

# GROUNDWATER AND HYDROGEOLOGY



## ABOUT MM



### **MM Spa**

is a leading Italian engineering firm specialized in the design and construction of public transportation infrastructure and urban redevelopment projects promoting the sustainable development of the local area.

Founded in Milan in 1955, MM is responsible for the construction of the city's entire metropolitan rail system - 108 stations and over 100 km of track - and for major traffic and hydrological engineering projects.


MM is now able to export the solid experience it has developed in this sector to other major projects throughout Italy and abroad. It has participated, for example, in the construction of the metropolitan rail systems in Naples, Rome, Brescia, Turin, Copenhagen and Thessaloniki, the light rail systems in Padua and Venice, and the Autostrada 35 (BreBeMi).

MM Spa offers services ranging from project design to technical and financial assessments, from preliminary characterization to work supervision, and from design validation to inspections, testing and quality control.

MM is now a business partner to public agencies on major public works, whose cost and complexity demand consolidated management capabilities and absolutely reliable technical and administrative support.

Since 2003 MM is also in charge of Milan's Water Supply Service, which includes abstracting, purifying and distributing groundwater, collection and treatment of municipal wastewater, and generally, planning maintenance and investments for the water supply and sewer systems.

In 2014, MM also undertook management of the real estate assets of the City of Milan, comprising over 38,000 subsidized housing units, parking garages and other facilities. To accomplish this, MM created the new organizational unit "MM Casa", which works alongside other company structures that are already managing city services.



## OBSERVATION WELL NETWORK AND QUANTITATIVE DATABASE



**Since the 1950s, the City of Milan and MM have constantly monitored the local water table via a dense network of observation wells distributed throughout the municipal territory.**

Field data is collected by specialized technicians who promptly report any anomaly and ensure constant maintenance of the observation wells.

Water table data (collected on a monthly or quarterly basis) are recorded in a dedicated database that allows for quick consultation and extraction. The implementation of automated procedures minimizes processing times while ensuring high flexibility of use.

The database contains the following information for each uniquely identified observation well: geolocated coordinates, altitude of wellhead, and all historical water table data.

### > FREQUENCY OF MEASUREMENTS

**Monthly:** observation wells with a long series of historical data

**Quarterly:** other observation wells

MM geologists have optimized the groundwater monitoring network (over 200 observation points in the city of Milan) over the years, regularly monitoring a selection of 121 observation wells, ensuring at least one observation point per every square kilometer.

The database currently contains more than 30,000 measurements, providing a wealth of information describing long-term water table trends to support decision-making.



Water table measurement



Extraction well maintenance





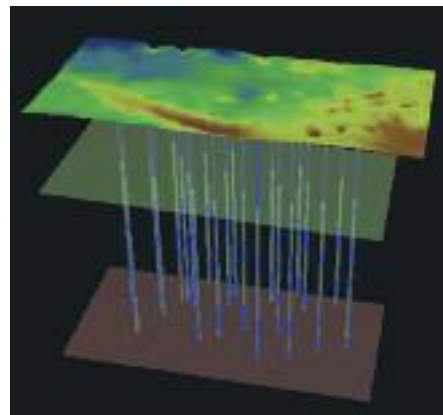
## GEOLOGICAL DATABASE

Sustainable use of groundwater resources requires thorough knowledge of the geological structure of the subsurface and the dynamics of groundwater flow through the aquifer.

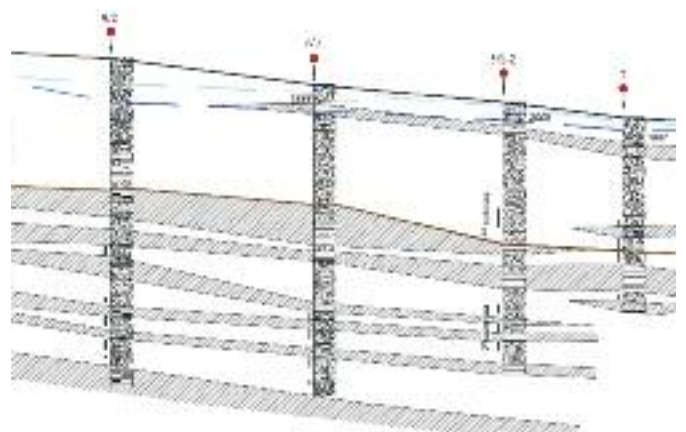
MM geologists have united in a single database all geological, stratigraphic, hydrogeological, hydrochemical and structural data available for more than 4,000 wells and boreholes in the Milan area.

The data have been referenced and normalized, without compromising their integrity, making it possible to use advanced geological and hydrogeological modeling software to produce nearly instantaneous geological sections and three-dimensional models, which are indispensable elements in a conceptual model of the subsurface.

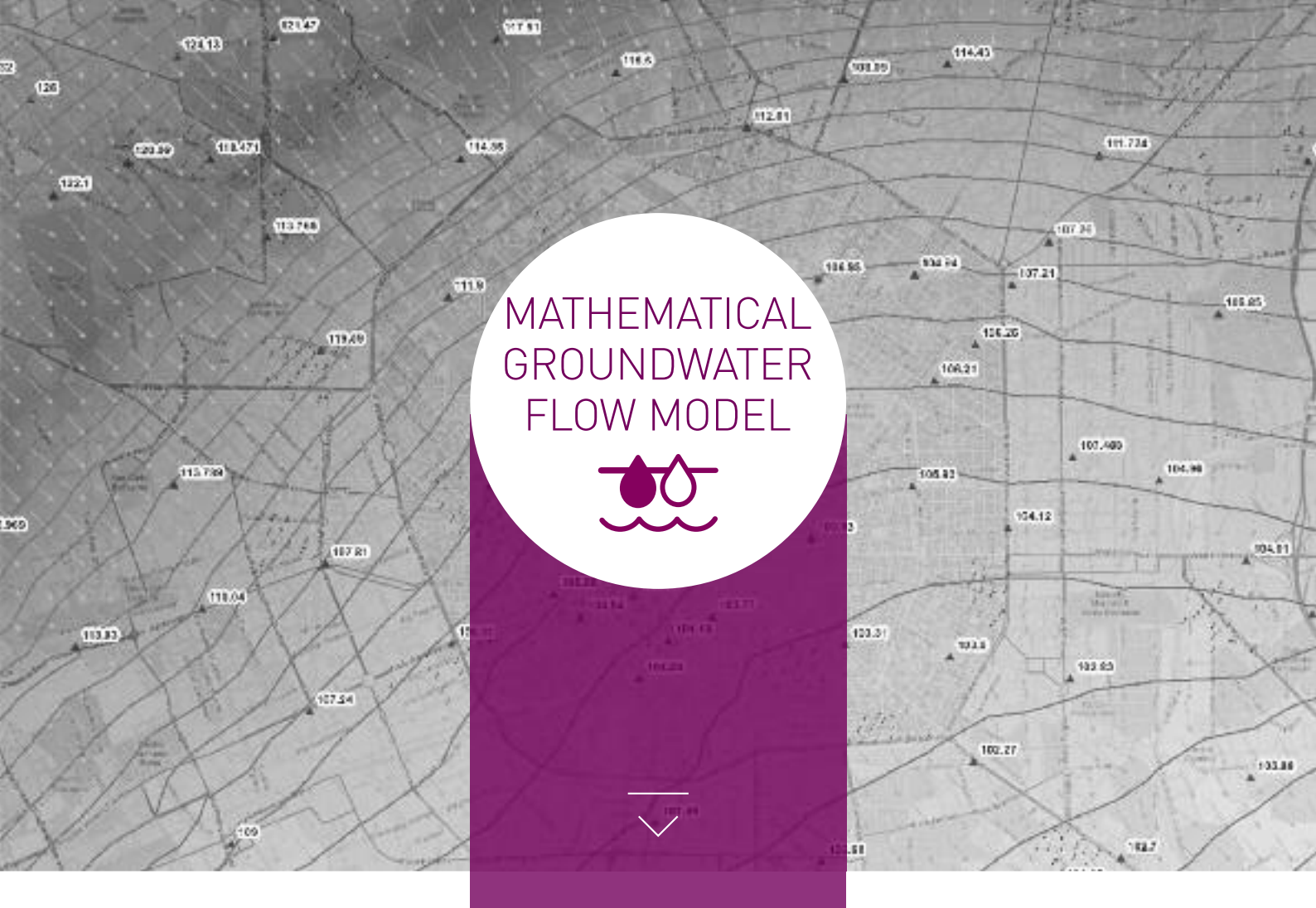
The processing and analysis of geological and groundwater abstraction data is one of the fundamental tools in safeguarding groundwater resources and orienting future management decisions.



3D subsurface model of Baggio pumping station



Geological section



## MATHEMATICAL GROUNDWATER FLOW MODEL



### **MATHEMATICAL GROUNDWATER FLOW MODEL**

As part of the Planning Agreement to monitor the groundwater table trend in the Milan area, signed by the Region of Lombardy, the City of Milan, the Province of Milan (now Metropolitan Milan), the Po River Watershed Authority and the Magistrate for the Po (now Interregional Agency for the Po River - AIPO), MM created a mathematical model as a decision-making tool (DSS) in monitoring recharge of the Milan aquifer.

Based on DHI's MIKE SHE water environment software, the groundwater flow model has been calibrated based on local hydrogeology and the data used to define the conceptual subsurface model. The study area encompasses the city of Milan and 84 neighboring municipalities (approx. 840 km<sup>2</sup>).

### **SUPPORT FOR RESEARCH**

Progress in the fields of geology and hydrogeology has led to the development of methods and technologies allowing optimum response to issues encountered on a daily basis associated with the city-subsurface complex. Recognizing the invaluable contribution of research in these fields, MM promotes collaborations with universities and scientific research centers to study the geological and hydrogeological dynamics of the Milan area. The major areas of research include: groundwater table trend in the Milan area, groundwater-aquifer structure interaction, detection and monitoring of

contaminants (both regulated and newly emerging), continual water table monitoring, geological and hydrogeological modeling.

### **GROUNDWATER AND ENVIRONMENT**

With its strongly industrial past, the city of Milan has multiple potential contamination sources threatening local groundwater quality. MM promotes continuous monitoring of groundwater quality to predict and address any impact on the quality of groundwater extracted as drinking water. In collaboration with the drinking water analysis laboratory, MM geologists promptly report any anomalies and provide information on the source and development of any negative impacts to groundwater quality.

### **MANAGEMENT SUPPORT**

MM geologists provide continuing support to the operation and maintenance of extraction wells, assessing their efficiency and maintenance needs. Accurate aquifer productivity assessments make it possible to properly design and dimension the extraction systems and to develop effective maintenance plans. Proper management of the groundwater extraction system ensures optimum operating conditions and long-term structural integrity.

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