Nuclear Waste Services

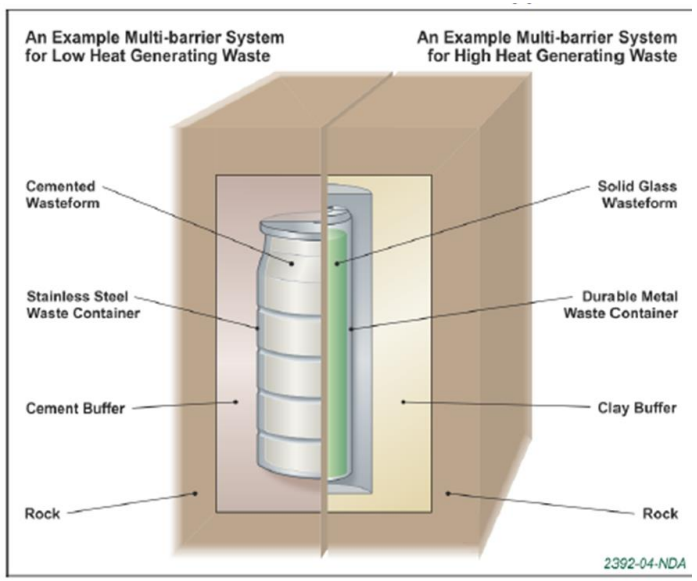
GeoDRAW: Derisking geological disposal of radioactive waste in the UK – NWS perspective

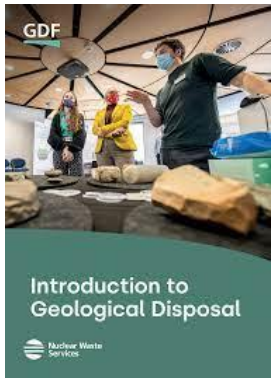
Lucy Bailey, Head of the NWS Research Support Office

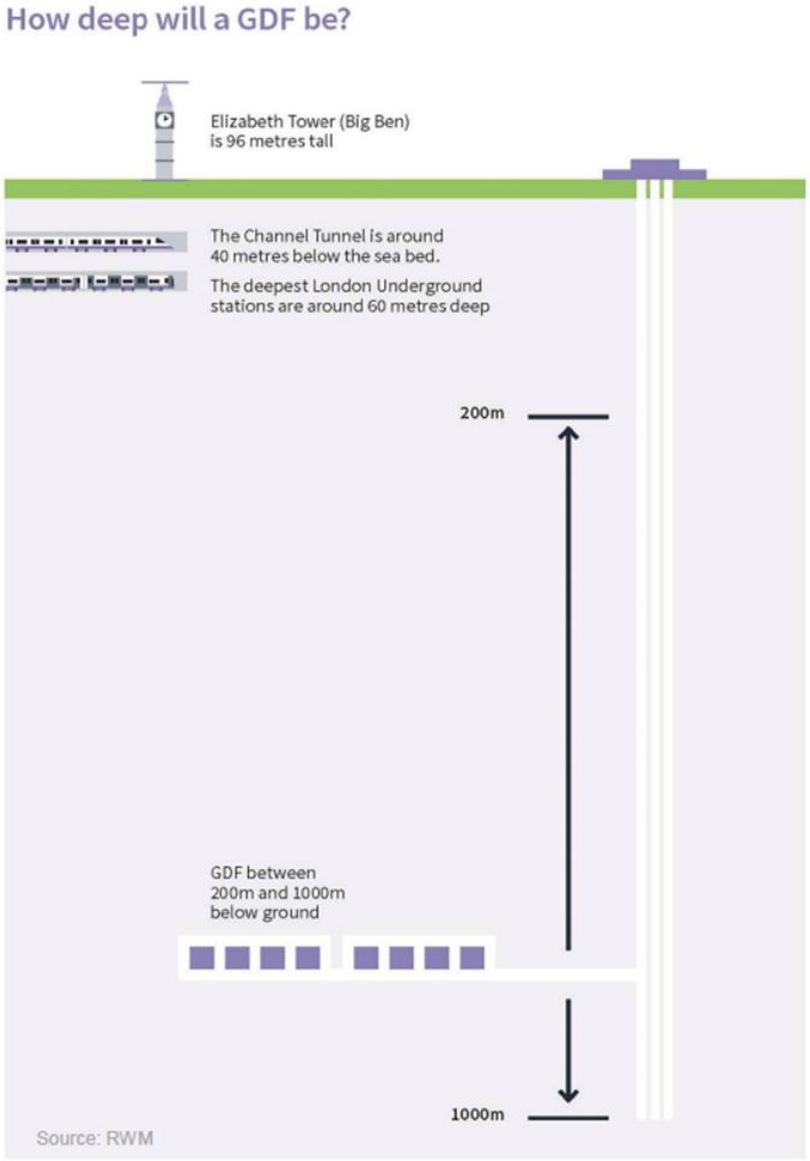
Simon Norris, Principal Research Manager

The UK radwaste challenge

The UK's current legacy of radioactive waste has been building for 60 years and while it is currently stored safely at UK sites above ground, that is not a viable and sustainable position for the many thousands of years while the waste continues to be a hazard







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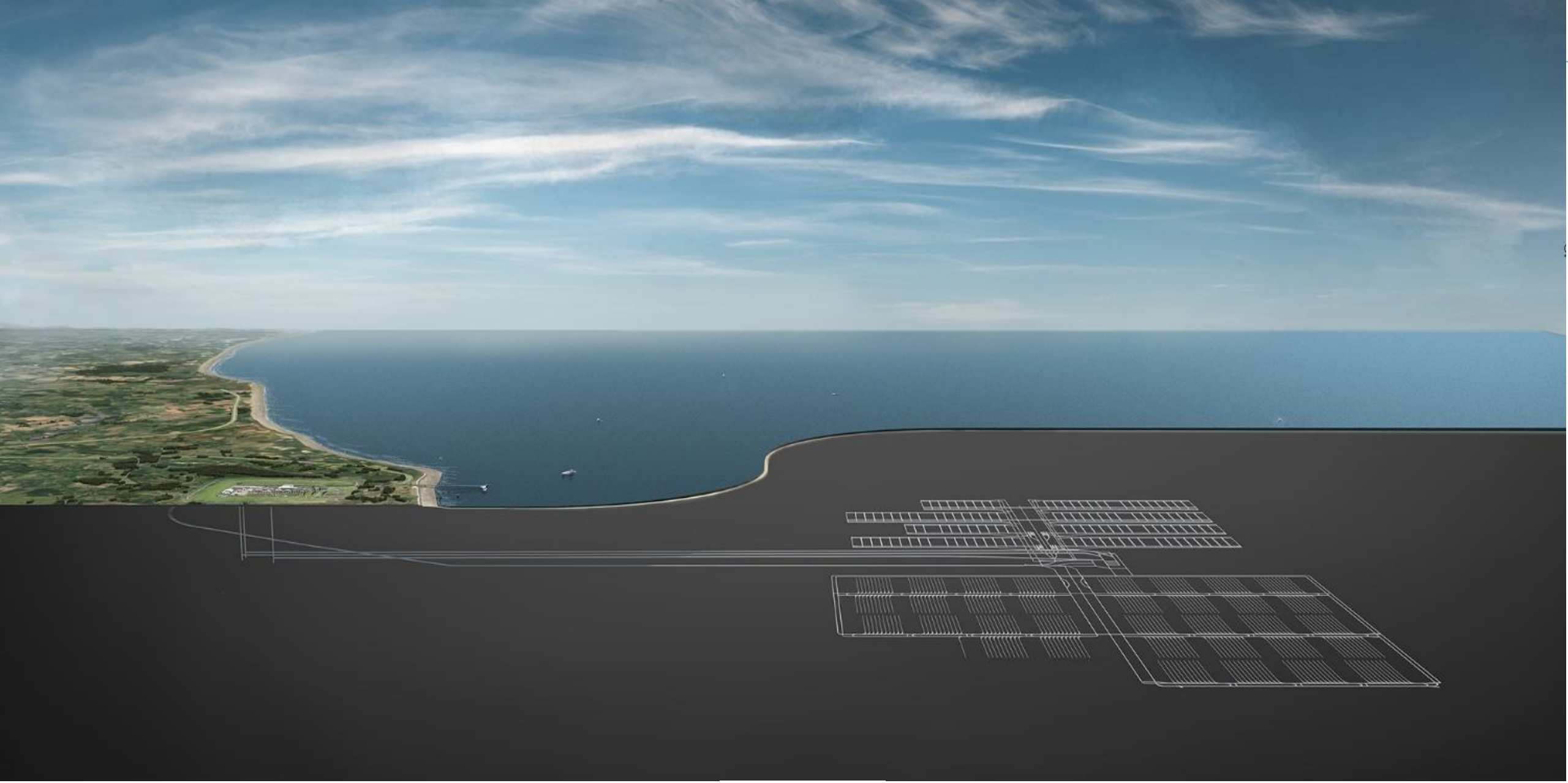

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Four Communities working in Community Partnerships

Likely GDF Sites will be inshore, under sea, accessed from land

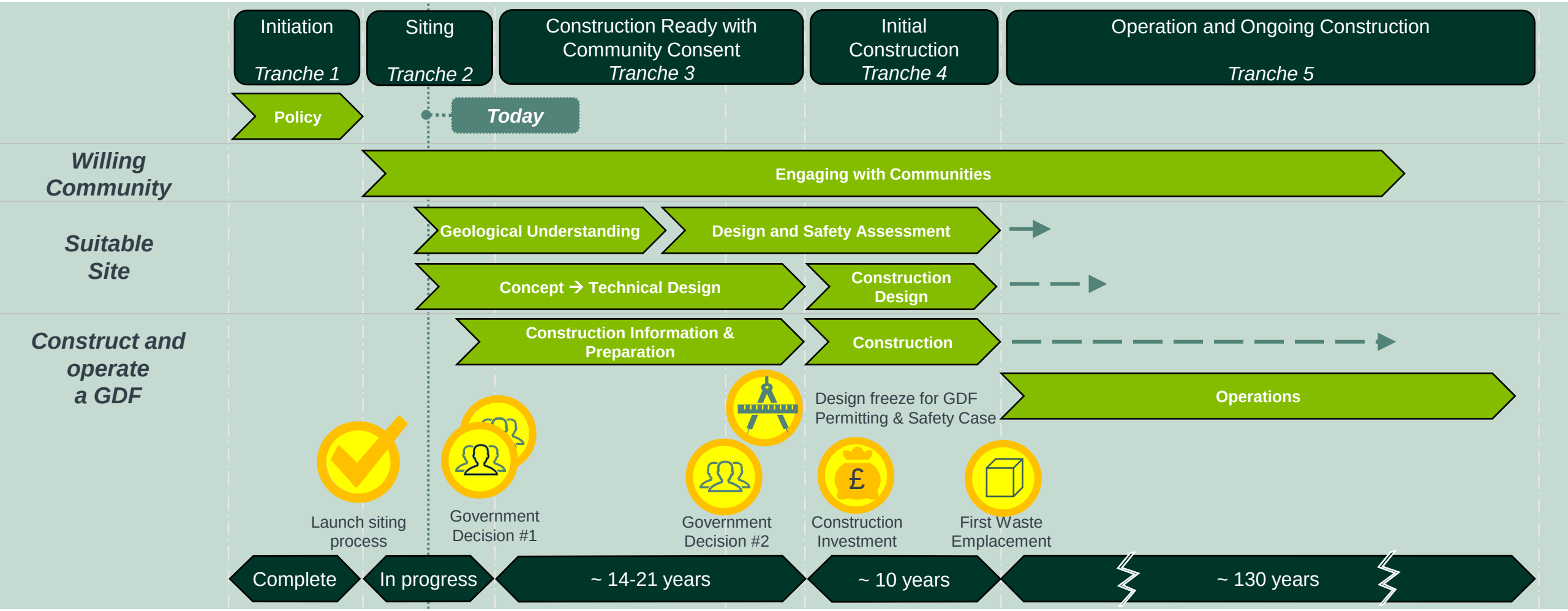
- Cumbria – location of Sellafield
- Nuclear communities
- Coastal sites
- Focus is mudstone geology inshore

- Coastal, specific brownfield site, flood zone
- Non-nuclear community
- Focus is claystone geology inshore

GDF

Nuclear Waste Services

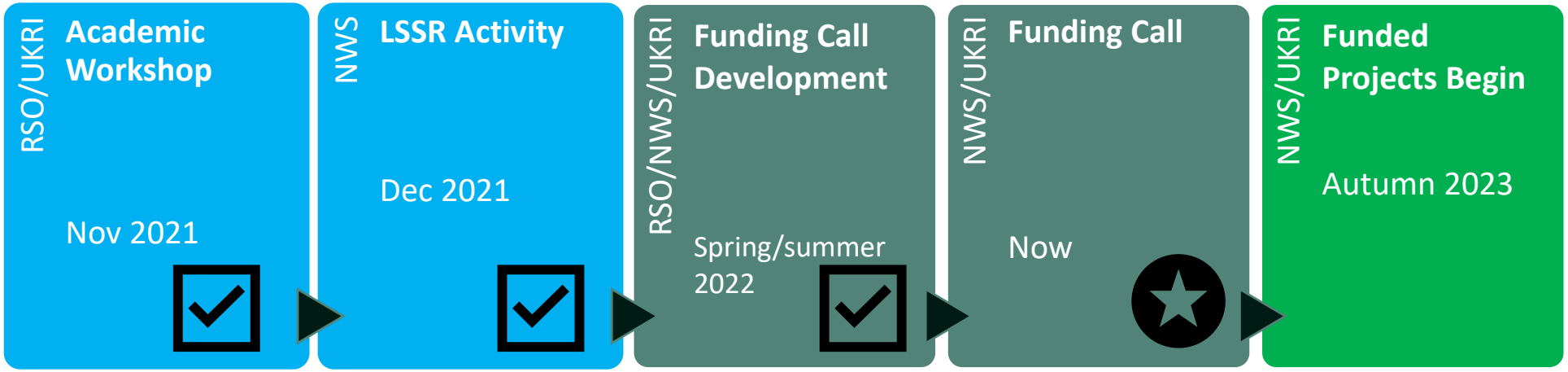
The importance of Early Career Researchers....!



Developing GeoDRAW

Defining LSSR research areas/objectives

Funding call development and delivery



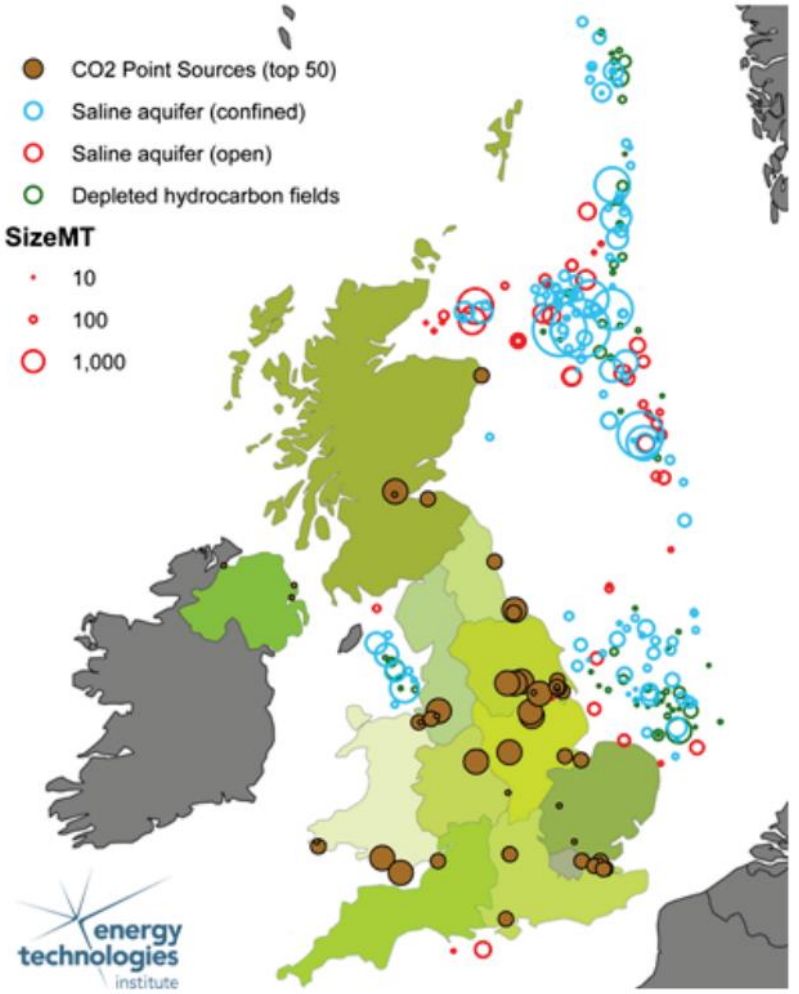
Sign up to our newsletter to be kept up to date with RSO events and funding opportunities

It's not just the GDF….

The energy transition and climate crises are creating new challenges for the subsurface

The combination of UK commitments to drive to net zero by 2050, and the current energy crisis, has led to a new and proposed developments off east and west coast:

- Energy extraction and production from geothermal resources.
- Retrievable energy storage, including compressed air, hydrogen and bio-methane.
- Permanent underground storage of CO_2, associated with carbon capture and storage.



Proximity of the UK's largest industrial emitters to CO_2 storage sites in the North and Irish Seas (DECC).

GDF

Core Store data

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1. Geological isolation challenges

This objective focuses on characterisation and conceptualisation of geological complexity and heterogeneity at multiple length and time scales within LSSR, addressing key knowledge gaps such as:

- **uncertainty** around the likely variation in values describing the **magnitude and evolution of flow and geomechanical properties** in LSSR formations in the UK (for example with varying lithology and heterogeneity)

- identification of **key processes** (for example, advection versus diffusion in the matrix, or transmissivity in the undisturbed far field or excavated damage zone) and how they will evolve over the lifetime of the repository

2. Contaminant pathways

The aim of this objective is to develop a mechanistic understanding of retention and, or transport within LSSR, for:

- **priority radionuclides** (for example, uranium and uranium series radionuclides)
- **longer lived fission products and non-radioactive contaminants** (for example, organics and heavy metals)

To increase understanding of the key controls on radionuclide transport processes in **evolving** LSSR systems, this objective will focus on radionuclide and, or contaminant behaviour, including:

- **radionuclide interactions within relevant LSSR host rock materials**
- **groundwater geochemistry**
- **biogeochemistry**

3. Mathematical modelling

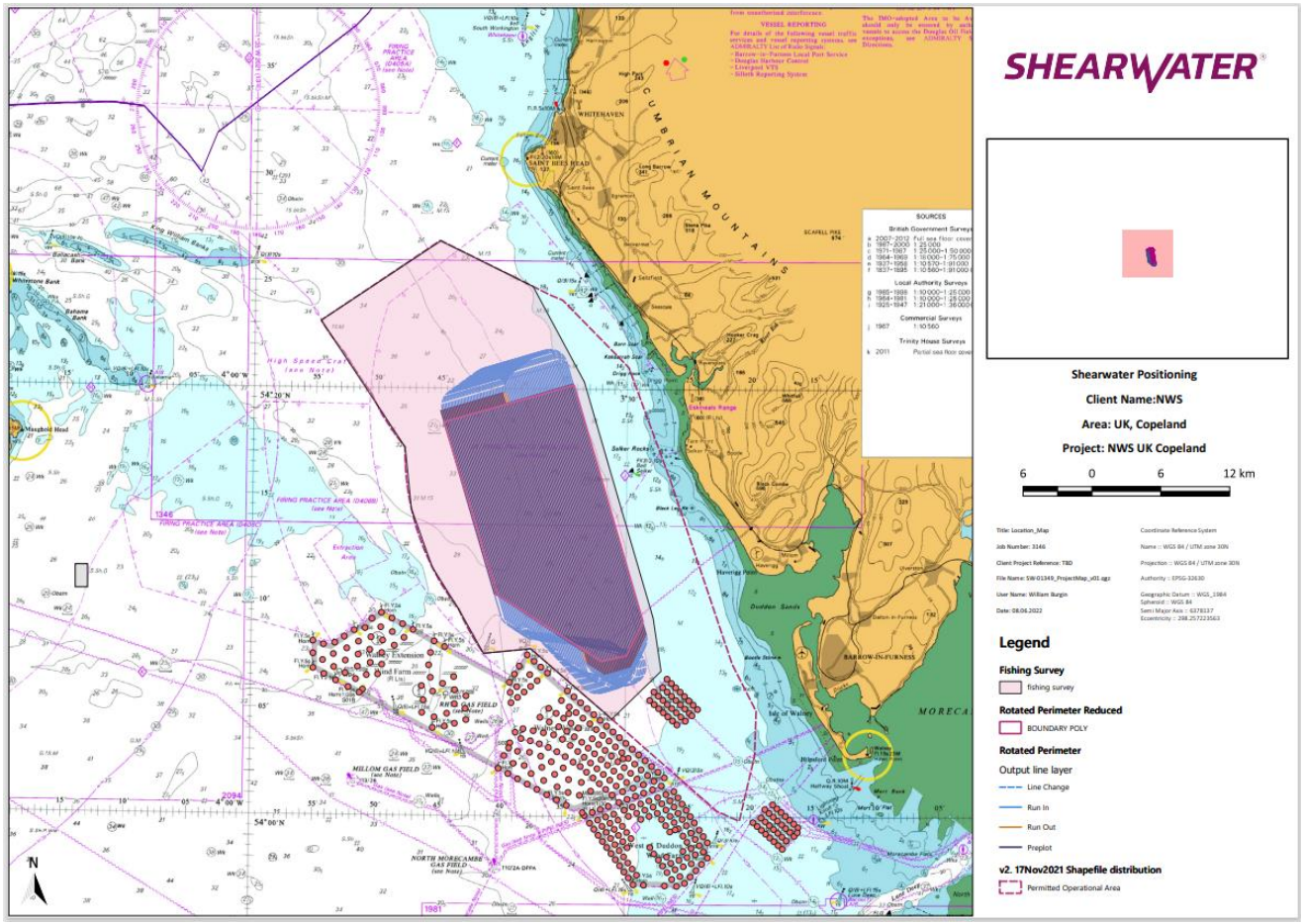
The mathematical models and codes developed as part of this research programme will focus on several key processes. For example:

- **thermal effects** from waste and damage caused by excavation process
- **fracture network development** and consequent effects on water and gas flow and transport properties
- deformation processes within the host rock and the overall **geochemical evolution** of the system

Additionally, this objective will seek to take new approaches to computational modelling by:

- building fully **coupled thermo-hydro-mechanical-chemical (THMC) computational codes** that can accurately model the growth and coalescence of fracture networks in LSSR
- **validating** these codes against relevant analytical solutions and, or data generated in objectives 1 and 2 of the programme.

We've begun site evaluation: Copeland 3D Seismic Survey



Map showing seismic survey area (purple) off coast of Copeland, UK.

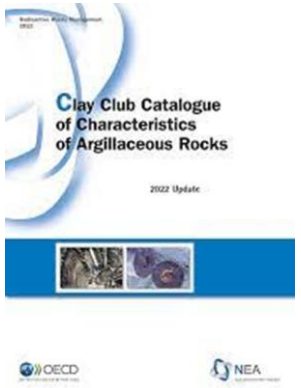
Marine location- Inshore waters

Target geology: Mercia Mudstone Group

The 3D seismic survey will:

- Confirm geological setting
- Define major geological features
- Determine rock volume

This will provide confidence in site potential and guide borehole locations



GDF

Nuclear Waste Services

The Environment Agency's research interests in support of our regulation of a future geological disposal facility

Presentation at webinar and networking event in support of the NERC/NWS Programme on Derisking Geological Disposal of Radioactive Waste in the UK, 19 January 2023

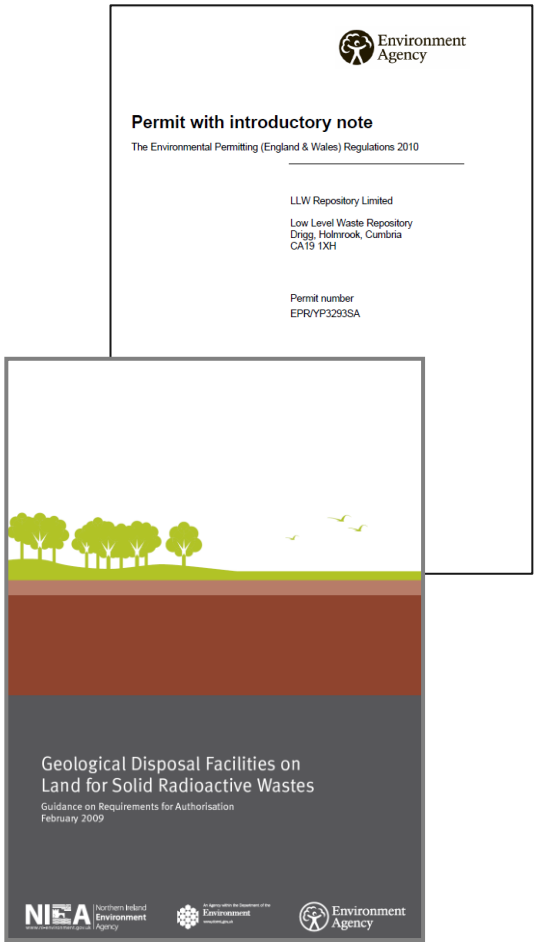
Candida Lean

Nuclear Waste Assessor & manager of EA's Pre-Application Advice and Scrutiny of NWS's Geological Disposal Facility Programme

Environment Agency

Our role as an environmental regulator

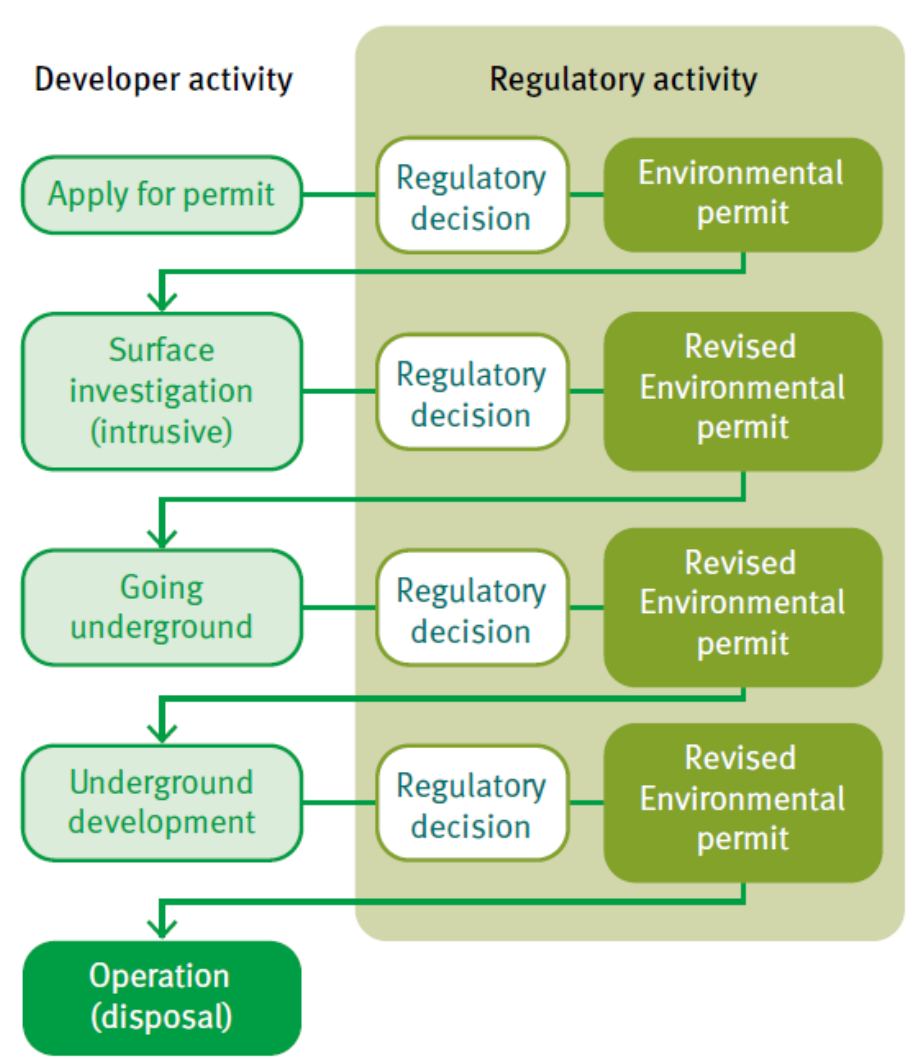
- We regulate disposal of radioactive waste under the Environmental Permitting Regulations (2016)
- Permits include conditions and limits to control radiological discharges and disposals to the environment
- An acceptable Environmental Safety Case (ESC) is required before we will issue a permit for disposal of radioactive waste
- We set high standards for protection of people and the environment now and in the future
- Our Guidance on Requirements for Authorisation (GRA) sets out the principles and requirements that a developer needs to address in an ESC



Environment Agency

Staged environmental regulation

- The developer will need an environmental permit to begin surface investigation e.g. drilling boreholes
- The environmental permit will need to be revised to enable development, operation, and closure of the facility
- We work closely with the Office for Nuclear Regulation (ONR) - a future geological disposal facility will require both an environmental permit and a nuclear site licence



Environment Agency

Our research interests

- Scientific research and analysis underpins everything the EA does, helping us to understand and manage the environment effectively.
- Our responsibilities make us key research users and our expertise and extensive data sets are an important research capability and resource.
- We recognise the importance of working in partnership and strive to work collaboratively wherever possible.
- We expect the industry to invest in and conduct its own R&D to support minimising the impact of radioactive waste on the environment, human wellbeing and health and we are willing to guide and support this where we can.
- One of our research priorities in understanding long-term performance of a GDF for HAW

Understanding the properties of the host rock and overlying strata are fundamental to assessing the performance of a GDF and making the ESC

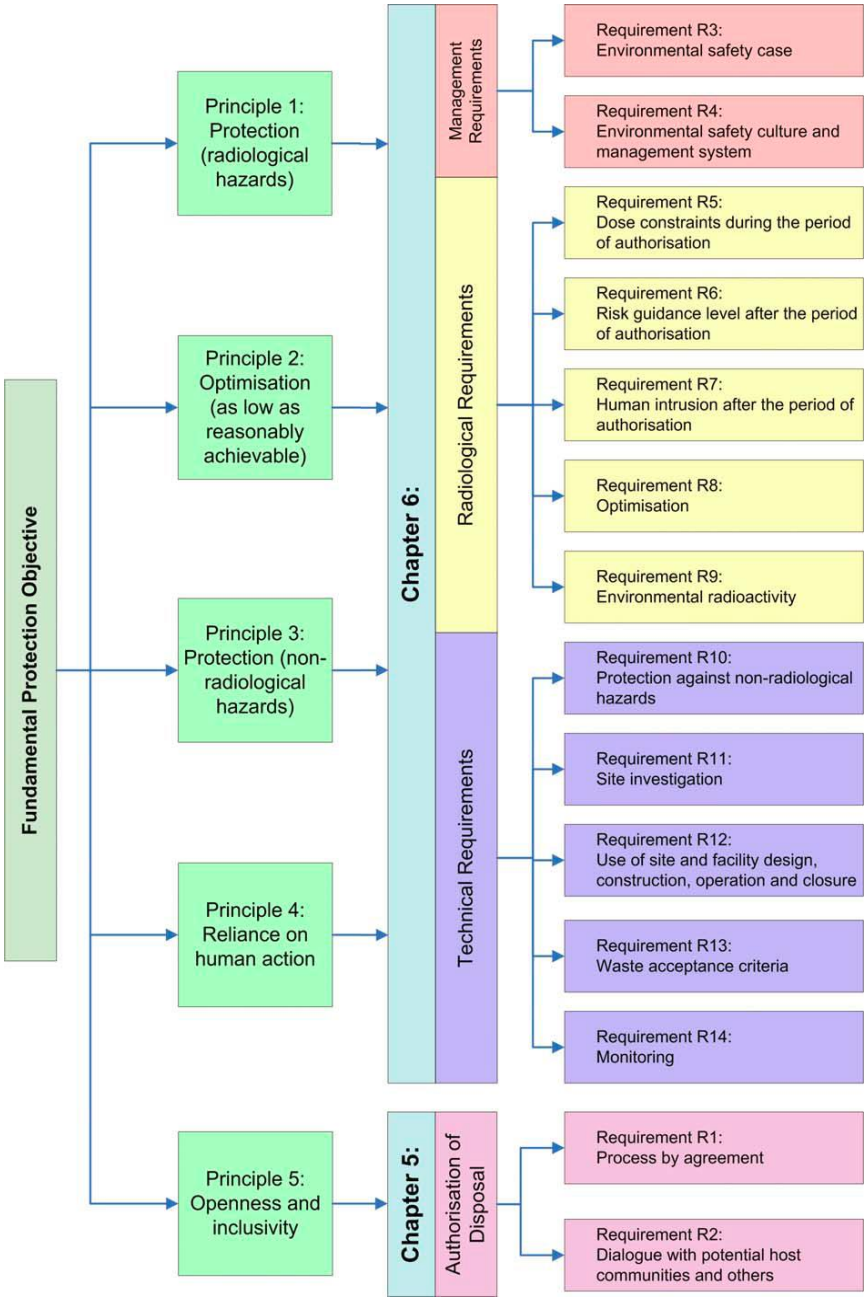
Environment Agency

Derisking Geological Disposal of Radioactive Waste

The programme objectives to understand and predict how potential LSSR host rock environments might be impacted by the introduction of a GDF cover:

1. Geological isolation
2. Contaminant pathways
3. Mathematical modelling

These closely relate to the requirements of our GRA - [Geological disposal facilities on land for solid radioactive wastes - GOV.UK (www.gov.uk)]



EA perspective – some relevant areas of concern / opportunity

- At this generic stage in the siting process, there remain fundamental gaps in the knowledge base relating to geological, hydrogeological, geochemical, biogeochemical and geomechanical properties of potential LSSR host rocks.
- Specifical challenges include (non-exhaustive list):
  - differing properties of potential LSSR host rocks and their implications on GDF construction, operation and long-term safety
  - interactions between engineered barriers and the host rock, extent and implications of the engineered disturbed zone and the degree and timescales of self-sealing
  - thermal impacts on the host rock
  - understanding heterogeneity at all relevant scales, upscaling
  - dominant controls on groundwater and gas migration in the geosphere
  - complexities of modelling groundwater and gas flow in clay and mudstone
  - impacts of microbial activity
  - effects of faults on host rock integrity, and on groundwater and gas flow
- This programme provides excellent opportunity to:
  - carry out independent fundamental underpinning research to inform development of the safety assessment and ESC for a future GDF
  - Identify gaps and future research requirements as the siting process moves from generic to site-specific
  - build skills and capability

Environment Agency

If you'd like to know more about the EA and ONR's role in regulating geological disposal

- **Link to our webpages on geological disposal:**
  https://www.gov.uk/guidance/regulating-the-geological-disposal-of-radioactive-waste-environmental-protection
  http://www.onr.org.uk/geodisposal.htm
- **Link to our annual scrutiny reports:**
  https://www.gov.uk/government/publications/geological-disposal-scrutiny-of-rwms-work-annual-reports
- **Link to our guides to regulating geological disposal:**
  http://www.onr.org.uk/documents/2019/geological-disposal-joint-working.pdf
  http://www.onr.org.uk/documents/2019/geological-disposal-overview.pdf

E-mail us at: nuclear@environment-agency.gov.uk

Environment Agency

Animation

- A short animation about the regulators' role in geological disposal is available on YouTube at https://youtu.be/HY9gcwhCDB4

Environment Agency

Natural Environment Research Council

GeoDRAW programme NERC introduction

Oliver Knevitt, Senior Programme Manager

Programme webinar and networking event

19 January 2023

NERC and UKRI delivery plan ambitions

Published September 2022

We will,

- pursue **positive outcomes for business and the environment that minimise the environmental impacts** of consumption
- pursue strategic programmes that address the critical environmental challenges […] and **work in partnership** with other research councils, funders and government to ensure a productive, resilient, and healthy environment
- co-create targeted programmes to mitigate environmental challenges and **pursue environmental opportunities**

Natural
Environment
Research Council

https://www.ukri.org/publications/nerc-strategic-delivery-plan/

What we are funding

Funding opportunity

Derisking geological disposal of radioactive waste in the UK

Opportunity status:	Open
Funders:	Natural Environment Research Council (NERC)
Co-funders:	Nuclear Waste Services (NWS)
Funding type:	Grant
Maximum award:	£5,000,000
Publication date:	22 November 2022
Opening date:	22 November 2022 10:00am UK time
Closing date:	23 March 2023 4:00pm UK time

Last updated: 28 November 2022

Start application ▸

Timeline

22 November 2022 10:00am
Opening date

19 January 2023 10:00am
Networking event

23 March 2023 4:00pm
Closing date

Mid May 2023
Interview panel

By 2 October 2023
Project starts

- Single large, diverse consortium
- £4M available from NERC/NWS at 80% FEC
- Must address all three objectives
- Stakeholder engagement
- Collaboration with the NWS RSO community
- Opportunity closes 23 March 2023
- Interview panel in May, projects begin October 2023

UKRI Natural Environment Research Council

https://www.ukri.org/opportunity/derisking-geological-disposal-of-radioactive-waste-in-the-uk/

What does “good” look like?

1. Excellent research

A sound and ambitious approach with transformative potential, and a capable team

2. Good fit to scheme

Likely to meaningfully advance the knowledge around the call’s objectives

3. A diverse and inclusive approach

A diverse team and ethos embedded throughout that brings in new perspectives

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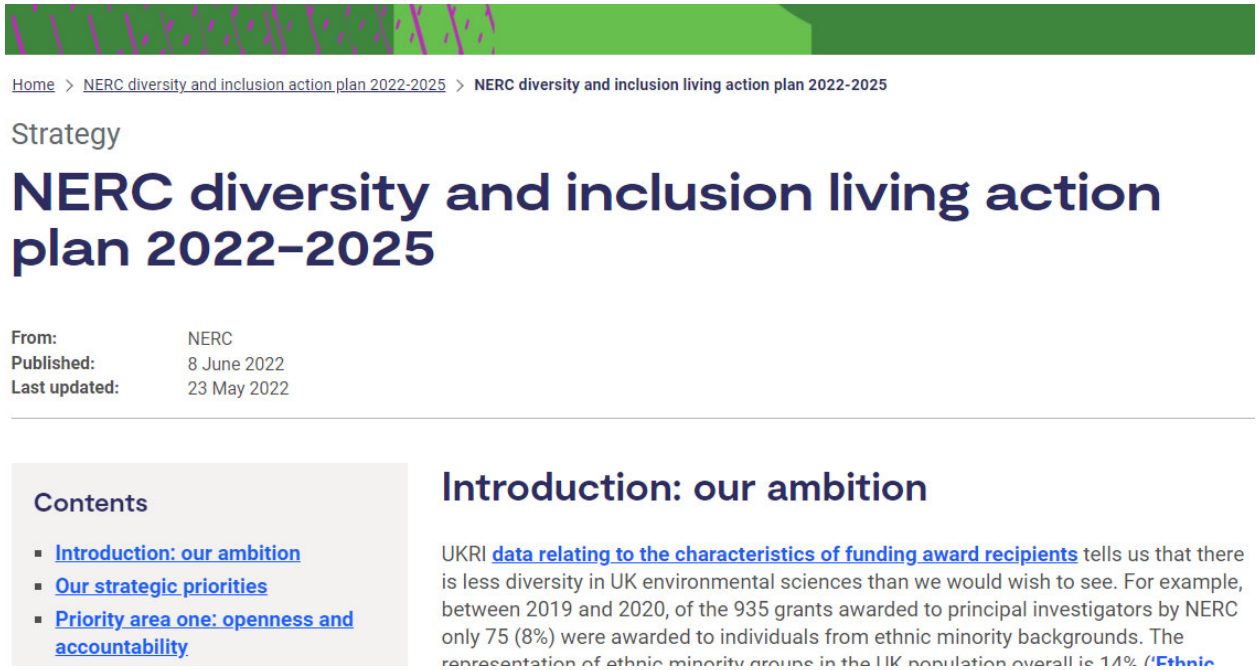
More on D&I at NERC



Home > NERC diversity and inclusion action plan 2022-2025 > NERC diversity and inclusion living action plan 2022-2025

Strategy

NERC diversity and inclusion living action plan 2022–2025

From: NERC
Published: 8 June 2022
Last updated: 23 May 2022

Contents

- Introduction: our ambition
- Our strategic priorities
- Priority area one: openness and accountability

Introduction: our ambition

UKRI data relating to the characteristics of funding award recipients tells us that there is less diversity in UK environmental sciences than we would wish to see. For example, between 2019 and 2020, of the 935 grants awarded to principal investigators by NERC only 75 (8%) were awarded to individuals from ethnic minority backgrounds. The representation of ethnic minority groups in the UK population overall is 14% ('Ethnic

For this call,

A diverse team has been assembled

- A diversity of insight, bringing new perspectives
- Early career researchers inclusion, and opportunities for development

We are not assessing protected characteristics nor asking for data.

Activities and attitudes that promote an open and inclusive research community

- Championing diversity and inclusion practice throughout the project plan, removing barriers to research participation

UKRI Natural Environment Research Council

https://www.ukri.org/publications/nerc-diversity-and-inclusion-action-plan-2022-2025

D&I resources

NERC's *making environmental science equal, diverse and inclusive* programme

- Virtual event recording https://www.ukri.org/events/nerc-diversity-and-inclusion-knowledge-exchange-virtual-event/
- Projects with relevant outputs include
  - Evaluating diversity and inclusion within the geochemistry academic ladder (E-DIAL) https://geochemdei.ac.uk/
  - Enabling Equitable Cultures of knowledge and practice in physical geography and environmental sciences, published https://www.rgs.org/research/higher-education-resources

Diversity in Geoscience, UK https://dig-uk.org/

Geological Society diversity resources https://www.geolsoc.org.uk/diversity

UKRI Natural Environment Research Council

Natural Environment Research Council

Thank you

Please see the UKRI GeoDRAW webpage for more info future updates, or contact geodraw@nerc.ukri.org for all queries about the call

https://www.ukri.org/what-we-offer/browse-our-areas-of-investment-and-support/derisking-geological-disposal-of-radioactive-waste/

Home > What we offer > Browse our areas of investment and support > Derisking geological disposal of radioactive waste

Area of investment and support

Derisking geological disposal of radioactive waste

The aim of this programme is to undertake fundamental research that will advance our understanding of the potential effects that the introduction of a Geological Disposal Facility (GDF) for radioactive waste might have on lower strength sedimentary host rock. This includes detailed conceptualisation of the geology and groundwater.

Budget: Total budget for this investment is £4 million, co-funded by the Natural Environment Research Council and Nuclear Waste Services (£2 million each)

Duration: This is a single programme running from 2023 to 2027. There will be 1

NERC: Natural Environment Research Council @NERCscience NERCscience