FRENCH LOW-LEVEL LONG-LIVED REPOSITORY PROJECT: ENSURING SUSTAINABILITY FROM THE EARLY STAGES

Sonia GUILLOT
Andra
Châtenay-Malabry, France
Email: sonia.guillot@andra.fr

Virginie WASSELIN
Andra
Châtenay-Malabry, France
Email: virginie.wasselin@andra.fr

Abstract

In France, Andra, the national agency for radioactive waste management, oversees the development of long-term solutions for all types of radioactive waste. Application of graded approach principles for Low Level-Long-Lived waste category disposal (i.e., for graphite and radium-bearing waste) raises specific environmental and safety concerns. For several years, Andra has been studying intermediate-depth repositories options, and a community in the Aube district (eastern France) has volunteered to host studies on its territory. At the current project “feasibility” stage, Andra decided to carry out an environmental diagnosis of the community to:

- Identify sectors with specific environmental values that should lead to their early exclusion of the sitting project;
- Collect data, structure, and analyse initial information on sectors sensitivity to give robustness to the “avoid/reduce/compensate” strategy;
- Pre-assess and analyse the possible impacts on environmental components (land use, water, air, biodiversity, landscape, economic activities including agriculture and forestry...) of a disposal facility from conception to post closure phase.

Linking safety and environmental studies at the earliest stage of project development helps to ensure robustness and to identify and specify project requirements in a holistic way. It also ensures that the project is built in line with sustainable development goals.

1. INTRODUCTION

Population and institutions are deeply concerned by radioactive waste disposal facilities safety and increasingly preoccupied by their environmental impacts on the territory.

At the heart of the environmental assessment process is the "Avoid, Reduce, and Compensate" sequence, which must be applied to all projects and at all stages of a project to reduce its impacts. (cf. art. L. 110-1, II, 2° of the French environmental code). The presentation of the "Avoid, Reduce, Compensate" approach is particularly important in impact studies and is a regulatory obligation in France. As a reminder, the article R.122-5, II, 8° of the environmental code prescribes to :

- avoid significant project adverse effects on the environment or human health and reduce effects that cannot be avoided;

- compensate, where possible, significant project adverse effects on the environment or human health that could not be avoided or sufficiently reduced. If it is not possible to compensate for these effects, the developer must justify this impossibility.

The inclusion of various environmental components such as biodiversity, land cover, greenhouse gases (GhG), human activities, water uses or even population way of life must be studied from the initial stages of the project to be able to take informed decisions and apply "avoidance" and "reduction" strategies to ensure the best project integration and sustainability approach in a specific area.

Practice has shown that the avoidance step is more effective when taken into account at a design stage and that considering environmental factors at a later stage creates more difficulties to set up strong avoidance and reduction actions. Indeed, if identified earlier, these issues can be addressed with a wider range of avoidance and mitigation solutions, and in some cases, this could have led to better social and environmental integration and even lower costs. The following study shows how with the aim of ensuring project safety it is also possible to consider environmental concerns, and how this concerted approach can result in a safer, more sustainable, and integrated project in the community.

After a short presentation of the project, the article will discuss about:

- How taking into account societal and environmental stakes at an early stage contributes to build a sustainable project;
- How the dialogue between safety and environmental teams is needed throughout the conception to ensure to obtain the project of less impact. The specificities of the environmental approach will be presented.

Moreover, we will explore how sustainable development goals of the United Nations are considered in the project, and how the approach, which integrates safety and environmental issues, contributes to these objectives.

2. LOW-LEVEL LONG-LIVED REPOSITORY PROJECT AND EARLY CONSIDERATION OF SOCIAL AND ENVIRONMENTAL ISSUES

2.1. Site selection

To meet France's radioactive waste disposal needs, a geological data review was conducted on French territory in the 1990s and early 2000s to identify areas that met the safety conditions defined by Andra and the French Nuclear Safety Authority (ASN). Geological data collected on argillaceous ground conducted to identify the most favourable areas following safety conditions (depth, wide, and regular natural impermeable layer). Additional safety factors included seismic activity, erosion, hydrogeology, human and environmental protection.

As a result of the assessment of these factors, a call for applications was sent to 3,115 communities to host safety, economic, environmental, and social studies on their territory. Forty-two of them showed initially an interest in hosting a centre or in carrying out field studies.

At the end of this process in 2013, a community in Aube district was identified to pursue the process. Near this community Andra already operates two facilities for Very Low-Level Waste VLLW and Low and Intermediate Level Waste Short Lived LILW-SL. These facilities are well implanted, accepted and participate to the territory economic development.

To characterise the area, the first step was to define a limited study area and conduct specific field studies to:

- Confirm the presence of the required safety conditions;
- Assess possible environmental risks within the area;
- Apply the “avoidance” part of the “avoid/reduce/compensate” strategy.

2.2. Aube district community, study area development

The first objective was in this territory to identify a limited study area based on safety and environmental data and exclude areas that did not meet safety standards.

In 2015, a geological field study was performed to determine the clay layer depth and condition under the community and identify sectors corresponding to the safety standards. The northern part was identified as corresponding to safety standard and the south part ruled out for a centre localisation (Fig. 1).

In addition, a hydrogeological study revealed the presence of artesian flows in the community western region, as a safety precautionary measure, the area has been ruled out as a potential host site. Other sectors were avoided based on safety and environmental parameters considered in this initial assessment:

- Avoiding towns with a 200 meters buffer around them to limit potential nuisance to local populations;
- Avoiding sheltered natural areas such as Natura 2000 in the community southern sector, given that Natura 2000 areas are of major ecological interest in Europe.

A technical constraint led to exclude another area in the eastern part because its surface was relatively small regarding the needs for a waste disposal centre.

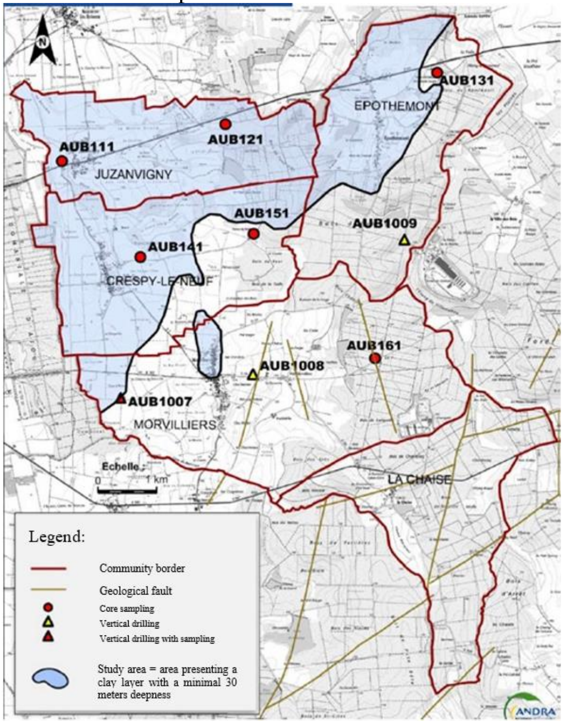

FIG. 1. Study aera and clay layer

Those combined parameters including social, environmental, safety and technical considerations, leaded to select the sector figured below (red area) (Fig. 2) as a potential host area, leaving hundreds of hectares to investigate.

3. CROSSING SAFETY AND ENVIRONMENTAL ISSUES AT AN EARLY STAGE

At this stage of definition of the implementation and the conception of the disposal facility taking into account safety and environmental issues enables to apply the avoidance step of the “avoidance, reduction” strategy fully.

The environmental stakes must therefore be considered to define the implementation of the centre.

3.1. Studies aeras

For this purpose, specific environmental study areas have been defined. The environmental study requires wider study areas than the blue zone defined in Figure 2 to anticipate any issues at the restricted study area borders (blue area). Moreover, to consider the global project and not only the repository centre, an additional area was defined as the expended area (green area) to study the potential issues linked to the centre supply and network needs (roads, rail terminal, energy, etc.). The environmental approach needs therefore to have wider aeras to cover the whole project.

Three study areas were defined:

- Restricted study area (indicated in red);
- Restricted study area with a 1 km buffer (indicated in blue);
- Expended area (indicated in green).

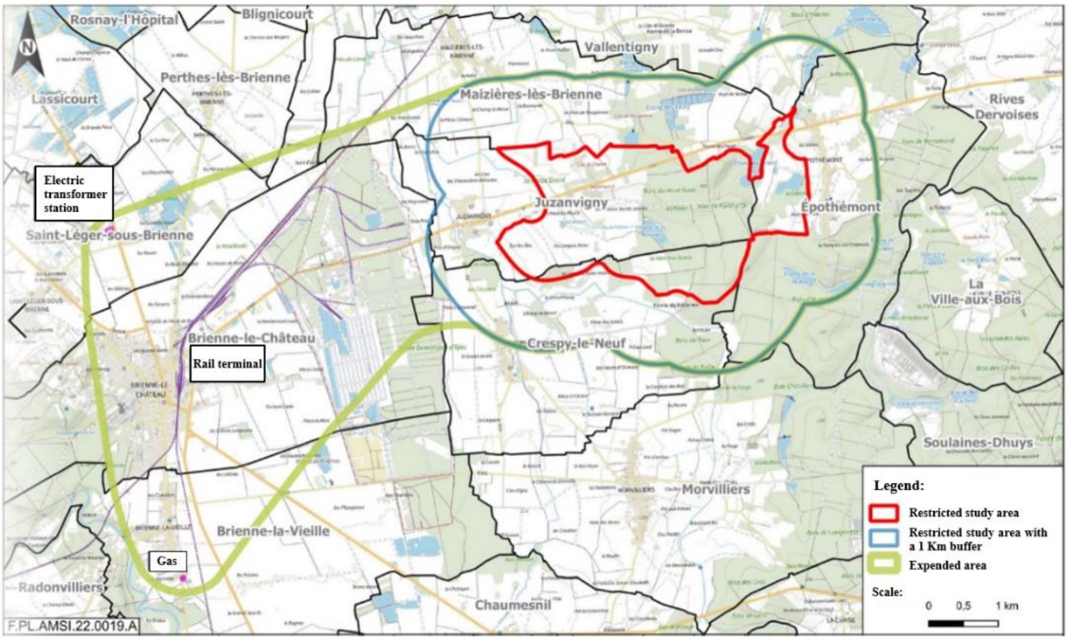

FIG. 2. Selected studies areas

3.2. Environmental components

Environmental components studied at this early stage are as varied as water (groundwater and surface water), geology, soil, biodiversity, population and territory, climate and air, landscape, economic activities (agriculture, forestry, tourism, etc.), infrastructures and networks, waste management, natural resources, technological risk, natural risk and cultural-historical-archaeological components.

Some of them are fully linked to safety concerns such as geology, water, technological and natural risks. However, the environmental approach looks at these criteria from a different perspective.

3.3. Concerted analysis

The environmental analysis is led with the team in charge of the facility's design. Data are required to be able to evaluate some environmental issues. On the other hand, the environmental analysis has an impact on the choices made for the centre implementation and conception features.

A dialogue is necessary throughout the conception stage to conceive a project of a lesser impact. For example, the centre's construction techniques (open-cast techniques, tunnel techniques, etc.) have very different impacts on the surface and therefore on the environment and need to be examined taking these aspects into account in addition to the economic, technical and safety aspects.

As an example of the investigation process, the following sections explain how the biodiversity and landscape studies were developed, conducted, and analysed to identify environmental issues in the territory and how identifying these risks helps to ensure safety and to develop a sustainable project.

4. BIODIVERSITY STUDY

4.1. Method

In a community characterised by a rural context (pastoral, agricultural and forestry lands), it was important to identify the local biodiversity systems. The aim was to obtain biodiversity data to describe the local biodiversity and to support project development decisions by identifying high biodiversity risks sectors.

Due to the extent of the area, it was not possible to apply the usual methods of investigation. In fact, it was impractical to undertake extensive fauna and flora inventories over hundreds of hectares. Furthermore, the biodiversity study also needed to include the ecological corridor and the wetland that crosses the area, so, a specific method was developed to identify and characterise local biodiversity.

Based on data from the regional biodiversity agency, wide ecological units were identified (agricultural lands, grasslands, forests, wetlands, etc.). All ecological units were described and classified by an ecological expert based on bibliographical data. The usual biodiversity linked to the different ecological units were identified and classified according to the presence or possible presence of species registered on endangered species lists (international, national, or local). Habitats and biodiversity knowledge provided an initial ranking of the ecological units and permitted to select areas to conduct on-site survey. Field visits allowed to assess the habitat qualities and helped improve ecological units ranking from higher to lower ecological values and vulnerability. To classify the habitat, various components were considered by the ecological expert such as:

- Proximity to protected or inventoried sectors (Natura 2000, ZNIEFF, etc.);
- Sectors importance for ecological connectivity;
- Overall habitat state and its importance for notable fauna;
- Wetlands presence or absence;
- Notable or protected plant species presence or absence;
- Sector representativeness on a local and regional scale.

4.2. Assessment and results

The study showed that only eight percent of the area was qualified as having a relatively high potential ecological risk, the identified area is close to the Natura 2000 site previously excluded. Fifty-four percent of the area was identified as having a relatively low ecological risk.

A map was developed to represent the identified territory issues (Fig. 3). The scale presented below is a scale to rate relatively the sectors of the studying area.

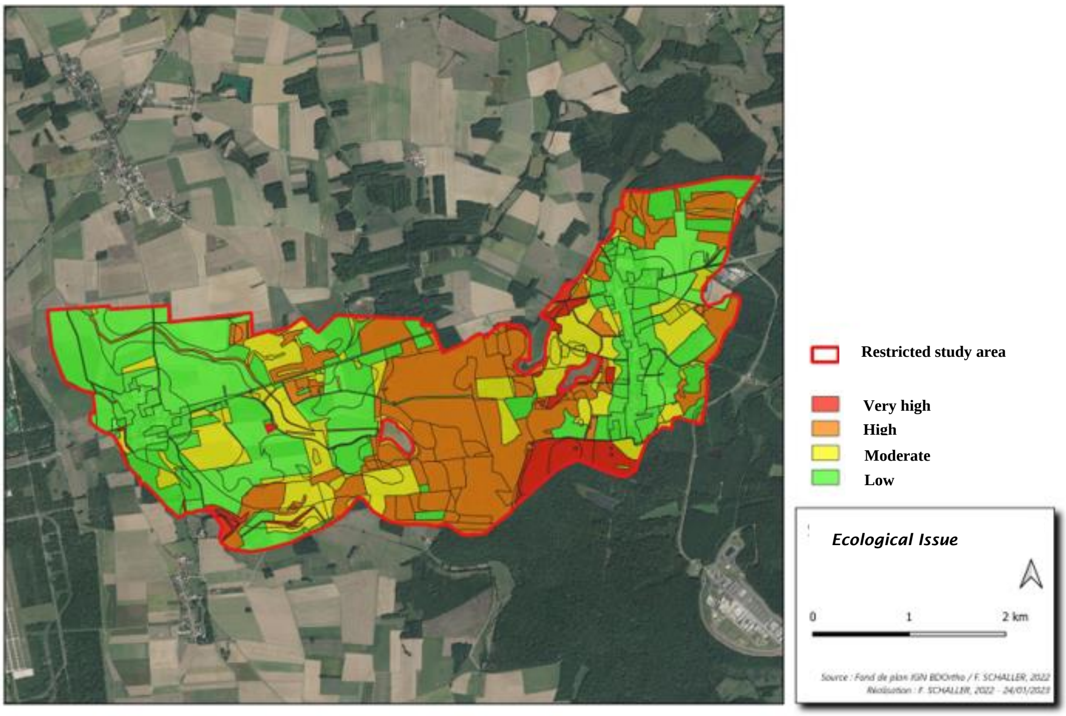

FIG. 3. Localisation and identification of local ecological stake level

5. LANDSCAPE STUDY

5.1. Method

Landscape is an environmental factor that depends on a variety of parameters such as topography, land cover and human settlements and activities. The study area is in a rural community where the population may have a strong attachment to the natural and rural environment. Two aspects were studied to identify likely landscape issues:

- Landscape features and qualities;
- Human perception and sensitivity to the landscape.

The aim was to identify within and around the restricted areas potential landscape issues for a centre location. The study was therefore undertaken in the three previously selected areas.

The landscape study method developed for the project consists of three steps: first a desk study using existing data, then a field study to specify some landscape elements, and finally a landscape assessment using data from the first two steps. For this study, it was necessary to define hypothetical locations and centre characteristics to test the centre landscape integration. The environment team worked with the design team to define some parameters of the potential future facility such as building height and floor area. Eight hypothetical locations were selected and studied to assess the possible landscape impacts. Potential views towards the centre locations were identified through a combined analysis of natural and anthropological factors. This enabled the development of a first map showing the possible views with issues from inhabited areas depending on the facility location

To confirm and complete the initial analysis, a field study was conducted by a landscape architect. This provided a more precise identification of the landscape's characteristics and qualities, and the identification of elements that could contribute to the project's landscape integration.

5.2. Assessment and results

Views and issues observed were characterised using photomontage prior to the application of the "avoid/reduce/compensate" strategy (Fig. 4). The photomontage illustrates that the centre could be visible from a significant distance on the photomontage right-hand side with a panoramic view towards the hypothetical site, while on the left-hand side a patch of vegetation could limit the views on the site.

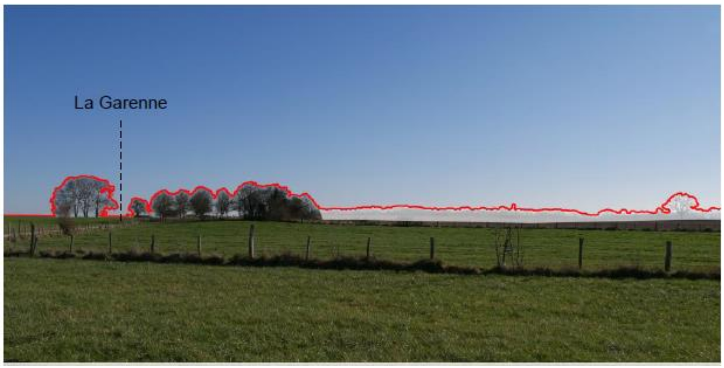

FIG. 4. Photomontage displaying the view from a village on the potential centre without the use of the "avoid/reduce/compensate" strategy.

A classification was made using a landscape dual assessment that considers both landscape quality and population potential landscape sensitivity. A map displaying the result exposed a conflict between population sensitivity and landscapes qualities (Fig. 5 FIG.). Indeed, a centre localised on the restricted study area left part (red dotted sector on Fig. 5), corresponding to agricultural lands can lead to population sensitivity issues because of open views from roads and villages. However, a centre localised on the restricted study area right part (yellow sector), inside a forest avoid population sensitivity risks but increase the risk of damaging qualitative landscapes. Furthermore, this area is also where the highest risks for biodiversity factor was identified (Fig. 3). To choose between a centre location on agricultural land or forest, other parameters need to be considered and local and regional stakeholders need to participate in this choice.

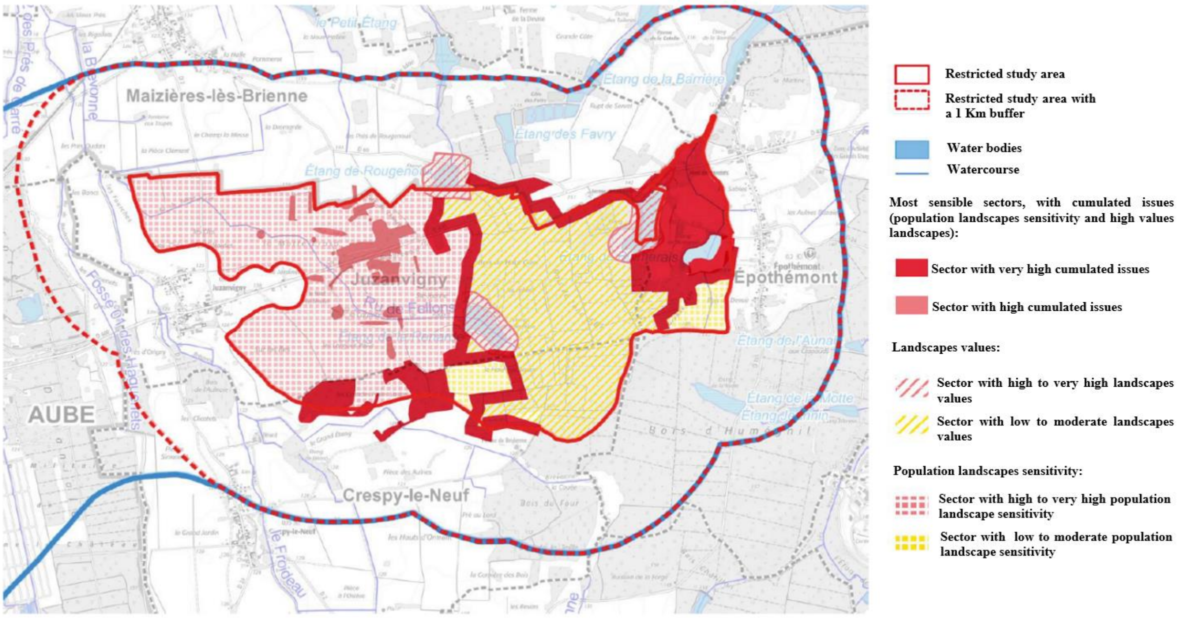

FIG. 5. Map displaying the risks linked to landscape quality and population sensitivity for a project hosted in the restricted area.

Landscape study conclusion provides preliminary recommendations to apply reduction actions such as:

- Using the local undulating topography to conceal tall infrastructure and store excavated soil;
- Using local vegetation as a cover;
- Matching structures height, shape, shade, and materials with the rural landscapes.

Thinking the facility integration from the conception stage allow to develop a long-term and sustainable landscape management plan from construction to closure phase. Some sustainability actions, like positioning the centre at the best location to limit or cancel the views cannot be implemented later and need to be integrated early on. Some landscape reduction actions may require years to reach full coverage capacity (e.g., vegetative cover) or they need to evolve over time according to the centre activities.

6. THE PROJECT AND THE SUSTAINABLE DEVELOPMENT GOALS

More than being satisfied in complying with regulatory frameworks, through combining safety, social and environmental concerns, the project is thought to be sustainable and integrated in the territory. In these aspects the project is in concord with the sustainable vision supported by the United Nations and promoted by the sustainable development goals (SDGs). The project development and its future effects can be linked to multiple SDGs like described in the following table.

TABLE 1. SOME PROJECT CONNECTIONS TO THE SDGS

Goal number	SDGs	Project actions linked to sustainable development
3	Good health and well-being	Ensure human, flora and fauna safety and protecting them from hazardous chemicals and air, water and soil pollution and contamination
8	Decent work and economic growth	Participate in the territorial economic development by improving or developing infrastructures, by creating work positions in rural areas and developing activities
9	Industry, innovation, and infrastructure	Developing sustainable infrastructures thank to innovation such as developing new technologies for a sustainable resources management

Goal number	SDGs	Project actions linked to sustainable development
11	Sustainable cities and communities	Avoid and help protect natural areas thank to environmental studies and the "avoid/reduce" strategy. Participate in regional and local sustainable planification by working with stakeholders
12	Responsible consumption and production	Plan a centre environnemental management plan. Raise awareness on environmental issues among agency teams and stakeholders
13	Climate action	In the further development of the project, one of the targets is to reduce the climate impact for example by developing the use of low-carbon materials
15	Life on land	The reduction of the project's right-of-way is an objective to limit the artificialization of land.

7. CONCLUSION

Andra applies a collaborative and systemic method to select a site for Low-Level Long-Lived Waste in an intermediate-depth repository centre ensuring safety and environmental sustainability. This study case showed a complementarity between safety and environmental considerations for protecting flora, fauna, and human's environment. Indeed, studying all the environmental factors described in the Environmental Impact Assessment Framework permitted to obtain a holistic understanding of the territory and to identify the factors presenting the highest issues risks. Moreover, this work allows to create links between Andra environmental, design and safety teams but also with local stakeholders.

Conducting an environmental assessment at a project early stage showed to be a long and iterative process to understand the territory specificities and risks linked to the project. But the macro safety and environmental assessment on the community, allowed in first place to exclude areas with identified risks and to define a study area to conduct specific field analysis. The study showed that the field investigations methods for each environmental component needed to be adapted to the wide area studied and the existing project elements at that time. This leaded the environment, safety, and design teams to develop an important co-operative work throughout the study.

The study demonstrated that even at an early stage it is possible to identify the principal environmental issues and to a certain extent apply the "avoid/reduce" strategy. But, when some factors risks are contradictory like landscape and biodiversity, other parameters such as local development strategies and stakeholders need to be included to take decisions adapted to the territory. The acquired knowledge is going to be used as entry data to realise a multicriteria (e.g., social, environmental, economic, technical, etc.) and multi-stakeholder analysis mainly by holding public consultations. This is to continue the host area selection process and to create a safe, sustainable, and integrated repository project.

From a national point of view, this project development matches the French government aims to promote safety and environmental sustainability in the national radioactive materials and waste management plan (2022-2026). This plan specifies that Andra needs to deliver a report concerning Low-Level Long-Lived waste category and their repository options. In that respect, Andra is creating a report summarising all the environmental and safety studies under a same document reporting the issues and risks associated to safety and environment factors that is going to be shared with the waste producers, local population, national, regional, and local government institutions. This report is going to be the basis for the ASN safety project validation. And for the agency this report is the base for working with the stakeholders and further refining the "avoid/reduce/compensate" strategy to develop an iterative and sustainable project.