CoRWM

Committee on Radioactive Waste Management

CoRWM REPORT

IMPLICATIONS OF INSHORE SITING OF A GDF

October 2022

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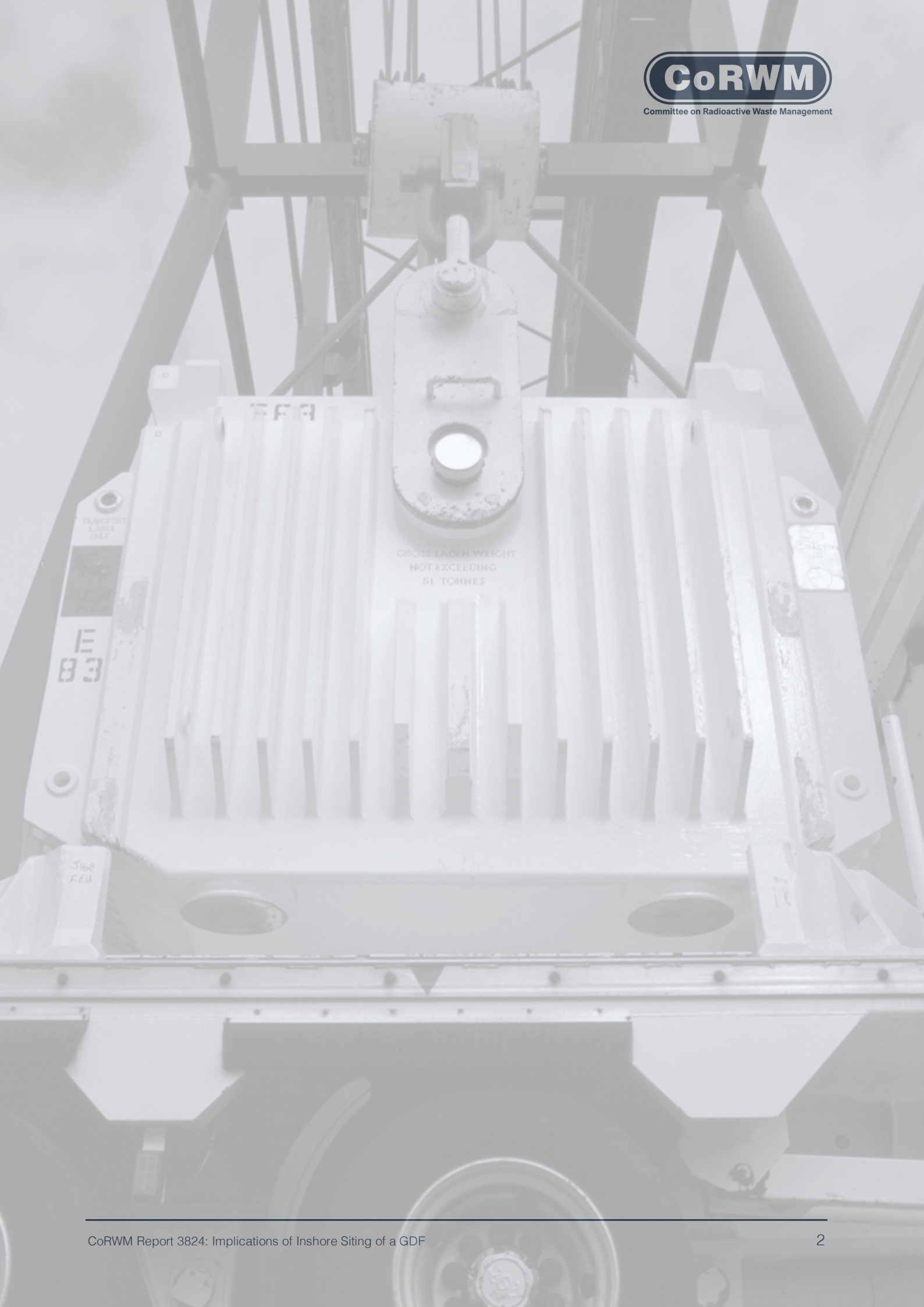
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1 Introduction

The UK Government has confirmed that a Geological Disposal Facility (GDF) is its preferred solution for the long-term management of higher activity radioactive waste (HAW).

The Nuclear Decommissioning Authority (NDA) is responsible for the delivery of a GDF with the subsidiary company, Radioactive Waste Management Limited (RWM)[1], appointed by the NDA to undertake the process of site selection, stakeholder engagement, design and implementation of a GDF (including construction, operation and closure).

To deliver a Geological Disposal Facility (GDF) three conditions will need to be met:

- a willing community's agreement to host the facility;
- achieving the suite of necessary regulatory consents; and
- securing government financial support to fund the work necessary.

There has been recent and growing interest in the option of an inshore GDF, that is, a GDF with waste reception and access facilities on land and disposal vaults sited within a suitable geological formation located deep beneath the seabed. It is therefore considered by CoRWM to be timely to consider the implications of an inshore location for the delivery of a GDF.

[1] RWM resides within NDA's Nuclear Waste Services (NWS) Division due to a recent reorganisation.

2 Inshore Geological Disposal

CoRWM's report 'Managing our Radioactive Waste Safely – CoRWM's recommendations to Government' (CoRWM Document 700), issued in July 2006, set out a shortlist of waste management options and made recommendations to government.

Report 700 recommended deep geological disposal as the preferred method for the long-term management of the UK Inventory of Higher Activity Waste (HAW)[2]. The report did not include any specific reference to the location of a GDF, remaining silent on consideration of an onshore, inshore or offshore location. Subsequently, preparatory work undertaken by government and by the developer has placed most emphasis on a GDF sited onshore.

Since the commencement of the current engagement process with local communities, there has been a growing interest in the option of an inshore GDF, that is, a GDF located within a suitable geological formation, deep beneath the seabed, accessed from waste reception facilities on land.

CoRWM's understanding of the inshore GDF option is that it preserves the fundamental characteristics of deep geological disposal, as originally recommended by CoRWM, because it relies on the same multi-barrier approach to ensure long-term safety. CoRWM notes the potential for the inshore GDF option to be confused with the sub-seabed disposal option, which was shortlisted by CoRWM but not recommended. An Inshore GDF, as described above, is not the same as sub-seabed disposal[3].

[2] The term Higher Activity Waste (HAW) refers to all radioactive material that has no further use that falls into the following categories: High Level Waste (HLW), Intermediate Level Waste (ILW) and the relatively small volume of Low Level Waste (LLW) that is not deemed suitable for disposal at the LLW Repository or the LLW facility at Dounreay.

[3] Sub-seabed disposal is defined as disposal in shallow sediments beneath the seabed, the disposal taking place at sea.

3 Inshore Setting

The UK territorial sea is defined by statute as extending out 12 nautical miles (22.2 km; 13.8 miles) from the low water tide mark (Figure 1). It is to all intents and purposes the same in legal terms as UK land territory, and the UK has full sovereignty.

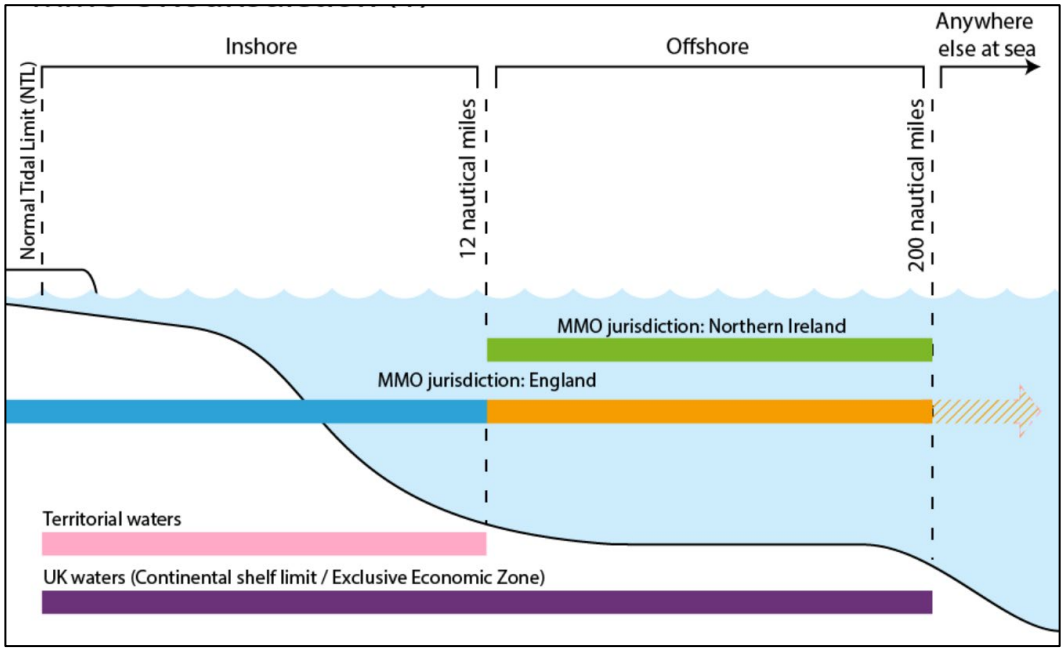


Figure 1: UK Waters Definition
(Source: UK Government, Marine Management Organisation, Marine Licencing Information)

Outside territorial waters, in the United Kingdom Continental Shelf (UKCS) or the Exclusive Economic Zone (EEZ), the UK's sovereignty is limited to what is allowed by public international law under the United Nations Convention on the Law of the Sea (UNCLOS) and other treaties.

There will be a physical limit on the distance that any underground tunnels can be driven out under the seabed from the onshore access location. Supporting CoRWM work indicated that this limit, based on historical sub-seabed mining elsewhere around the UK and capability of tunnelling technology, would not exceed 20km. This practical limit would place the disposal vaults for an inshore GDF beneath the seabed of the UK territorial sea.

There will also be minimum depth criteria below the seabed to ensure adequate depth of rock cover above the GDF, to eliminate any risk from seawater ingress or geotechnical related impacts from the construction of the GDF.

Historically, formal guidelines for depth were developed and set out by British Coal in their operational regulations to limit the tensile strain in overlying rocks for different methods of undersea coal extraction; the minimum depth of cover was 60m and 105m, dependent upon the mining method employed. These minimum depth criteria will be satisfied for an inshore GDF because the environment regulators apply a depth envelope for a GDF of between 200m to 1000m. The depth selected for an inshore GDF within this range will be informed by the Safety Case.

Through National Geological Screening (NGS), high-level geological screening information for the inshore environment around England and Wales has been made publicly available by RWM to provide a basis for discussions about the suitability of inshore geology for siting a GDF (available at the following Government website: https://www.gov.uk/guidance/about-national-geological-screening-ngs).

Historically, exploratory geological investigations in the inshore area have been performed by various actors. As such, some detailed information pertinent to certain areas of the inshore already exists. The NGS results will inform the planning of further geological investigations by RWM, in areas participating in the siting process. These might include seismic surveys and deep borehole investigations.

CoRWM have produced illustrations of both onshore and inshore geological disposal facilities, as shown in Figures 2 and 3, respectively. These illustrate the geographical setting for each concept, highlighting the many similarities. The key differences are associated with the layout and dimensions.

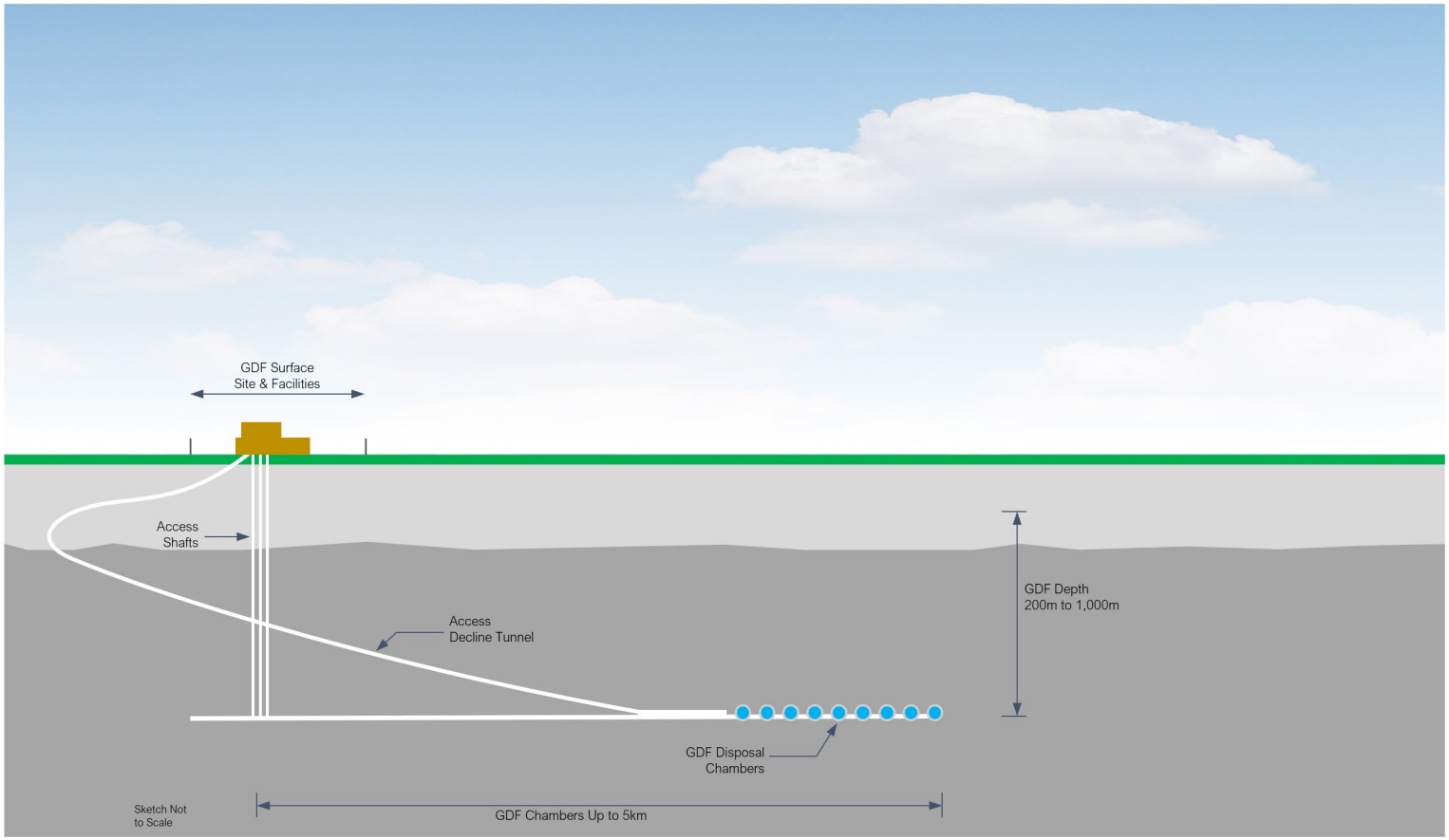


Figure 2: Onshore GDF Schematic (CoRWM)

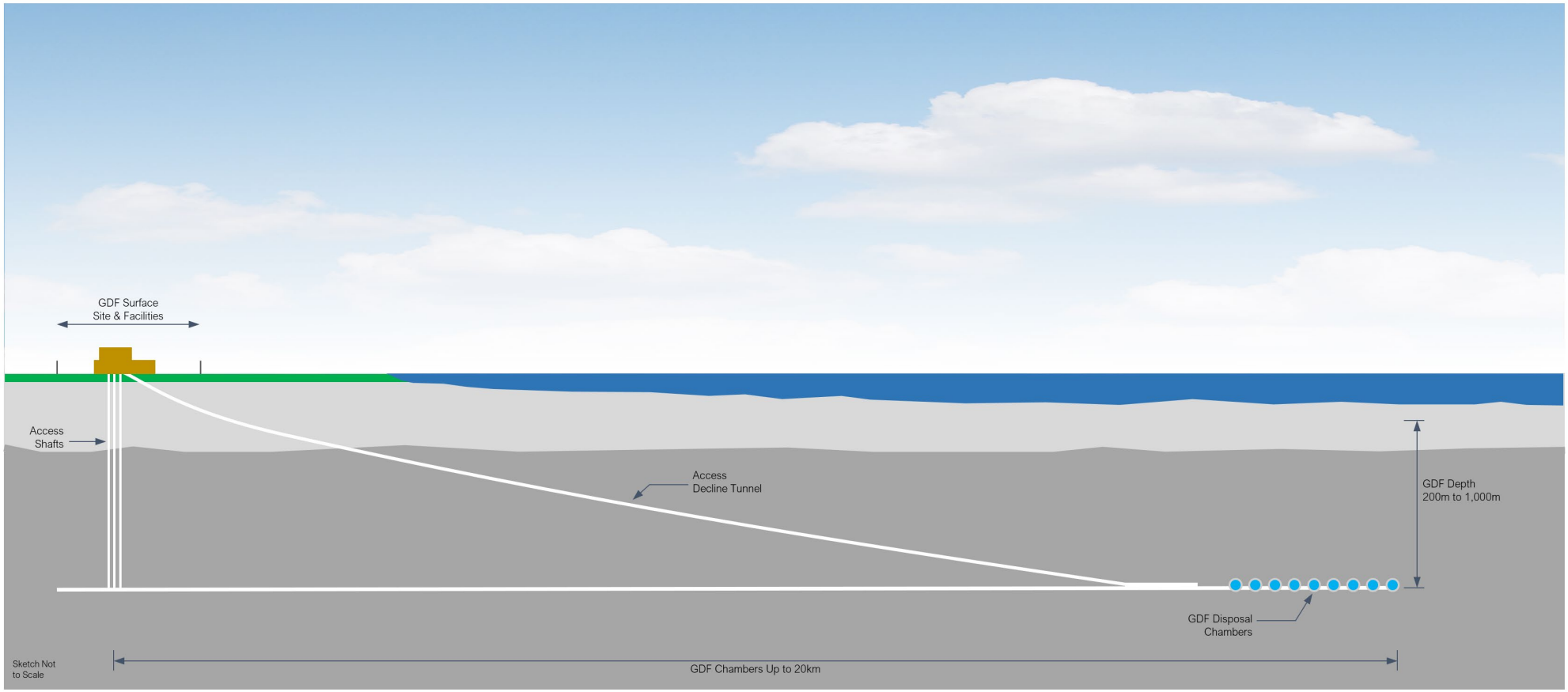


Figure 3: Inshore GDF Schematic (CoRWM)

4 Economic Aspects

The specific location of a GDF, whether onshore or inshore, will have a significant bearing on cost. For an inshore GDF there are a number of factors that merit consideration, these include:

1. the particular requirements for offshore geological investigation work, which would include:
   - offshore seismic surveys;
   - marine environment surveys;
   - sub-seabed exploration drilling programme;
   - long-term instrumentation & monitoring of drillholes;
   - bathymetric surveys and long term seismic and settlement monitoring of the seabed; and
   - detailed hydrogeological assessments and baseline data development.
2. the distance between the onshore receipt facilities and the disposal tunnels which will affect:
   - the extent of the construction works necessary to create the long-distance underground tunnels (many kilometres);
   - transportation distances & timescales for waste package movements in the GDF;
   - the selection of grout materials and equipment for long distance pumping systems for backfilling; and
   - the demand for ventilation and other restrictions due to the distances of tunnelling involved[4].
3. the ability to monitor performance of the GDF during operation and, if deemed necessary, post-closure; and
4. the need for additional licencing such as, for example, from the Marine Management Organisation (MMO) and agreement with the Crown Estate.

There may also be factors that reduce costs. For example, the simplicity of the hydrogeological environment may reduce the cost of design and construction of engineered barriers.

[4] The lateral displacement of the receipt facilities and vaults may also be a factor for an onshore GDF.

5 Social Considerations

Support from the public, stakeholders and observers in relation to any GDF is critical to being able to satisfy the Test of Public Support and to obtaining a social licence to operate any such facility. The UK Government policy framework for a consent-based process, set out in the document 'Working with Communities' (BEIS, December 2018), makes several references to the possibility of an inshore GDF (paras. 6.13 and 6.22) but the framework often assumes an onshore facility (see for example paras. 4.4, 5.19, 6.4, 6.84). The Welsh Government's policy for implementing geological disposal takes a similar approach.

The policy framework sets out the siting process for RWM to work in partnership with communities and the principal local authorities that represent those communities – i.e., district councils, county councils and unitary authorities. This process can be applied for an onshore or an inshore GDF and covers:

- definition of the area of search;
- the constitution of working groups;
- the role of principal authorities;
- definition of the potential host community;
- the operation of the test of public support;
- eligibility for funding; and
- the operation of community benefits.

The increased interest in an inshore GDF may mean that additional guidance is needed for some elements of the framework.

Further to the above, CoRWM has considered various topics for which the location of a GDF inshore may result in different public perceptions. These are listed in Table 1, along with comments on how these perceptions might be responded to.

Topic	Onshore	Inshore	Comment
Underground construction & safety risks	The concept of underground construction, tunnelling and mining is widely understood	In comparison, the concept of underground excavations beneath the seabed are generally less well understood	Construction beneath the seabed may create additional concerns. These concerns can be explored by reviewing global experience of sub-seabed excavation, e.g., in Sweden and Finland.
Long term safety	An onshore GDF disposes of waste 'below people's feet'	An inshore GDF buries waste some distance away from 'below people's feet'	An inshore GDF may improve public views with regard to the acceptability of the location given the perceived change in proximity to the actual disposal site. It may however result in concerns over contamination of the sea.
Undersea working	Not applicable	Mis-understanding of undersea working may be widespread	Operations beneath the seabed may create additional concerns about safe working. These concerns can be explored by comparing the access and operational methods with those of an onshore GDF.
Effects on other countries' interests	Not applicable	Changed proximity to other states and distancing from UK	It may be considered that locating a GDF inshore may result in issues of public international law within the marine environment.
Contamination into the sea	Concerns regarding hydrogeological movement of groundwater from onshore	The siting of a GDF under the seabed will inevitably lead to concerns regarding contamination of the marine environment	Modelling will be necessary to confirm that radionuclide release to the sea will remain below the Risk Guidance Level for the duration of the operational and post-closure periods for both inshore and onshore GDF locations.
Public Perception / Social licence	Perception may be that the onshore GDF is essentially the responsibility of the operator who requires the support of the local community	Perception of an inshore GDF may be that placing wastes inshore is somehow more "out of sight out of mind" and a less ethically responsible solution	An inshore GDF may be perceived as being more than a matter for the local community but belonging to a wider and potentially international community with an interest in the marine environment. This ethical dimension of how responsibility is addressed will be a part of obtaining the "social licence" to construct and operate an inshore GDF

Table 1: GDF location and potential differences in public perception

6 Technological Impacts

6.1 Design & Exploration

The inshore GDF option does not appear to introduce any new or novel design aspects that cannot be reasonably defined or completed based upon current knowledge, methods and available resources.

Likewise, the inshore option does not introduce any new or novel exploration aspects that cannot be reasonably defined or completed based upon current knowledge, methods and available resources, e.g. marine-based seismic exploration.

The main technological challenge is likely to be related to the ability to obtain sufficient relevant 'ground truth' information to inform the design and eventual construction. An inshore GDF may require some alternative approaches to be considered and adopted, most notably, exploratory tunnels driven from onshore into the inshore zone where suitable underground facilities can be installed for borehole drilling and monitoring of the GDF zone.

6.2 Constructability

All of the historical and current evidence demonstrates that constructing underground tunnels beneath the seabed is very well proven and presents no technological challenges, especially given that modern tunnelling methods and techniques have developed significantly over the last few decades into extremely mature, well proven and safe systems for providing long term infrastructure and transportation tunnels.

Indeed, there are international parallels. For example, the Forsmark SFR (final repository for short-lived low and intermediate level radioactive waste) facility in Sweden is also an inshore disposal facility, with a depth of c. 60m below the seabed, with the vaults accessed via tunnels that descend from an island (onshore) location.

The design of an inshore GDF should not need to differ from an onshore GDF, apart from the distances involved in accessing the GDF disposal vault zone locations from the onshore access site. This is likely to extend the distances of access tunnels from onshore, albeit it is unlikely that the additional distance would be more than 20km.

6.3 Monitoring Programmes

RWM do not currently envisage a post-closure monitoring or surveillance programme. However, potential host communities or other key stakeholders may wish to see some form of monitoring programme to provide assurance that a disposal facility for radioactive waste performs at the required level of safety during both the operational and initial post-closure phases.

The IAEA Safety Guide on geological disposal facilities describes monitoring and surveillance in the pre-operational, operational, closure and post-closure periods for geological disposal facilities, as follows:

1. the pre-operational period includes concept definition, site evaluation (selection, verification and confirmation), safety assessment and design studies. The pre-operational period also includes the development of programmes and procedures required in support of the application for a licence for construction and initial operation of a disposal facility. The monitoring and testing programmes that are needed to establish baseline conditions need to be put in place during this period.
2. the operational period begins when waste is first received at the facility. From this time, radiation exposures may occur as a result of waste management activities, and these are subject to control in accordance with the requirements for protection and safety.
3. the post-closure period begins at the time when all the engineered containment and isolation features have been put in place, operational buildings and supporting services have been decommissioned, and the facility is in its final configuration. After its closure, the safety of the disposal facility is provided for by means of passive features inherent in the characteristics of the site and the facility and characteristics of the waste packages.

Monitoring in an inshore environment may be more technically challenging than an onshore environment. For example, it may require:

- semi-permanent offshore structure/s for instrumentation and monitoring equipment and data transmission, such as monopile (wind turbine base) or anchored buoy arrangements; and
- underground monitoring installations during GDF operation which are established separately and maintained post-closure for performance monitoring.

7 Legal and Regulatory Considerations

7.1 International Law

In 2005 CoRWM commissioned a report from a leading UK environmental law academic on the legal considerations of sub-seabed disposal[5], as a number of respondents to the Nirex[6] 'The Way Forward' process questioned whether a sub-seabed based GDF would be contrary to the UK's obligations under public international law. This resulted in CoRWM Document No. 927[7], which provided a comprehensive analysis of the relevant international law, with the instruments being:

1. the UN Convention on the Law of the Sea (UNCLOS);
2. the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, and the 1996 Protocol to that Convention; and
3. the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention). The report considered the mechanisms for dispute resolution in the event that another Contracting Party to these Conventions challenged the UK's interpretation.

CoRWM Document No. 927 summarised its conclusions on the various Conventions. It noted that the Conventions were more likely to affect disposal from ships or from offshore installations than from tunnels accessed from land.

UK Nirex itself obtained Counsel's Opinion on these issues, which considered in detail the background materials to the Conventions and reached the following conclusions:

1. the relevant Conventions would not preclude the long-term disposal of radioactive waste in sub-seabed brine formations which are accessed by tunnel from the UK land-mass;

[5] Although advice was sought in relation to seabed disposal CoRWM believes the legal considerations may be relevant to an inshore GDF.

[6] Nirex was a United Kingdom body set up in 1982 by the UK nuclear industry to examine safe, environmental and economic aspects of deep geological disposal of intermediate-level and low-level radioactive waste.

[7] Sub-Seabed Disposal of Radioactive Waste – Legal Considerations, Professor Richard Macrory and Ray Purdy (2 February 2005).

2. the UK would have the rights necessary to construct and use a GDF, certainly in UK territorial waters and probably in the EEZ/UKCS;

3. it would need to ensure that there would be no pollution of the marine environment and comply with specific principles (Sintra Statement) as to levels of emissions of radionuclides over the life of the facility, so as to be "close to zero", due to the OSPAR Convention which would apply to sub-seabed disposal accessed from land. This would not preclude a facility, but requires specific conditions to be met, in particular the "close to zero" requirement, which is a more onerous standard than the 'as low as is reasonably achievable (ALARA) principle; and

4. any such proposal would also be subject to requirements in terms of environmental assessment (including assessment of transboundary effects) and assessment of effects on internationally protected marine conservation sites.

7.2 Development Consent

In terms of development consent, it makes no difference under the Planning Act 2008 whether the GDF is under land or under the seabed. Section 30A of the Act which refers to a GDF requires that:

a) the main purpose of the facility is to be the final disposal of radioactive waste;

b) the part of the facility where radioactive waste is to be disposed of is expected to be constructed at a depth of at least 200 metres beneath the surface of the ground or seabed; and

c) the natural environment which surrounds the facility is expected to act, in combination with any engineered measures, to inhibit the transit of radionuclides from the part of the facility where radioactive waste is to be disposed of to the surface.

The construction of an inshore GDF is covered by the provisions of the 2008 Act if the facility (when constructed) will be in England or waters adjacent to England up to the seaward limits of the territorial sea. Similarly, the wording of section 30A would cover exploratory deep boreholes in connection with a sub-seabed facility (on the same basis as the GDF) as long as the borehole is constructed to a depth of at least 150 metres beneath the surface of the ground or seabed.

An inshore GDF proposal would engage with other regulatory regimes than would a simply land-based proposal, as discussed below.

7.3 Nuclear Site Licensing

On ordinary principles, legislation applies to UK territorial waters unless expressly extended to a wider scope, for example the UKCS. It is possible, where the context of legislation expressly demands it, for jurisdiction beyond the territorial sea to be inferred. The Nuclear Installations Act was not written with inshore application in mind and would require amendment to bring an inshore GDF within the licensing regime.

If nuclear site licensing is applicable, there appears no clear reason why licensing and regulating an inshore GDF would be different in principle to an onshore facility. The duty to reduce risks so far as reasonably practicable and the need for a safety case would be equally applicable.

7.4 Environmental Permitting

The Environmental Permitting (England and Wales) Regulations 2016 apply by regulation 1(3) to:

a) England and the sea adjacent to England out as far as the seaward boundary of the territorial sea; and

b) Wales, within the meaning given by section 158 of the Government of Wales Act 2006 (which defines Wales as including the sea adjacent to Wales out as far as the seaward boundary of the territorial sea).

There is accordingly a basis for regulating an inshore GDF.

7.5 Marine Licensing

The boreholes required for characterising geology will require a marine licence for the drilling activity in the marine inshore environment. An inshore facility may require licensing under the Marine and Coastal Access Act (MCA) 2009. Once the more detailed nature of an inshore GDF development is designed, consideration would need to be given to whether marine licences are required for the construction and use of a GDF.

In addition, the Marine Management Organisation (MMO), as regulator under the MCA 2009, will be an important consultee in the development consent process under the Planning Act 2008.

7.6 Other Aspects

Additional areas for consideration will include:

1 the Habitats Regulation Assessment (HRA), a scheme for the protection of wildlife habitats and species under the EU Habitats and Wild Birds Directives, which continues to apply under UK law, and

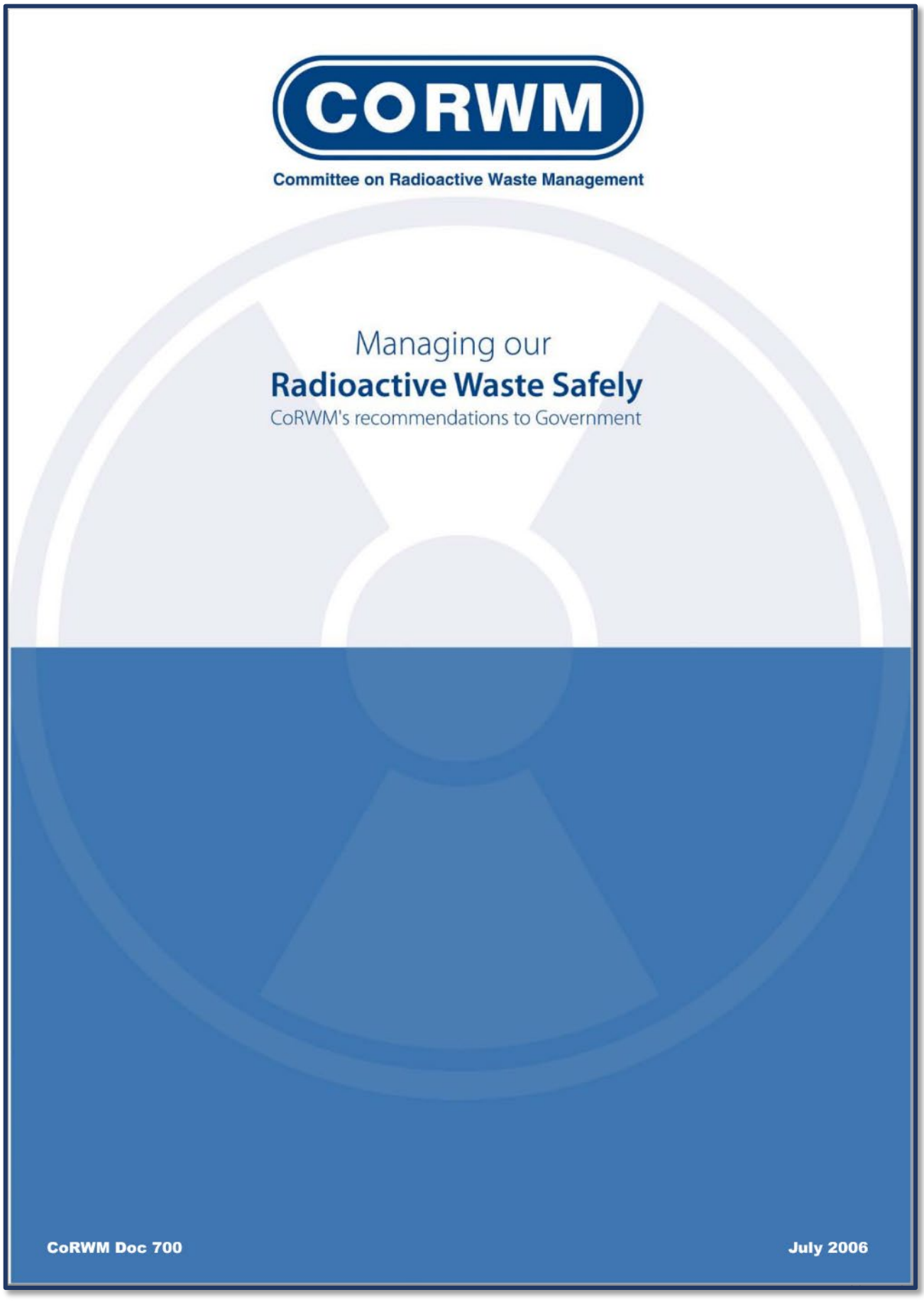
2 land & mineral rights ownership, including the consent of the Crown Estate, who are likely to have their own views on the terms and conditions of such consent.

8 Conclusions

CoRWM notes the recent and growing interest in the option of an inshore GDF, that is, a GDF with waste reception and access facilities on land and disposal vaults sited within a suitable geological formation located deep beneath the seabed.

CoRWM has concluded that an inshore GDF preserves the fundamental characteristics of deep geological disposal, as originally recommended by CoRWM, because it relies on the same multi-barrier approach to ensure long-term safety.

CoRWM has considered the economic, social, technical and legal implications of an inshore location for the delivery of a GDF and notes that there is at least the potential for an increase in cost relative to an onshore solution, some additional questions of public perception, and some unresolved legal uncertainties that would not arise in the case of an onshore GDF.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We welcome feedback on the content, clarity and presentation of CoRWM Reports.

Please do not hesitate to contact us if you would like to provide feedback or if you would like further information about radioactive waste management issues.

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