Innovative Adaptation of Mining Hydrogeology Practices during a Pandemic

Sofia Nazaruk[1], Grace Yungwirth[2], Jessica Nicholls[3], Gareth Digges La Touche[2]

[1]*Golder Associates, Attenborough House, Browns Lane, Stanton-on-the-Wolds, NG12 5BL, UK, snazaruk@golder.com*

[2]*Golder Associates, 20 Eastbourne Terrace, London, W2 6LG, UK, gyungwirth@golder.com, GDLTouche@golder.com*

[3]*Golder Associates, Cavendish House, Bourne End Business Park, Bourne End, SL8 5AS, UK, jess__nicholls@hotmail.co.uk*

Abstract

Traditional mining hydrogeology practices during site characterisation programmes have relied heavily on the availability of experienced practitioners to travel to mine sites. This was not possible during the COVID-19 pandemic and adaptations of previously established workflows were required. This paper aims to outline an approach for the remote oversight of field programmes by experienced practitioners and outlines the relative risks, rewards and key limitations to the approach developed.

Keywords: Site Characterisation, Data Collection, Remote Support, Mining Hydrogeology Practises, COVID-19 pandemic

Introduction

Global working practices, including overseas travel and fieldwork at mine sites, were heavily disrupted by the COVID-19 pandemic. Adapting working practices in a dynamic environment became a necessity for many mining projects to progress critical studies and design work to support their operations or advancement of new projects. The development of remote oversight and supervision procedures for hydrogeological site investigations are an example of adapting industry practices to meet these challenges.

The remote support workflow developed for the supervision of site characterisation programmes can allow experienced mining hydrogeologists to provide fully remote support to mine-based staff undertaking ground characterisation programmes. Where appropriate, the adaption of mining hydrogeology practices to allow the option of fully remote oversight of site characterisation programmes can be taken forward beyond the pandemic epoch, however this approach should be weighed against the limitations and is not expected to replace the need for experienced practitioners to attend site on occasion.

Traditional Mining Hydrogeology Practices

Site characterisation activities typically progress with the support of in-person oversight or quality assurance/quality control (QA/QC) from experienced practitioners. Traditionally this has involved the travel of experienced specialist staff to mine sites where they would work closely alongside local site-based staff for large proportions of the site characterisation programme. Experienced mining hydrogeologists may typically design, supervise, carry out or record the following as part of hydrogeological site investigations:

- drilling and hydrogeological, geological, or geotechnical logging of investigation boreholes;
- installation of abstraction, dewatering or groundwater monitoring boreholes;
- instrumentation of boreholes to measure groundwater quality/chemistry, groundwater level, pit wall depressurisation, etc.;
- testing of boreholes to estimate yield or hydraulic parameters;
- implementation of groundwater management strategies; and

- identification and measurement of groundwater inflows to adits, open pits, or other infrastructure.

Many of these activities were traditionally considered to require on-site supervision by experienced practitioners in order to be implemented correctly and to ensure QA/QC criteria are met. However, adaptation of the traditional approach to undertaking these tasks has been required during the pandemic period.

Adaptations During the Pandemic

As it was not possible for experienced mining hydrogeologists to travel to mine sites, an adapted approach was developed to allow remotely supported mining hydrogeology site investigations to progress during the global pandemic (fig. 1). The adapted approach focuses on: structured project planning; transfer of knowledge and training to local or site-based staff; streamlined data sharing; effective and frequent communication; and remote data processing and analysis.

Structured Project Planning

The successful planning of a remotely supervised hydrogeological site investigation is dependent on:

- adequate (longer) time allowed for the planning period within the project schedule; and
- early and direct engagement with contractors and the site team executing the work.

Whilst structured planning has always been essential to hydrogeological site investigations, traditionally this process may have been time constrained and cut short to allow for travel of remotely or internationally based practitioners to the mine site, the focus being on "getting there and kicking off the work". This practice meant that planning may have remained at a high level until experienced practitioners arrived at the mine site to discuss practical and logistical details with local and site-based staff. Where time constraints were in place, detailed planning may have previously run concurrently with the commencement of fieldwork, however this was not possible during the pandemic, so it is essential that adequate time for planning be incorporated into the project schedule.

Detailed planning and design during the pandemic required the early engagement of locally based staff and contractors. Previously practitioners may have only spoken to the mine staff (who often directly select and engage contractors) prior to arrival at site and the first engagement with contractor staff and detailed review of the available equipment took place after arrival on site. Early and direct engagement with contractors and site-based staff allowed understanding of the availability of equipment or materials which facilitated early identification of site-specific or practical limitations and revision of detailed designs (fig. 2). This was aided by review of technical specifications of the equipment, photographs and videos of the equipment condition, and

Figure 1 *Adapted Workflow for Remote oversight during the Pandemic (images: Golder).*

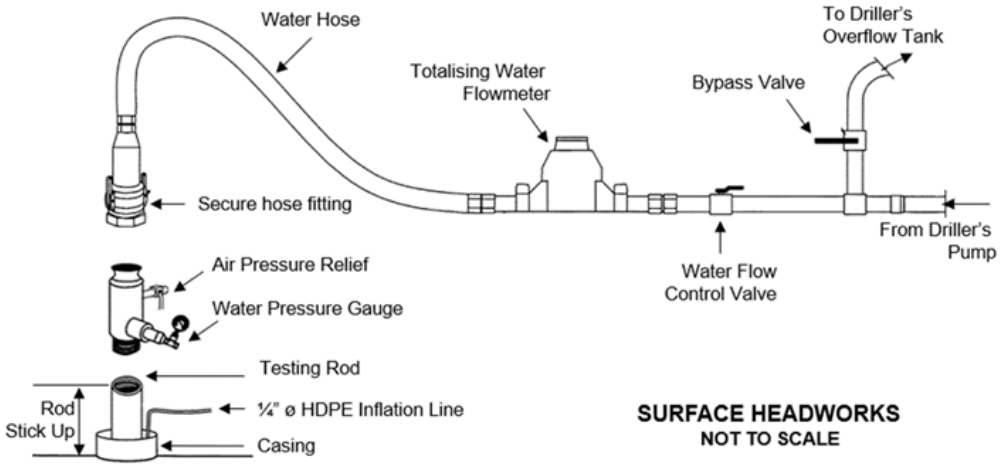

Figure 2 *Example of Design Drawings Used to Demonstrate Requirements to Local Staff (images: Golder).*

iterative test runs of equipment assembly and operation. The process for example, identified unsuitable pressure monitoring equipment and allowed for appropriate equipment to be sourced prior to the commencement of testing. Allowing time in the schedule to iteratively test and refine planning and designs are important during this stage.

Transfer of Knowledge and Training to Local or Site-Based Staff

Remote training and knowledge transfer to local and site-based staff was made successful by:

- early assessment of site staff skillset including recruitment of local support from other disciplines or academia;
- production of detailed training materials supported by site specific visual aids including drawings and photo/videos; and
- active and iterative review of test runs of field procedures.

Remote training of local or site-based staff enabled the successful implementation of the remote oversight workflow and the execution of the programme to an acceptable standard. Understanding the skillsets and experience of the local workforce is crucial to the planning process and dictates the level of detail required within the remote training process. Many mine sites were noted to employ local staff with a geological background, which proved useful to effectively implement early stages of the of the investigations, such as borehole siting and drilling. Collaboration of the mine sites with local universities were also sometimes used to supplement the local workforce and, with remote support from experienced practitioners, students were able to fulfil such roles as the installation of flow monitoring equipment or monitoring of groundwater level and chemistry.

Remote training during the pandemic was supported by the production of extensive visual aids including detailed drawings (fig. 2) supported by photos (fig. 3), site-specific field procedure manuals (Golder, 2020) and blank proforma templates for field record sheets to ensure the recording of full technical field data during the field campaign. Where possible, test runs of the field procedures and the QA/QC of practice data (such as the review of geotechnical or geological logs produced using old core) allowed local staff the opportunity to ask questions and improve their understanding of the data requirements prior to the commencement of the actual site characterisation programme.

Streamlined Data Sharing

Data sharing made use of multiple types of digital technology and multiple communication media as follows:

- regular and frequent real time visual communication directly from the field;

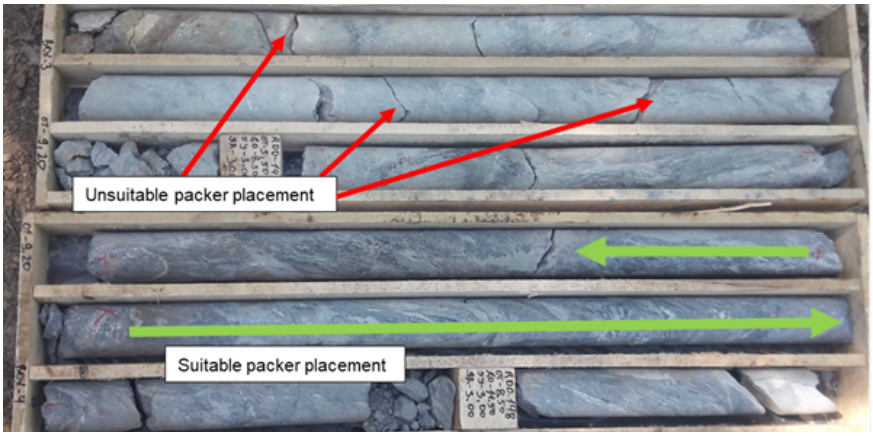

Figure 3 *Examples of Experienced Practitioner Review of Field Images (images: Golder).*

- the use of annotated photographs and recorded video from the field where communication infrastructure was not sufficient for real time communication;
- other types of digital data collection such as drone photography or video footage in lieu of site walkover; and
- a reliable and expert supported shared dataroom for efficient and regular data transfer.

The use of digital technology was used to supplement the transfer of knowledge to local staff and allow for rapid information sharing or QA/QC review. Where sufficient infrastructure exists, the use of video calling using mobile telephones or laptops was found to be highly effective in clearly communicating issues from staff in the field to the remote supervision staff. Where access to internet was poor or limited to certain work areas at the site, the use of annotated photography (fig. 3) and recorded video transmitted as soon as field staff could move to an area with digital signal was also found to be an effective tool. All sites that were remotely supported during the pandemic were found to have sufficient infrastructure to allow for these types of communication.

Other types of digital data, such as drone photography or video footage, were used in lieu of traditional site-walkover methodologies. For example, major geological features or zones of groundwater seepage (fig. 4) were identified from digital data and used to enhance the understanding of the site conceptual model. With the provision of detailed guidance, suitable drone footage was often able to be recorded by site-based staff or locally based contractors. Additionally, the remotely supported installation of automated equipment and, where practicable, telemetry systems can help to minimise the amount of data handling, and potential for data loss, by locally based staff.

Establishing a shared dataroom (such as a Microsoft SharePoint site) for uploading daily logs, risk registers and field data was crucial during the remote oversight process. This improved transparency of the investigation progress, clarity during discussions and enabled prompt review of collected data. Issues sometimes arose, such as lack of access or loss of data, when the site-based teams hosted the shared space. Benefit and security were found when experienced practitioners managed directly managed the dataroom.

Effective and Frequent Communication

Effective and frequent communication is required between remotely based supervisors and site staff making use of the following:

- a multi-tiered communication approach to support oversight and QA/QC process; and
- regular and ongoing review of collected site data as it is produced to allow for iterative correction or adjustment of procedures and data collection methodologies.

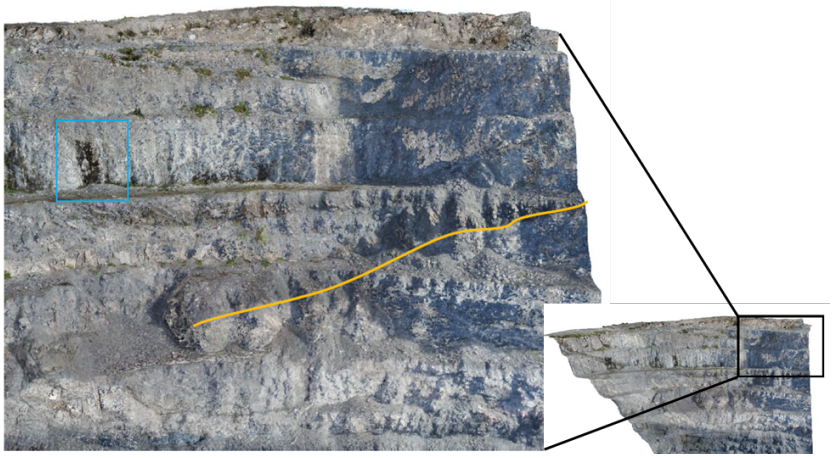

Figure 4 *Example of How Drone Footage Can be Used to Remotely Identify Geotechnical or Hydrogeological Features. Blue = Seepage Zone, Yellow = Geological Contact (images: Land and Minerals Consulting, 2018).*

A multi-tiered communication approach was utilised to support the remote oversight and QA/QC process. In addition to the initial information sharing and kick-off calls during planning stages, daily calls were arranged between the local staff and remote experienced practitioners to discuss the detailed designs, field procedures and daily site activities. The use of instant messaging applications also provided support on an ad-hoc basis and allowed for live communication while staff were at workfaces such as drilling, testing or monitoring locations. This process replaced the conversations which may have traditionally occurred organically while experienced practitioners were in the field. It also allowed for the identification and swift resolution of technical issues.

To ensure the quality of the field programme, daily or weekly QA/QC reviews of the data collected were required to be carried out by experienced practitioners and were completed entirely remotely and in discussion with the on-site overseeing engineers. Due to the fast-paced and multifaceted nature of site characterisation programmes, site-based QA/QC reviews of data by experienced practitioners may have been conducted at less frequent intervals previously. There can therefore be inherent benefits in the requirement for more frequent review when operating remotely, such as early adaptations to data collection methodologies.

Remote Data Processing and Analysis

All data processing and analysis was completed remotely by experienced practitioners to inform the interpretative phase of the investigation. This stage of the site characterisation process remained largely unchanged from pre-pandemic practices however, as described in the previous section, were conducted as the study progressed to iteratively inform subsequent phases of the investigation.

Risks, Rewards and Limitations of Approach

As with all approaches, consideration should be given to the relative risk versus reward and the practical limitations of the remote oversight approach. As there are many parties involved in hydrogeological field programmes (for example, the mine staff, local communities, financial investors, consultants, contractors and local students or academics), these considerations may vary for each stakeholder.

Benefits of the above outlined remote oversight approach can include:

1. Reduced travel time for experienced practitioners and reduced travel costs to the mine.
2. Reduced environmental footprint and increased environmental sustainability due to a lower number of flights and shorter travel distances when utilising local staff.

3. Reduced rotation of overseas based staff and increased consistency of experienced practitioner involvement throughout the field programme.
4. Once field materials and procedures have been established, set-up time for subsequent studies at the mine site may be reduced.
5. Increased frequency in data QA/QC review can identify and allow for rectification of data collection inadequacies early on in the field programme.
6. Increased transfer of knowledge and upskilling of site-based staff and increased opportunities for local student internships.
7. Many mines are under pressure from local communities or financial investors to utilise the local workforce and this approach can help ease this pressure and improve relationships with local communities.
8. Consolidation of experienced practitioner effort from a full day on site to a few hours a day can again reduce costs to the mine and free up experienced practitioners time to provide remote support to multiple projects simultaneously. This may prove to vital to progressing multiple studies during upturns in the mining market.

Risks and limitations of the remote oversight approach can include:

1. Early time constraints can lead to deficiencies during the initial project planning and structuring phase. These may then permeate through to the data collection and interpretation phases. It is essential to allow enough time and resource for planning activities.
2. The approach can only be effective where local staff and contractors are suitably skilled to uptake the required remote training.
3. Limited experience with the equipment can lead to an increase in both technical risks (for example loss or damage of boreholes, data, or testing equipment) and health and safety risks (for example risks to operators when using pressurised equipment).
4. Language barriers, lacking communication skills, and time in the programme for increased remote communication, can be a challenge and a risk to investigations. Investigations where pressure to advance does not allow for regular communications to remote supervision staff or utilisation of either local staff or experienced practitioners who are not suited for this type of remote oversight and communication will lead to poor data collection.
5. The approach may not be suitable where additional communication challenges are faced, such as a large time difference, limited overlap in working hours or inability to access the internet or other communication mechanisms at regular or semi-regular intervals throughout the field programme.
6. Effective implementation relies on the depth of practitioner's experiences and possessing a suitable archive of photographs, field demonstration videos and diagrams.
7. There is need for close supervision and thorough QA/QC checks to ensure data quality is not compromised. This ongoing activity should always be prioritised over progression of the programme.
8. Remote supervision may not be a suitable substitute for site visits required by Competent Persons for financial market reporting.

Conclusions

The remote oversight approach outlined in this paper can allow data collection to progress at locations where travel or access may be restricted. The fully remote oversight approach presented does not, and should not, fully replace the need for traditional supervision or QA/QC on mining hydrogeology characterisation programmes, which must be implemented as soon as practicable or at an appropriate stage in the mining study.

The approach can be used to reduce a project's travel related carbon footprint, allow the mine sites to realise time and cost savings on their programmes while also upskilling site-based or local staff. There are inherent risks to be considered with the remote oversight approach related to the potential for loss or damage of boreholes, data or testing equipment and the potential for reduced quality of data collection when

compared with a traditionally supervised investigation. The approach can however add value to mining projects where other factors may restrict a traditional approach. The relative risk and reward should be assessed on a project specific basis.

References

Golder Associates (UK) Limited (2020) Hydrogeological Monitoring Well Installation Guide. Document reference 19131151.103/B.0.

Land and Minerals Consulting (2018) Bjornvatn North, Major Structures Summary. Produced for Golder Associates (UK) Limited.