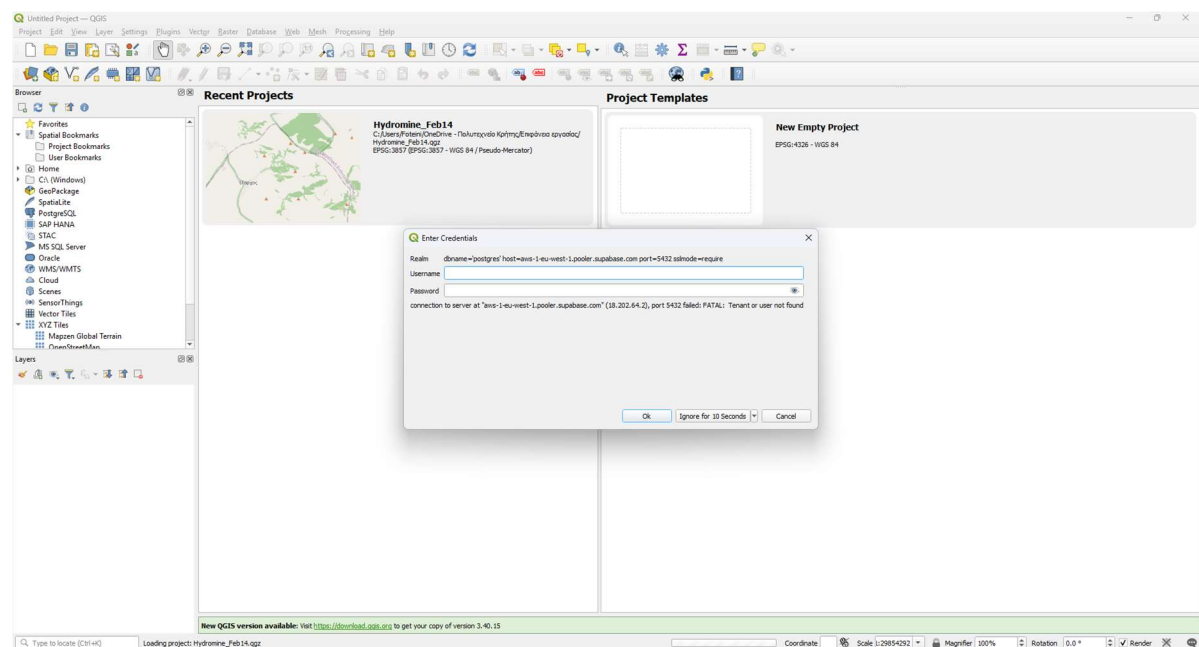


Figure 2.1: Connection to the Database

Access to the database requires authentication. Please use the following Username and Password to connect to the online PostGIS database (see Fig. 2.2):

Username: postgres.ksbsndakkvrayihpqxzo

Password: Zka98weReOpsv891LLnVctWe

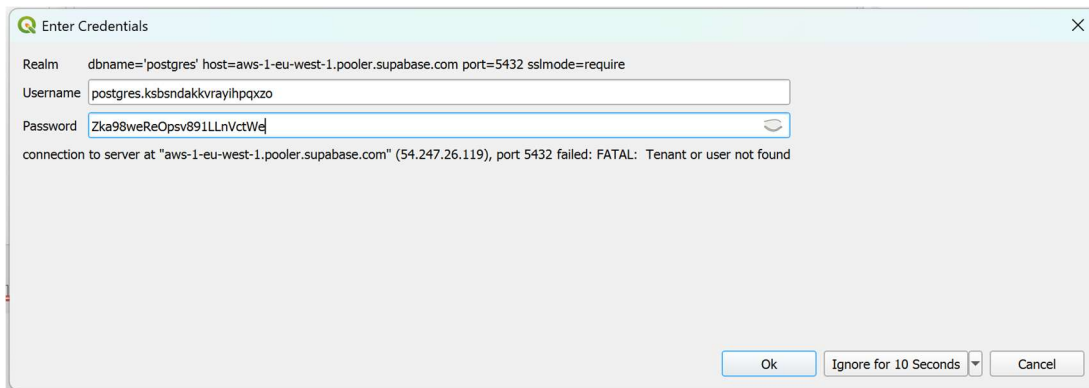


Figure 2.2: Login to the Database

After connecting to the database, the user is able to navigate through the map and explore the potential locations for Small Pumped Hydro Storage (SPHS) systems installation, each reservoir of the candidate sites is marked with a blue colored dot (Fig. 2.3).

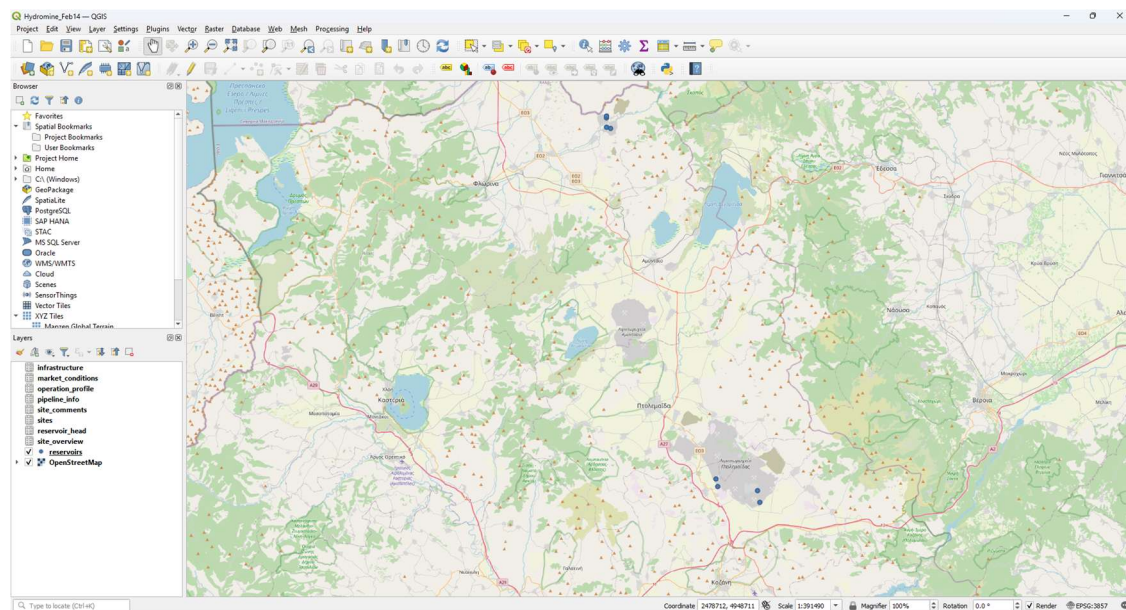


Figure 2.3: Overview of Hydromine database in QGIS

Also, the user can see the layers shown in Figure 2.4 (down left on QGIS screen).

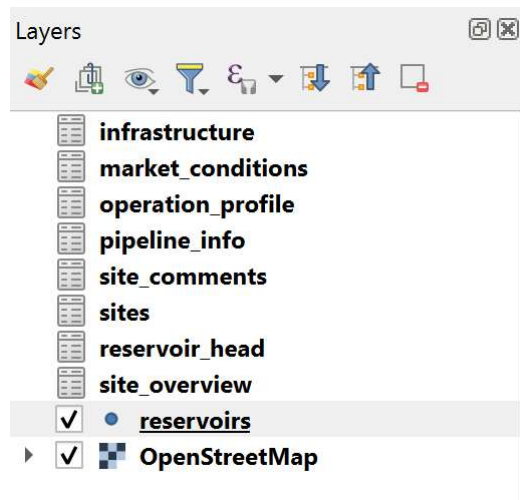


Figure 2.4: Layers for Hydromine in QGIS

From the tables listed in the layers, at this step only **Reservoirs** is connected to the map. **OpenStreetMap** should display area names in the local language.

2.3 Setting up Table Relationships

At the current moment, the relationships between the tables are not established in QGIS and they should be set up by the user as follows.

Starting by picking the **Project** tab from Left-side top, then click “**Properties**” as shown in Figure 2.5.

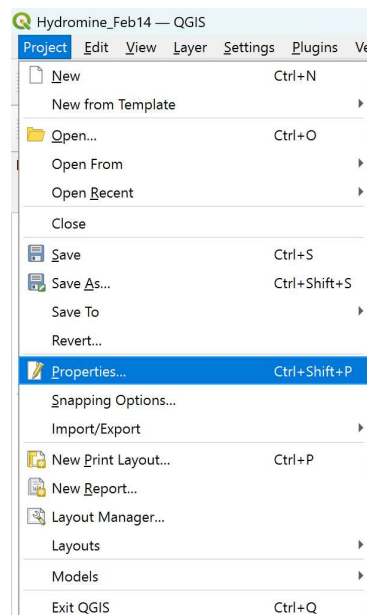


Figure 2.5: Project - Properties

Then, from the left-side choices, clicking “**Relations**”. The user should be able to see the relations shown in Figure 2.6. By clicking “**Apply**” and then “**OK**” the relations are set up.

These are the relationships between the various tables of the Hydromine Database, and how QGIS reads them. All tables are referenced by “**Site.**” The “**Reservoirs**” Layer has georeferenced coordinates and thus it is the one that contains the information required.

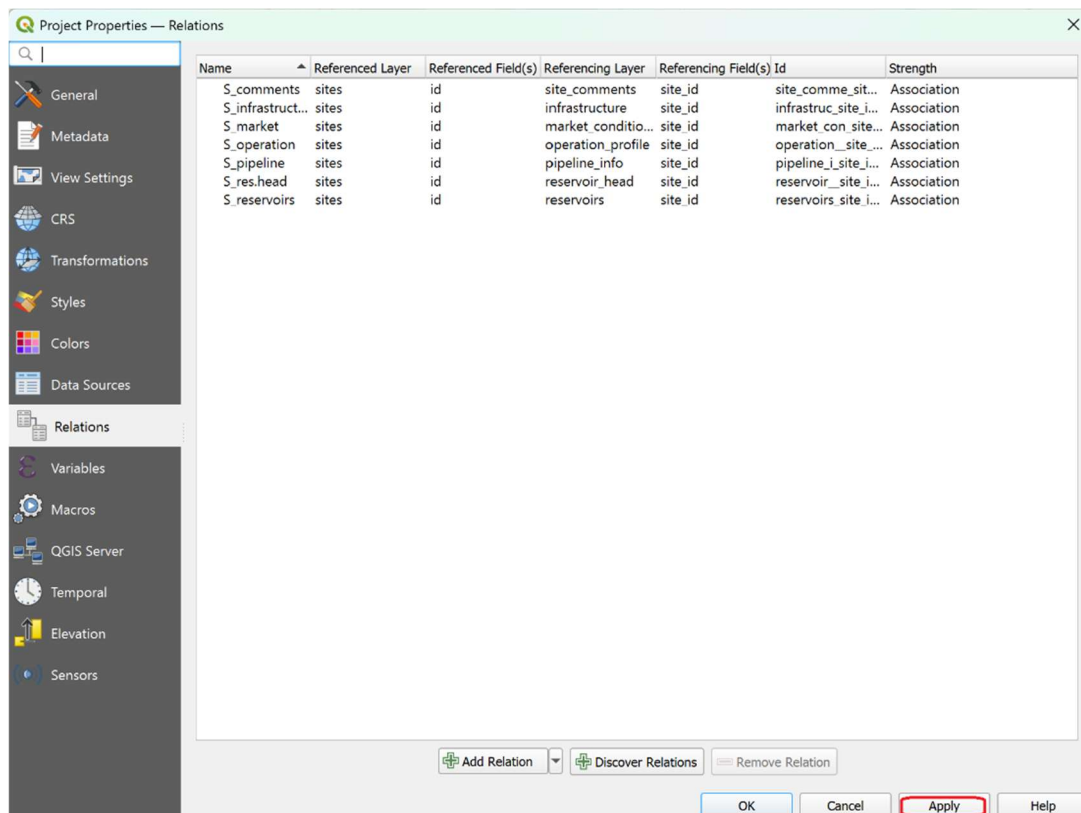


Figure 2.6: Table Relations

2.4 Navigating the map and reading the information of the data points

The map is generally navigated by using the Pan Map tool located in the Attributes Toolbar (Figure 2.7). As previously mentioned, each reservoir of the potential sites for Small Pumped Hydro Storage (SPHS) systems installation is marked with a blue colored dot (Figure 2.8).



Figure 2.7: Pan Map tool in the Attributes Toolbar

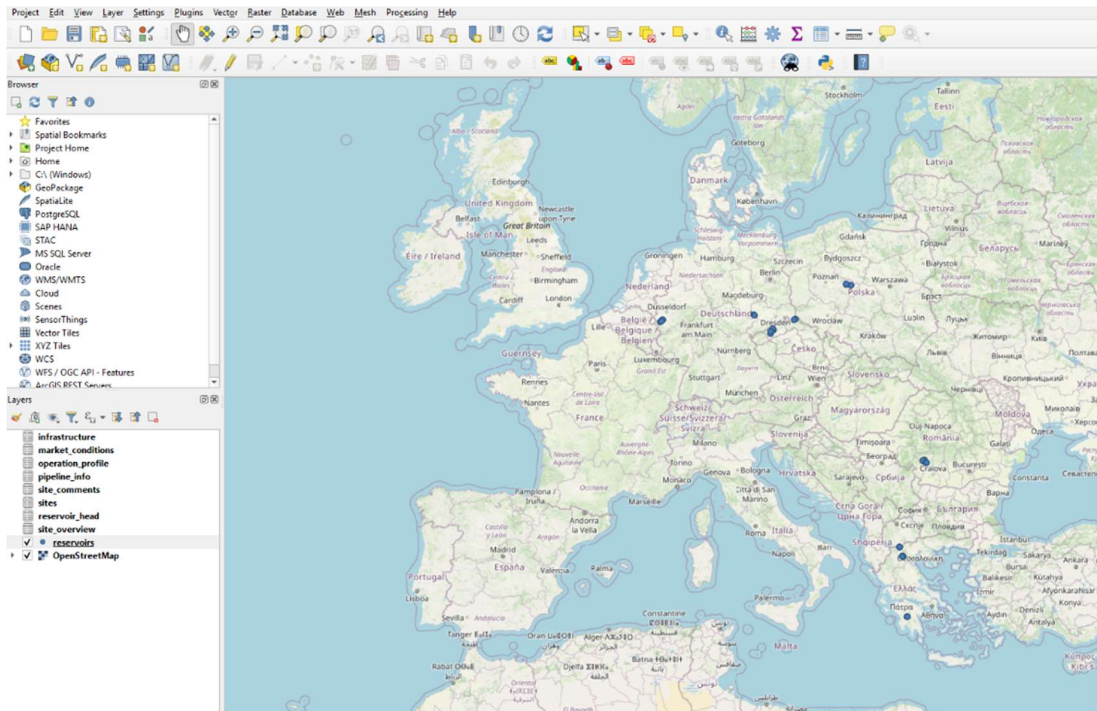


Figure 2.8: Map overview showing potential reservoir locations in each country

Next, in order to be able to use the “**Identify Features**” tool of QGIS, the user should have the **reservoirs** layer selected, as shown in Figure 2.10 as this is the one where the coordinates are stored. With the help of the Identify Features tool which is located in the Attributes Toolbar (Figure 2.9), clicking on a selected dot the **identify results** appear in a separate window on the right side of the screen (Figure 2.10).

Note: **OpenStreetMap** should display area names in the local language.

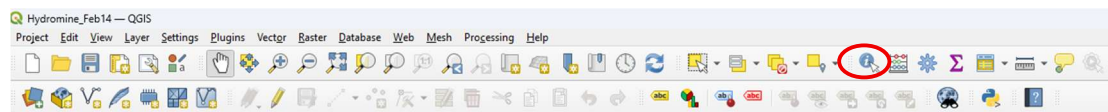


Figure 2.9: Identify Features tool in the Attributes Toolbar

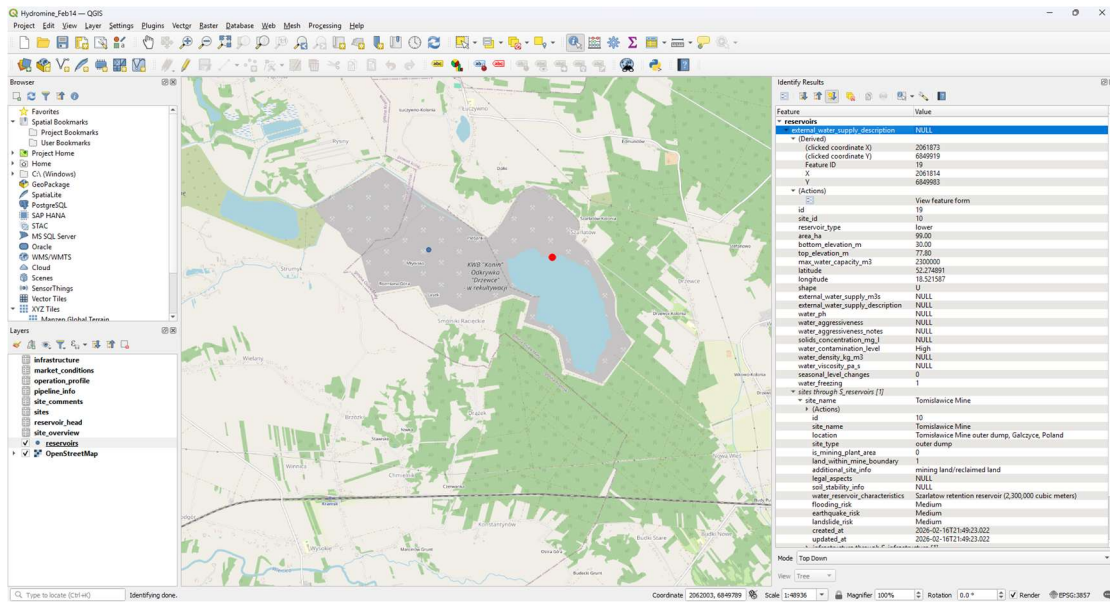


Figure 2.10: QGIS map- identify results window

A summary of the groups of data presented in the **Identify Results** section on the potential PHS locations includes the following:

- General location data: location, type of site, info about land’s legal aspects and additional info about stability of soils and main parameters of rock/soils. Also, water reservoir characteristics and risk level due to flooding, earthquake or landslides.
- Parameters of both lower and upper reservoir where PHS shall be installed: area, elevation and water capacity of reservoirs, coordinates, distance and inclination angle between reservoirs, pipe length, reservoir shape, parameters of water, seasonal water level changes and additional info about expected storage operation profile.
- Infrastructure and electricity grid: access and proximity to the electricity grid, grid type and working voltage, existence and distance of renewable energy installations in the greater vicinity, working voltage and power of the installation and access road to site.
- Market, financial, legal and social issues (per country/region): region’s energy demand, promotion of investment in energy storage units and particularly in PHS, social acceptance of activities related to energy production/storage, existence of regulations related to energy storage units and particularly for PHS, location of PHS in protected areas or in their vicinity, and lastly an estimation of the average industrial energy price: peak vs. Off-peak.

Note: A “NULL” value indicates that there is no available data in that particular field.

Additionally, QGIS users have the option to view the different tables of data for all potential locations grouped together by choosing a table from the Layers list at the bottom left of the screen and then right-click on it and choose the **Open Attribute Table** option (Figure 2.11). A new window will appear containing the collective data of the selected table (Figure 2.12).

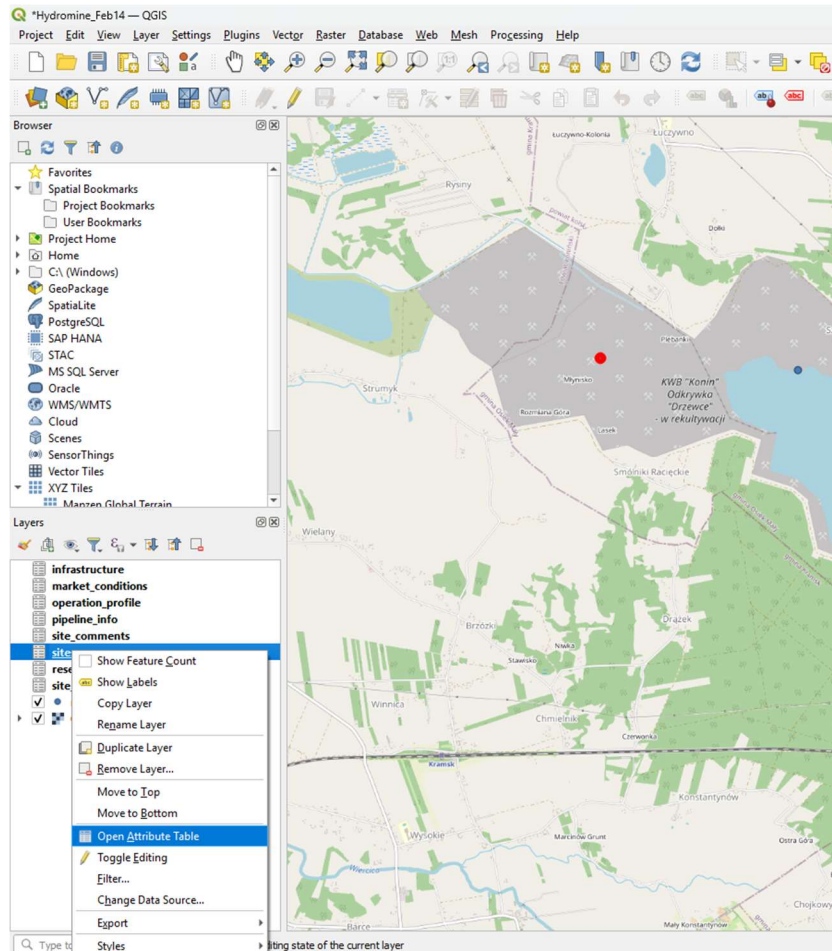


Figure 2.11: Opening attribute table from the layer tables

The screenshot shows the 'sites' attribute table in QGIS. The table has 17 rows and 14 columns. The first row is highlighted in green. The columns are: id, site_name, location, site_type, _mining_plant_are_within_mine_bour, additional_site_info, legal_aspects, soil_stability_info, reservoir_characte, flooding_risk, earthquake_risk, landslide_risk, created_at, and updated_at.

id	site_name	location	site_type	_mining_plant_are_within_mine_bour	additional_site_info	legal_aspects	soil_stability_info	reservoir_characte	flooding_risk	earthquake_risk	landslide_risk	created_at	updated_at
1	Achlada Lignite...	Achlada, Florin...	Mine slopes	1	1 open pit lignite ...	NULL	There is a stabili...	The lower reser...	Low	Low	Low	2026-01-19T21:...	2026-01-19T21:...
2	Achlada Lignite...	Achlada, Florin...	Mine slopes	1	1 open pit lignite ...	NULL	There is a stabili...	The lower reser...	Low	Low	Low	2026-01-19T21:...	2026-01-19T21:...
3	Notio Pedio Mine	Notio Pedio mi...	Mine slopes	1	1 open pit lignite ...	NULL	From the availa...	The lower reser...	Low	Low	Low	2026-01-19T21:...	2026-01-19T21:...
4	Kardia Mine	Kardia mine, Pt...	Mine slopes	1	1 open pit lignite ...	NULL	According to th...	The lower reser...	Low	Low	Low	2026-01-19T21:...	2026-01-19T21:...
5	Megalopoli Mine	Megalopoli, Ar...	Mine slopes	1	1 open pit lignite ...	NULL	NULL	The lower reser...	Low	Medium	Low	2026-01-19T21:...	2026-01-19T21:...
6	Pesteana Sud a...	Pesteana Sud - ...	Closed open pits	1	1 mining land	No need to tak...	Along time, esp...	For Pesteana Su...	Low	Low	Low	2026-02-16T21:...	2026-02-16T21:...
7	Pinoasa and Ro...	Pinoasa - Rosia ...	Active open pits	1	1 mining land	No need to tak...	Numerous land...	Rosia open pit f...	High	High	High	2026-02-16T21:...	2026-02-16T21:...
8	Tismana and R...	Tismana - Rovi...	Active and clos...	1	1 mining land	No need to tak...	Tismana open ...	Tismana does n...	Medium	Medium	Medium	2026-02-16T21:...	2026-02-16T21:...
9	Bogdalow Mine	Bogdalow Mine...	outer dump	0	1 Reclaimed land	NULL	61% cohesive d...	NULL	Low	Low	Low	2026-02-16T21:...	2026-02-16T21:...
10	Tomislavice M...	Tomislavice Mi...	outer dump	0	1 mining land/re...	NULL	NULL	Szarlatow reten...	Medium	Medium	Medium	2026-02-16T21:...	2026-02-16T21:...
11	Patnow Mine	Patnow Mine in...	inner dump	0	NULL	reclaimed land	deforestation n...	NULL	Low	Low	Low	2026-02-16T21:...	2026-02-16T21:...
12	Vrsany Mine	Vrsany mine, C...	mine slopes	1	1 majority minin...	no or minimu...	blocks of clayst...	Ujezd reservoir...	Medium	Medium	Medium	2026-02-16T21:...	2026-02-16T21:...
13	CSA Mine	CSA mine, Czec...	mine slopes	1	1 majority minin...	no or minimu...	the stability of L...	Marcela reservo...	High	High	High	2026-02-16T21:...	2026-02-16T21:...
14	Libous Mine	Libous mine, C...	internal dump f...	1	1 mining land	no needs	no problems	Nechranice res...	Medium	Medium	Medium	2026-02-16T21:...	2026-02-16T21:...
15	Hambach Mine	Mining lake Ha...	mine slope / ou...	1	1 Lower reservoir...	The mine dum...	The mine dum...	The lower reser...	High	High	High	2026-02-16T21:...	2026-02-16T21:...
16	Inden Mine	Mining lake Ind...	mine slope / ou...	1	1 Lower reservoir...	The mine dum...	Mine dump bul...	The lower reser...	High	High	High	2026-02-16T21:...	2026-02-16T21:...
17	Groitzscher See	Mining lake Gr...	old mine slope ...	0	0 Lower reservoir...	Upper reservoir...	Mine dump in f...	The lower reser...	Medium	Medium	Medium	2026-02-16T21:...	2026-02-16T21:...

Figure 2.12: Opening attribute table for the sites table

IMPORTANT NOTE

QGIS users can view and export data but besides that they are **not able to insert or edit data** directly in the Hydromine database. Therefore, any changes performed in QGIS are saved locally in the user's project on his PC. Data management lies in the responsibility of the database administrator (TUC team) whom the user should contact for any data addition or update.