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CHALLENGE: Characterisation and monitoring using existing in-ground assets

Sellafield Ltd would like to explore new game changing technologies and techniques which could help develop a deeper understanding of groundwater hydrology, water flow and surface and sub-surface contamination to create a 3D picture of sub-surface heterogeneity within MSSS and the wider Sellafield site.

This call for innovation is open to applicants from any sector including industries such as oil and gas, mineral mining, chemicals, pharmaceuticals, and water.

Sellafield are seeking a proof of concept project which could be deployed in a real environment as soon as is practicably possible. Solutions for any aspect of this challenge are invited.

Application deadline: 12pm, Friday 25th September 2020

Introduction

The Magnox Swarf Storage Silo (MSSS) is a facility on the Sellafield site that was built in the 1960s to store waste from fuel reprocessing under water. Sellafield Ltd is in the process of decommissioning the MSSS facility and retrieving the waste so that it can be stored in a more modern facility elsewhere on the site.

As part of these decommissioning activities, Sellafield need to develop a better understanding of the geology around the MSSS building, obtain an increased resolution and understanding of ground contamination, monitoring contamination in ground water, how it is moving, its behaviour and spatial evolution. They are seeking ideas, innovations and technologies that will deliver game-changing improvements over the current techniques used.

Current practice

Sellafield currently employs traditional techniques to periodically measure and monitor ground conditions through sampling at well locations around the site. Wells are usually positioned based on technical need and available access.

The current approach consists of drilling boreholes of approximately 150mm in diameter to a depth of interest, usually somewhere between 8m and 80m. The boreholes are installed with a standpipe of either 50mm or 75mm internal diameter. The process is relatively expensive, costing between £50 - £100k per borehole, and wells are generally installed as part of a specific investigation campaign.

Once a well is installed, a pump is left at the bottom of the borehole to pump out ground water to measure and monitor field geochemical parameters and to collect samples for laboratory analysis. The frequency of pumping is determined by specific monitoring needs and the well water is purged prior to collection to ensure samples are representative of the groundwater surrounding the well. The analytical techniques used to test samples will depend on the well, but generally include radiochemical and major ion analysis as a minimum.

Borehole locations and the number of boreholes on site are restricted by factors such as accessibility, the need to avoid buried services and a requirement to minimise operator radiation exposure during drilling.

The Sellafield Land Quality team build on borehole sampling information with interpolation of groundwater quality data to develop conceptual models of ground conditions. Appropriate purging of the well may be required to ensure that the sampling is representative of surrounding groundwater geochemistry.

Challenge aims

Sellafield would like to explore techniques and technologies which may deliver significant improvements over the current practices employed.

Applications are invited for technological solutions to meet part or all of this challenge, which may be broken down into the following categories:

1. **Deployment of equipment to support data gathering** – what techniques could be used to support data gathering to:
   a. Increase the number of areas data can be collected from
   b. Obtain data without the need for groundworks
   c. Obtain data through novel instrumentation on drilling rigs
2. **Gathering and analysing new data** – how can Sellafield improve the quality of data through the use of alternative sensing, measurement, recording or analysis techniques?
   a. Increase the quantity of collected data
   b. Modelling of complex and interacting groundwater flow fields
   c. Perform real-time remote analysis and characterisation including of radionuclides
3. **Data cleaning and analysis of existing datasets** – how can better information be extracted from existing datasets?
   a. Obtain new insights into existing datasets e.g. using data mining techniques

To achieve these aims possible approaches may include but are not limited to:

- Continuous monitoring capabilities
- Use of novel geophysics, drone surveys, satellite imagery, by studying gas emissions etc.
- Wireline geophysical survey techniques
- Groundwater flow mapping using surface geophysical techniques to identify potential high flow pathways
- Groundwater flux measurements
- Novel surface and in-well analysis and sampling techniques to improve radiometric surveying (e.g. measuring strontium 90, caesium 137 and tritium)
- Aerial surveys to aid in determination of groundwater–surface water interactions

Constraints

The following constraints need to be considered when developing potential solutions, including:

Access

- The number of boreholes on site is restricted
  - Utilizing existing boreholes is preferred wherever possible to drilling new holes
  - Locating new boreholes is governed by existing infrastructure contraints
- Some boreholes are not installed at depths of interest; boreholes are installed at a variety of depths governed by groundwater monitoring requirements – monitoring drives the depths rather than characterisation
- There are significant challenges associated with installing new wells including the need to:
  - Avoid buried services
  - Minimise the potential for electromagnetic interference between survey and plant equipment
  - Operate on a congested plant where drilling areas are usually 5 x 10m with a 7m overhead clearance required. The presence of sub-surface legacy structures may also need to be considered

Environment

- Radiation levels may be >100 μSv/hr in areas of interest
- Potential radiological contamination of specialist characterisation and monitoring equipment must be accounted for

Functional requirements

- Solutions which offer continuous in-situ monitoring at a specified frequency are preferable to those which necessitate periodic sampling and lab testing
- Precision, accuracy and repeatability of technologies must be demonstrable
- Wireless communication solutions are preferred, subject to achieving acceptable data security and demonstration of reliability
- Output data should be compatible with INSPIRE metadata standards and specifically with the Sellafield land quality database (LDQMS) SQL server, for example flat data files such as .dat, .csv, .xls. Sellafield can supply an example data sheet if required
- The solution must operate in an entirely consistent and predicable manner to build stakeholder confidence. Solutions which communicate reliably for extended periods of time without requiring intervention are highly desirable
- Solutions which are deployed in or near wells must be capable of operating in a radioactive environment. There is likely to be little activity in the wells and at the surface, but headwork instrumentation may be subject to activity levels >100 μSv/hr. Support and guidance will be provided by Sellafield to help applicants develop radiation hardening for their technology if required
- Proposed solutions which involve the interrogation of existing data sets necessitate applicants holding the Cyber Essentials Plus certificate issued by the National Cyber Security Centre

https://www.ncsc.gov.uk/cyberessentials/overview

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What next?

Game Changers are hosting an online briefing webinar for this challenge. Details of the webinar will be available on the Game Changers website www.gamechangers.technology.

If you have new ideas or innovations which can be applied to address this challenge we invite you to join us.

If you'd like more information about the funding available through the Game Changers programme please visit www.gamechangers.technology/our-process.

The deadline for applications for this challenge is 12pm, Friday 25th September 2020.

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