**Project: Sustainable Hydro Assessments and Groundwater Recharge Projects**
**Project acronym: SHARP**

**Lead partner: WATERPOOL Competence Network GmbH**
Elisabethstraße 18/II, 8010 Graz, Austria
www.sharp-water.eu

# APPENDIX: Long version of good practices

| GP 11 | **Development of a groundwater monitoring database and data capture templates for optimisation of data quality and transfer** |
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**Project Partner:**
International Resources and Recycling Institute (IRRI)

R. TURNER

## Drivers for improving hydrogeological understanding in urban areas

The need to develop detailed understanding of urban hydrogeology is becoming ever more important, and is driven by two main pressures. The first is a desire to manage the groundwater resource in order to maintain its many uses within the urban environment – such as abstraction for industrial or potable use; as an energy resource through ground source heating or cooling; in providing essential baseflow to urban waterways; and as a receptor for storm water drainage through Sustainable Drainage Systems (SuDS). Urban groundwater systems are likely to be significantly disturbed by historic, current and future anthropogenic activities, and the effects of these need to be understood if the entire resource is to be maintained in a sustainable way. The second driver is legislative, and relates to the Water Framework Directive's (WFD) requirement to establish the effective, long term monitoring of water bodies within all European member states The WFD demands that all member states have a national groundwater monitoring scheme in place to ascertain the baseline status of groundwater resources and the potential for potable supply.

# Developing groundwater monitoring in Glasgow

In Glasgow, as in most other cities, there is not enough hydrogeological information to allow the development of a good understanding of the groundwater system. Before the start of this project in 2008, the British Geological survey held only 119 records of groundwater level within the entire Glasgow urban area, and many of these were one off measurements from boreholes drilled decades before. The data were often of poor quality with little or no information regarding borehole construction, surface elevation or the stratigraphic horizon being monitored.

However, other groundwater data did exist from sites within the Glasgow area, with Glasgow City Council increasing its volume of held data from 2000 onwards. In particular, recent (post 2004) redevelopment works at major regeneration sites in the city (such as the Clyde Gateway, Shawfield, the Commonwealth Games village and the extension of the M74 motorway), all provided sources of continuing groundwater monitoring. This monitoring information was being collected by consultants and provided to Glasgow City Council (GCC), but GCC did not have the resources to manage it effectively, so that the data was stored haphazardly, in different formats, and it was difficult, time consuming and costly to extract and make available.

BGS carried out a two-stage programme to improve the efficiency and effectiveness of managing current and future groundwater monitoring data. A dedicated database was designed to store and allow easy retrieval of monitoring data; and a set of data entry templates was designed to ensure the collection of high quality, relevant data.

## Database

A bespoke database was designed by data management and groundwater specialists at BGS. The database structure was designed in Microsoft Access, but was designed so that in future it can be incorporated into corporate BGS Oracle databases. Its structure allows both time series data and single one-off monitoring data to be stored for each monitoring point (borehole), alongside key metadata or index information (geology and borehole construction details). This data can then be easily spatially interrogated within GIS software and compared or potentially merged with other existing BGS datasets characterising, for example, chemistry and borehole log data. The usability of Microsoft Access employed here as the front-end user-interface allows key stakeholders to gain access to the relevant data quickly and easily.

Figure 1 demonstrates the logical structure of the design of the monitoring database. It is a database that holds the groundwater monitoring data in array lists, which enables effective data searches and is more flexible than if the data were held in a table format. The database was populated initially with monitoring data from the four major regeneration sites in Glasgow mentioned above, for which recent (post 2004) data are available. While populating the database a number of issues relating to data quality, availability and consistency became obvious.

In particular, data from each site were collected by different consultancies and the format of data records was not consistent between different companies, and even varied over time within the records provided by a single company as different staff or reporting formats were employed. This is largely as a result of there being no obligation or guidelines detailing the protocols for recording and presenting hydrogeologically relevant data.

As a result, bespoke operations and queries had to be developed in order to transfer data obtained from different organisations into a single coherent database. Funds existed during this project to facilitate this time intensive data transfer as a one off trial, but it was clear that this process would need to be increasingly automated if the upkeep, and therefore the integrity of the monitoring database and the value of the information it stored, was to be maintained, and if future data sharing initiatives were to be possible.

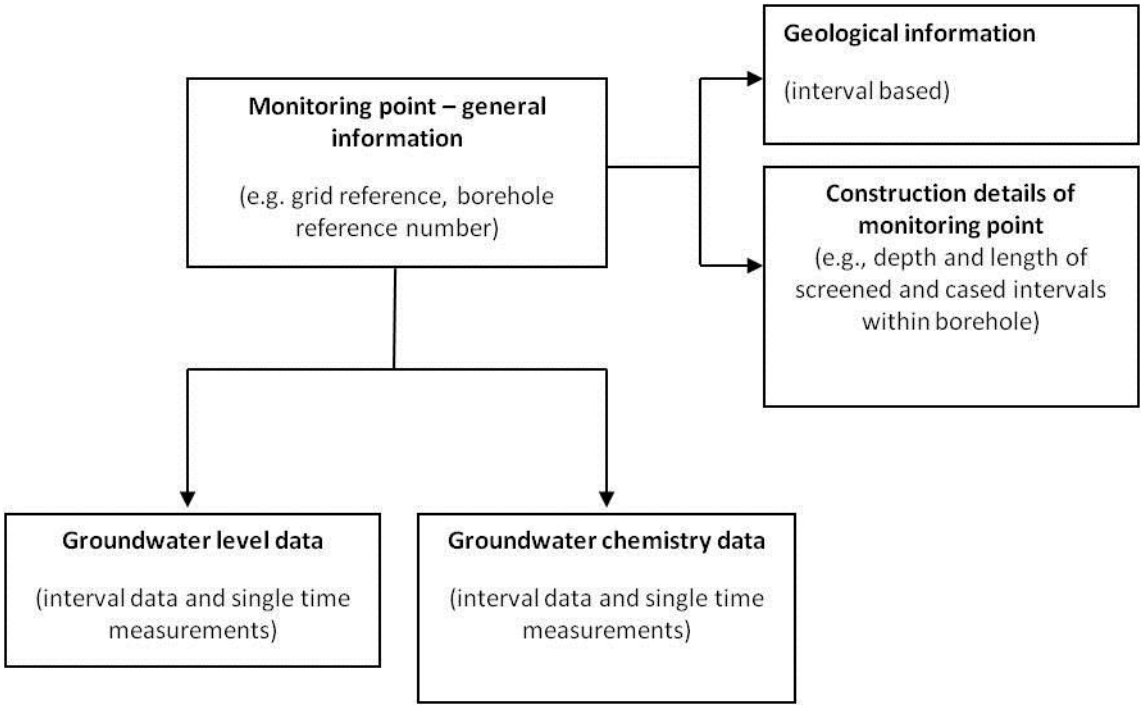


*Figure 1: Conceptual structure of the ORACLE database containing Glasgow's groundwater monitoring data. (The boxes represent entities).*

A second issue was the recognition that essential borehole index data are typically not reported to GCC with ongoing monitoring data. At present much of the borehole index information is provided separate to ongoing groundwater monitoring data, within the main body text of a consultancy report. Extracting this information from the reports and matching with the correct boreholes for which monitoring data are reported requires a considerable amount of additional work and creates additional risk of error.

## Data Templates

In light of these issues, data capture templates were created for use by any contractors providing groundwater data to Glasgow City Council. The templates were designed by BGS in partnership with GCC and with input from the major consultancies working in the city, in order to ensure take-up of the template. These templates ensure that standardised data and the minimum required index data from each groundwater monitoring borehole are recorded. Ensuring that borehole index information is present alongside the monitoring data will be a tremendous advantage in terms of ease of analysis and data value in the future.

As important as ensuring that all necessary data (eg index data) are included is ensuring a consistent format for data entry. The data capture templates were designed in Microsoft Excel, which is widely used in the industry and is acceptable to consultants working to collect and record data. The templates provide a separate field for the capture of each relevant hydrogeological data type, which is always in the same location in the template. When data are read from the templates into the database, these unique but consistent field structures allow the production of automated look up routines to read from the digital input data files and then populate the database with the new data. The automation of this data update process will both lead to quicker – and therefore cheaper – data transfer, and will reduce errors in data transmission due to human error and therefore increase the value of the data.

To date, the data capture templates have been developed in draft and positive feedback has been obtained from consultancy firms working on some of the major regeneration sites in Glasgow. Full trials of the templates will start from autumn 2011, with consultancies on some of the major regeneration sites in Glasgow using them to record monitoring data. The transfer of these data from the templates to the BGS database will then be tested and refined. The templates have already received approval from the Glasgow City Council department working directly with groundwater data, and are currently awaiting official sign off at senior level. Once that happens, the templates will become the means of recording and transferring groundwater monitoring data for the whole of Glasgow.

## Future Plans

Assuming the successful uptake and implementation of these templates, it is envisioned that the same protocol could be expanded to include information on engineering, geotechnical and geophysical data. All such data could be stored in the same database, increasing its value still more.

The development of the data capture templates is a valuable best practice which will prove hugely beneficial within the Glasgow urban area, and would also be a distinct advantage if rolled out to consultancy and government institutions nationwide. The implications for the rapid transfer and update of data between all institutions involved in groundwater management and research are profound, but will require significant cooperation between organisations.

The content of this document is based upon the work detailed in the following BGS internal reports:

Bonsor HC, Ó Dochartaigh BÉ. Groundwater monitoring in urban areas – a pilot investigation in Glasgow, UK.

Bonsor HC, Bricker SH, Ó Dochartaigh BÉ, Lawrie KIG. Groundwater monitoring in urban areas: pilot investigation in Glasgow, UK, 2010-11.