PIGGY-BACKING HYDROGEOLOGICAL TESTING ON TO RESOURCE DRILLING PROGRAMMES

Author: William Harding | +44 2920 348 157 | wharding@srk.co.uk

Some years ago, I was visiting a Client at a large operational mine where the subject of field investigation requirements to support a slope optimisation study was being discussed. The Client was deliberating over the (not inconsiderable) costs of undertaking a dedicated hydrogeological borehole drilling and testing programme to make up for the shortfall in knowledge about the local groundwater regime. Various options were explored during this meeting, including piggy-backing the hydrogeological investigation on existing or future resource holes. The Client seemed surprised at this juncture and explained that whilst the company had drilled 'hundreds' of exploration holes over the years, none had ever been used for purposes other than resource evaluation and all had been backfilled or had subsequently collapsed. Unfortunately, this realisation by the Client that they had unwittingly thrown away the opportunity to save large sums of money through the simple act of using their resource holes to capture other forms of information useful to the project is still encountered in the mining industry.

Piggy-backing is an essentially opportunistic procedure, making use of holes designed for other purposes to obtain supplementary information that is useful to the project. An example of this is the use of a resource evaluation hole to capture geotechnical or hydrogeological information during drilling and, after completion, to convert that hole to a monitoring well for measuring long term groundwater levels and water chemistry.

Put simply, piggy-backing is just a way of extracting the maximum value from a drilling campaign. This value takes several forms: most obviously it saves money, but because much of the benefit of piggy-backing is seen in early-stage development (when resource drilling is most prevalent), it enables the Client to set-up a baseline monitoring scheme to support their scoping and environmental impact studies at an early stage in project development. It also allows timely management decisions to be made about the water and geotechnical-related challenges likely to be faced by the operation, which is an essential part of project de-risking.

As stated, a piggy-back investigation is predominantly an early stage exercise in data capture, but the principle applies when and wherever holes are being drilled; for example, this method could be undertaken during operations on the back of holes used to prove-up resource, or to test rock-mass properties in new areas of the mine. The decision on whether to invest in piggy-back work is also driven by confidence in the resource, which may not be adequate, and which is why this approach is unlikely to come in to play during first pass drilling, or even during initial grid drilling. However, a considerable advantage of piggy-back work is that the scale, technical sophistication and cost of activities can be tailored to match the level of the mining study and the overall level of confidence in the project. Table 1 illustrates this point with short, low risk, low cost data collection techniques prevalent during the initial grid drilling stage, ramping-up to more sophisticated (and costly) methods during the main technical phases of 'greenfield' site evaluation and, later during mine operation.

The SRK Cardiff groundwater team have been developing a capability in piggy-back style testing for a number of years and now routinely use most standard hydrogeological techniques on the back of resource (and geotechnical rock) characterisation programmes. Recent examples include detailed investigations conducted on the back of a resource drilling programme for a mining major over two, five-month long winter seasons in Arctic Finland, another for a Client in Ecuador and a third for the Curraghinalt Gold project in Northern Ireland.

Table 1: Piggy-back hydrogeological techniques: different project stages versus cost and time

Initial Grid Drilling ← - - - - - - - - → Later infill Drilling

Test Type	BASIC DATA COLLECTION (during drilling)	AIRLIFT TESTING (during drilling)	SMART WELLS (after drilling)	SPINNER TESTING (after drilling)	PACKER TESTING (during or after drilling)	VIBRATING WIRE PIEZOMETERS (after drilling)	PUMPING TESTS (after drilling)
General Comments	• Water strikes • Static water levels • Changes to drilling rate • Mud losses • Structural and lithological logging	• Carried out intermittently down the hole • Generally done by the contractor	• Lightweight tubing installed by hand • No rig required	• Lightweight sond deployed in hole using wire line tools • No rig required	• Post-drilling test work using straddle packers and performed in conjunction with spinner logging • Rig required	• Pressure transducers mounted on uPVC tubing and grouted-in hole • Rig required	• Test typically performed over 1 to 10 days (depending on objective) • Pumps, rising main, flow meter, discharge line etc. • No rig required.
Parameters	• Indicative water levels and qualitative picture of aquifer distribution and properties	• Indication of vertical variation in permeability	• Water levels • Water quality	• Identify discrete flowing features • Variation in permeability with depth • Water quality sampling	• Permeability across targeted sections of the hole	• In-situ pore pressure	• Permeability, storage, boundary conditions • Water quality sampling
(1)Approximate additional Cost (per hole)	Negligible	Low (< USD 1000)	Low (USD 1500 – 3000)	Moderate Contractor: USD 8,000- 10,000	Moderate (2)USD 6000 – 8000	High USD 12000 – 16000	(3)High USD 10000 – 15000
Additional Time (per hole)	Negligible	< 1 day	< 1 day	1 – 2 days	2 days	2 - 3 days	3- 5 days

Notes:

(1). Consultant fees (field time and analysis), materials, equipment hire and courier charges. However, this does not include rig standing time.

(2). Packer hire and courier cost (per month). This cost has been spread over 6 holes.

(3). Assumes a 4-day pumping test.

The first of these examples, being the most extensive, warrants a little more description. The project is a greenfield site and the target is a poly-metallic ore hosted in basic and ultra-basic igneous rock. Due to soft ground conditions, the Client was forced to conduct the bulk of its resource drilling during the winter months when the ground is frozen hard. The importance of understanding the groundwater regime for this project was recognised by the Client at an early stage and it was decided through careful planning and discussion with SRK that this information should be captured on the back of the exploration drilling. Apart from the tough working environment that an Arctic winter presented to field staff, there were additional challenges to factor in to the design of the investigation including the selection and adaptation of hydrogeological testing techniques to NQ (76mm) diameter cored holes, some more than 1000m deep, and unstable ground conditions that necessitated testing during and immediately after drilling to avoid borehole collapse and possible equipment loss. It was also impressed on SRK that the drilling schedule was time-critical, so whatever approach decided upon by the team could not impose more than a 4-day delay (typically) to each hole. The approach adopted essentially fell in to two parts, the first part which necessitated the presence of the drilling rig over the hole, entailed single packer testing during drilling to derive in-situ hydraulic conductivity (Figure 1), followed in a selection of holes by the installation of grouted-in vibrating wire piezometer (VWPs) to obtain temporal and spatial pore pressure distribution in the rock mass (Figure 2). The second part, this time without the rig over the hole, consisted of an initial survey of completed exploration holes to test for openness and stability followed by the selection of suitable holes for geophysical wireline logging and flow logging to develop vertical salinity profiles and to identify and hydrogeologically characterise discrete geological structures. Flowing structures were also sampled for groundwater chemistry by deploying mechanically operated sample chambers down each hole. In addition, several of the holes were converted by hand to standpipe monitoring holes using Smartwell™ materials (Figure 3) and a selection were later reamed, cased and converted to pumping wells by the exploration rigs when there was a gap in the resource drilling schedule. One such pumping test was targeted at a large thrust fault close to the ore body, which was considered a potential hydrogeological risk to the future operation and was pumped continuously for some 20 days to obtain hydrogeological properties and assess longer term boundary effects.

This Finnish project and other recent examples have served to demonstrate to our Clients the value of the piggy-backing approach. Whilst there is a point beyond which the limitations of piggy-backing outweigh its advantages and a dedicated hydrogeological investigation is required, our experience shows that this method is of huge advantage to Clients in the earlier stages of a project when the emphasis is on developing an initial, but nevertheless robust understanding of the local groundwater regime without recourse to significant capital outlay.

Figure 1: Monitoring a Packer Test

Figure 2: Vibrating Wire Installation

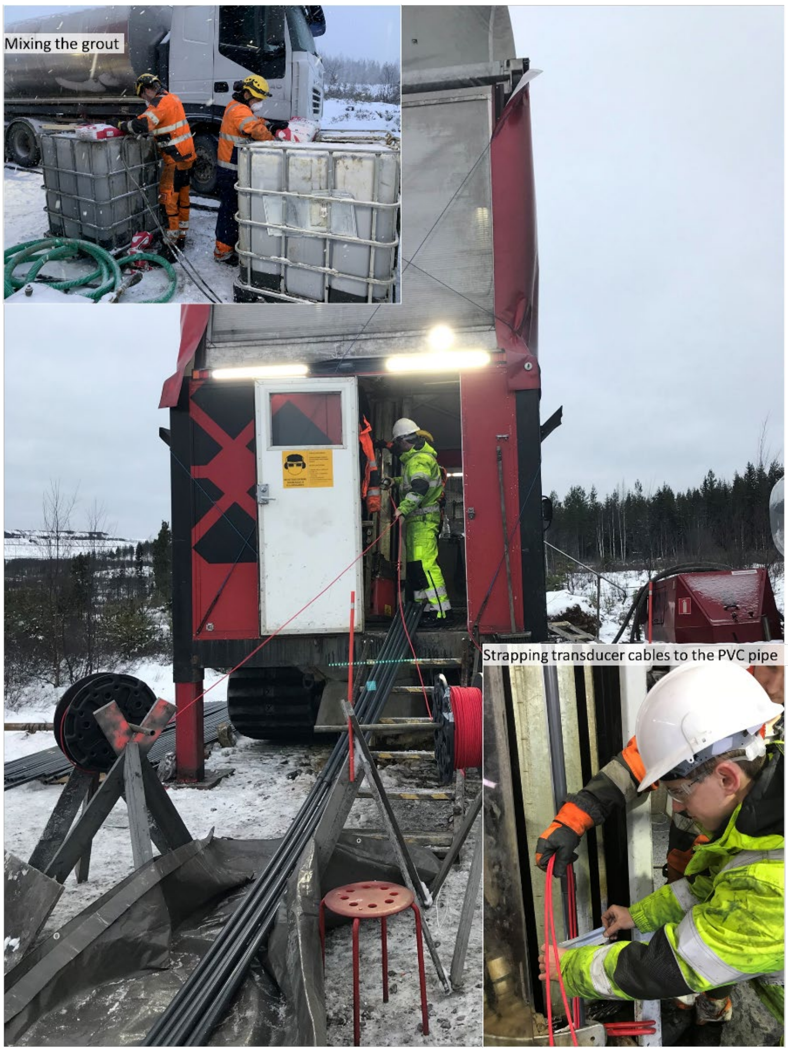

Figure 3: Preparing for a Smartwell installation