Co-funded by the Walloon region

DI2.1.1 Deliverable – Archives and inventory report

Date: June 2021

SUBJECT:	...						
☒	report	☐	information	☐	consideration	☐	decision
To:	...			From:	ULiège and BGS		

Introduction

The site of Les Champs Jouault is an active landfill located in the Commune of Cuves, south of Manche Region, France. It is operational since April 6th, 2009 and it is authorized to collect and treat 75,000 tons of waste a year. Its activities are divided in four areas: collect and sort industrial waste, valorise recyclable materials and ensure treatment of non-hazardous final waste.

Site specifications

The site is divided in several waste cells -each covering more than 5000 m^2. When filled with waste, they are equipped with a leachate recirculation system and operated as a bioreactor. The operating rate is about one cell filled each year. In addition to sorting and valorisation of waste and biogas, Les Champs Jouault also recovers rainwater to create a wetland favourable to biodiversity. An aerial view of the site taken in 2019 is shown in Figure 1.

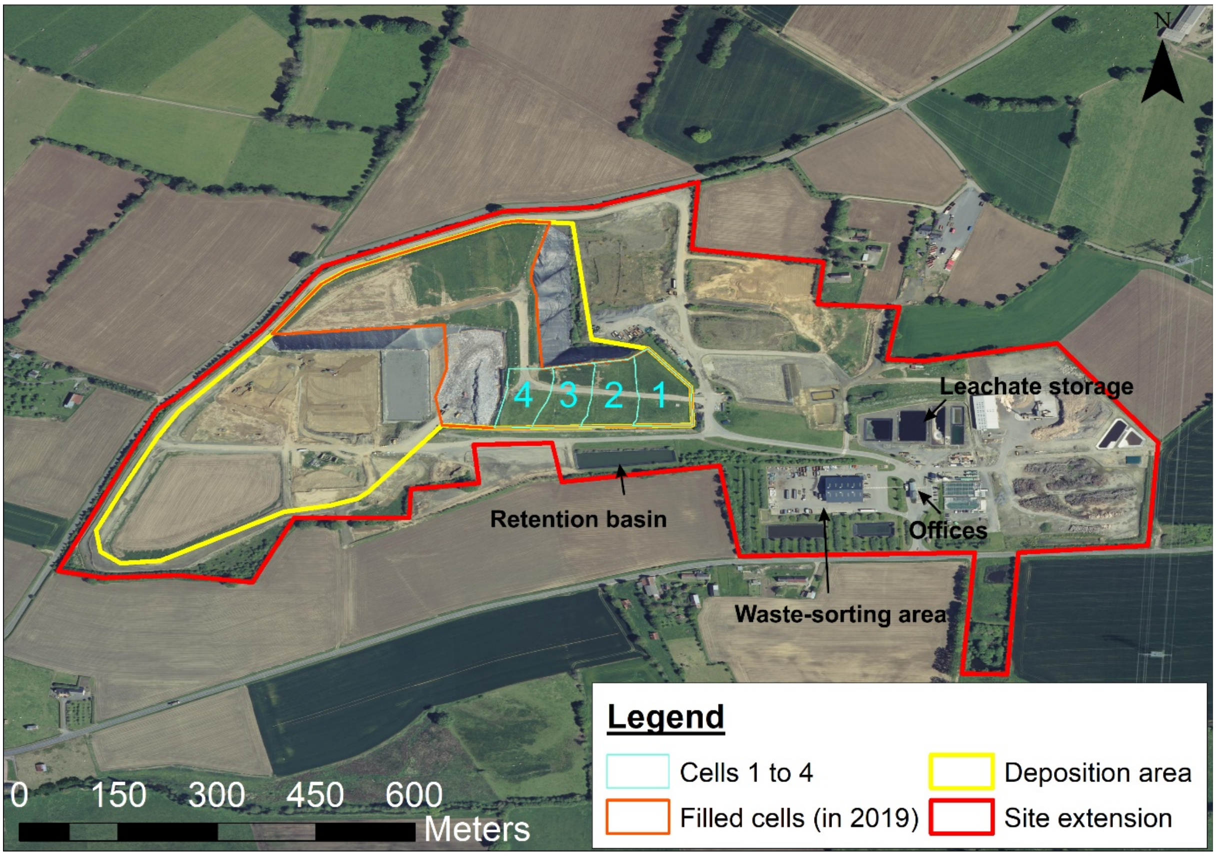

Figure 1: Extension of Les Champs Jouault landfill (red), delimitation of the waste deposition area (yellow), waste cells already filled (orange) and example of cells delimitation (cyan). The aerial view was taken in 2019. Image from Institut National géographique et forestière (IGN), France.

Before the landfill was created, the land consisted of fields and meadows. From a geological point of view, the site is built on top of non-carbonated loess and siltite/argillite/sandstone/grauwacke and conglomerates from the formation of Granville and La Laize (see Fig. 2).

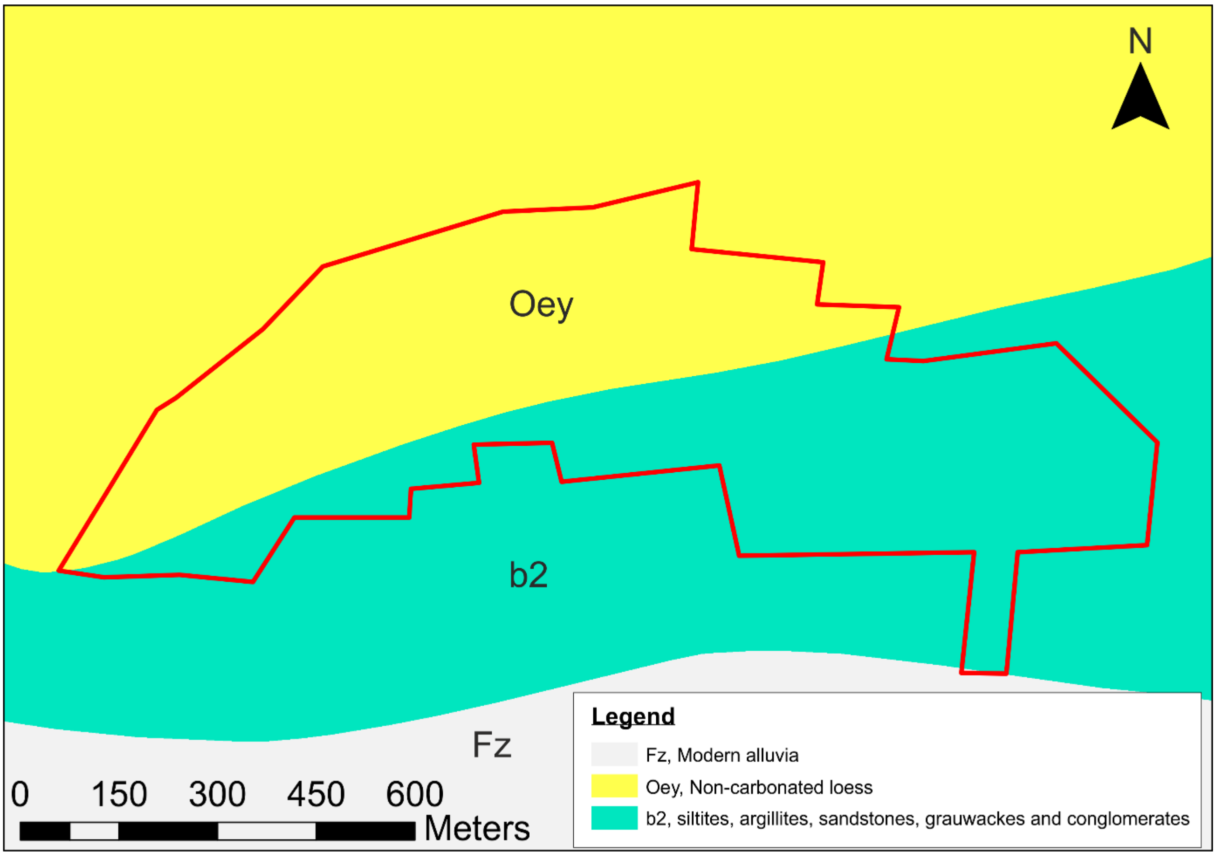

Figure 2: Geological map (from InfoTerre, 2020)

Structure of a cell

The plan of the extension of the cells is shown in Figure 1 (see yellow polygon). The cells are filled progressively starting from the southeast (cell 1). They are about 50 m wide and 100 m long for a thickness of wastes between 10 and 17 m. Information available from 2014 indicates that cells 1, 2, 3 and 4 (see cyan polygons in Figure 1) are mostly composed of industrial waste (60.7%, 47.2%, 42.4% and 43% respectively); although they also contain residual household waste and bulky waste. Recyclable materials are supposed to be removed from the waste streams by waste providers. In 2019, cells 1-10 and 13-14 were already filled and sealed (see orange polygon in Fig. 1). The sealing is made with a geomembrane combined with a 0.5 m bentonite layer to ensure that no leachate can reach the geological host. One piezometer per cell is used to show water saturation within the waste body. For the recirculation, leachate is injected approximately every 3 months on top of the waste materials through horizontal tubes grouted over a length of 6-8 m.
The vertical structure of a cell is composed of distinct layers as illustrated in Figure 3. The layering of the cells comprises from top to bottom a 1 m of soil cover overlaying a 10-15 m thick layer of waste. The bottom of the cells consists of a 0.5 m layer of draining materials.

To maximize biogas extraction and to reduce environmental risk, the whole cell structure is double sealed with a clay layer acting as a passive barrier and a HDPE geomembrane as an active barrier (see Fig. 3A).

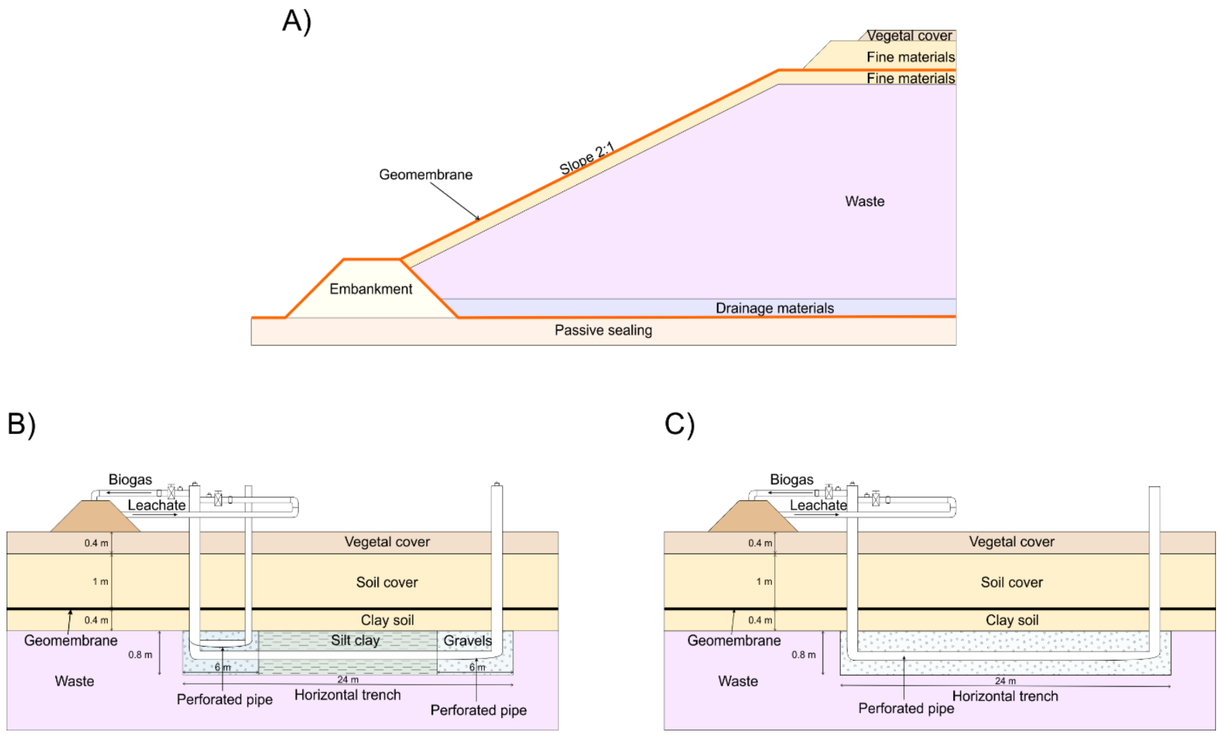

Figure 3: General cross-section of a cell in Les Champs Jouault (A) (modified from Grossin-Debattista et al. 2014), biogas extraction and leachate recirculation systems in cells 3 (B) and 4 (C). The same pipes are used for biogas extraction and leachate injection (modified from Audebert et al. 2016).

For the biogas extraction and leachate recirculation, pipes are embedded in gravel-filled trenches along the top of the waste layer. An example of the circulation system implemented in cells 2 and 3 is provided in Figure 3B and C, respectively. Figure 4 shows the setup as it can be observed at the surface.

Figure 4: Gas extraction and leachate recirculation system implemented in the landfill.

Existing sensor network

As part of a collaboration between « La société SAS Les Champs Jouault », the university of Caen, the society ACOME and 2 research units of IRSTEA, several cells of the landfill were equipped with sensors. These include:

- in cell 3, three lines of 24 stainless steel electrodes for electrical resistivity tomography (ERT) and induced polarisation (IP) installed in November 2011 below the HDPE geomembrane in three trenches dug in the clay layer just above the waste (Figs. 5A and 6);
- in cell 4, three lines of 24 electrodes installed in October 2012 below the HDPE geomembrane in three trenches dug in the clay layer above the waste and one line of 24 electrodes at the base of the waste deposit (Fig. 6);
- fibre-optic cables for temperature monitoring in cell 4 (Fig.5B);
- a meteorological station on top of cell 3;
- a biogas flowmeter in cell 4;
- Aquaflex soil moisture sensors in cell 4;
- ERT line within the waste body (with automated time-lapse monitoring) in cells 8 and 9.

Short-term and long-term experiments were setup. Short-term experiments involved the monitoring of leachate injection in cells 3 and 4 with ERT and IP. Results showed that leachate injection could be optimized by better design of the PVC strand perforations. The long-term measurements aimed to demonstrate the rates of biodegradation in the cells. A large dataset was obtained, containing much information that is difficult to interpret as many parameters can have an impact on the observed long-term signatures. We refer to Grossin-Debattista et al. (2014), Audebert (2015) and Jouen (2018) for more details about the setup implemented and the results obtained.

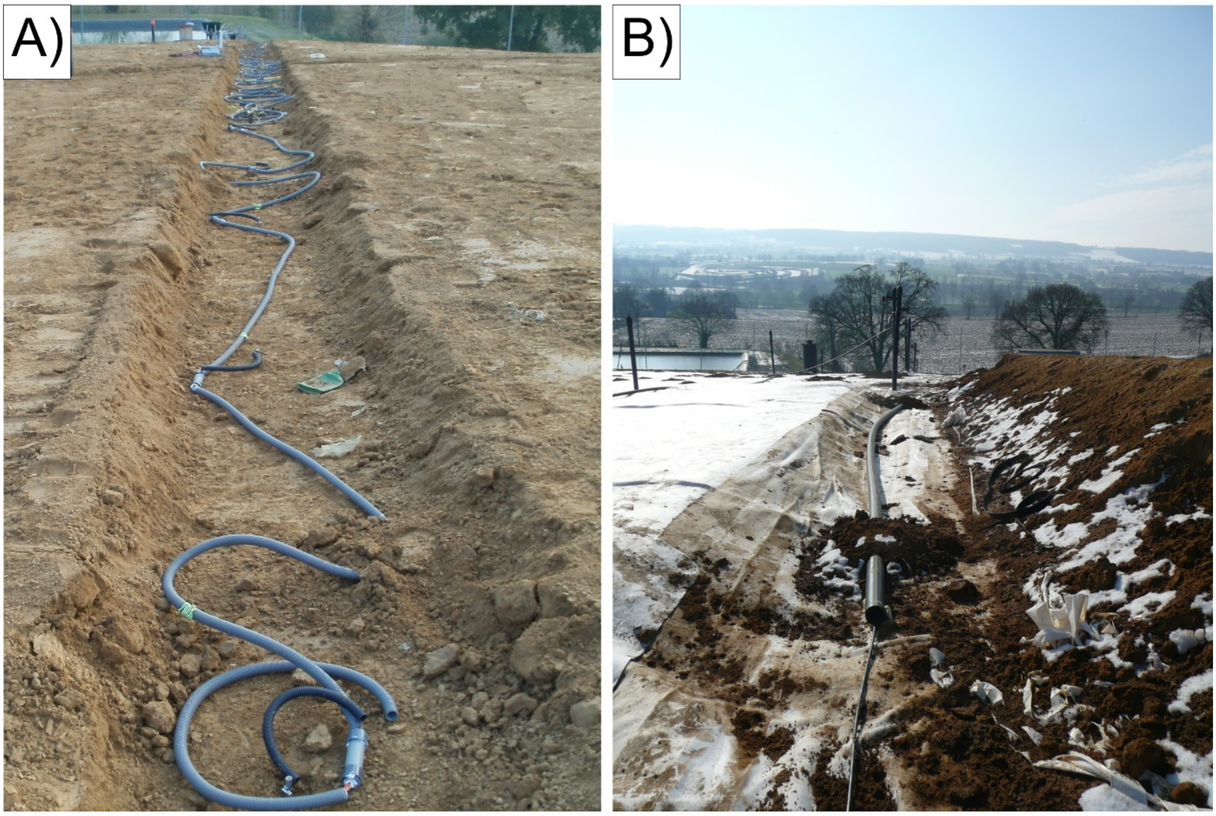

Figure 5: A) Installation of the electrodes in cell 3 and B) Installation of optical fibre cable for temperature monitoring (Grossin-Debattista et al. 2014)

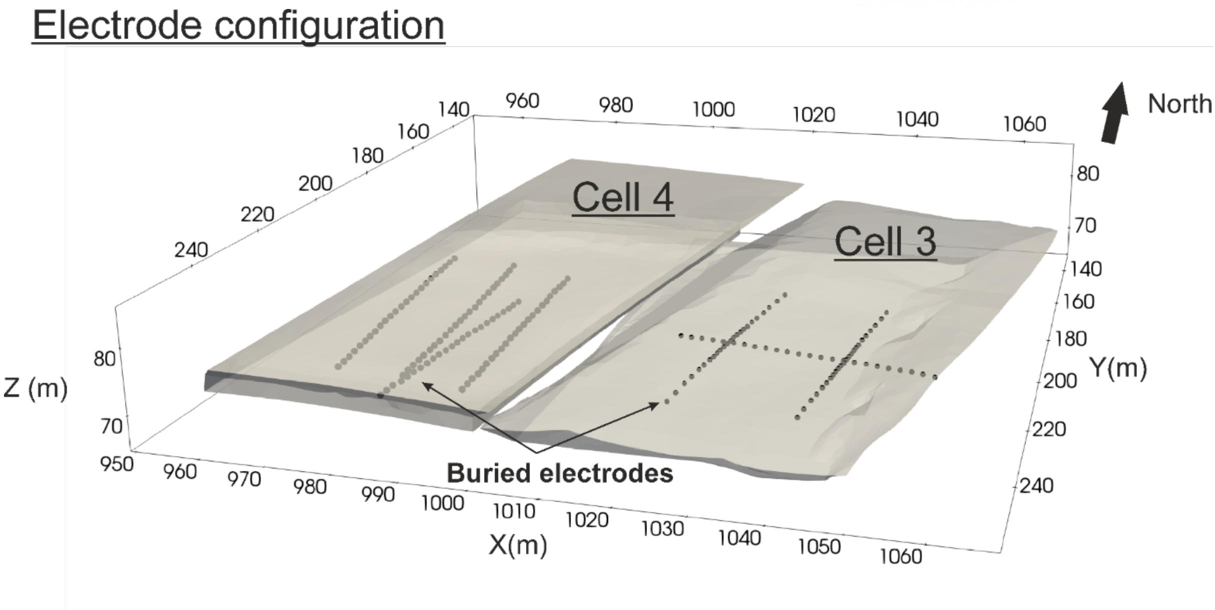

Figure 6: Electrodes configuration in cells 3 and 4.

Zones of interest for the geophysical survey

From the data collected, it appears that the most interesting cells to investigate in the scope of RAWFILL are cells 1 to 4. Firstly, because these are the oldest cells present in the landfill (see closure dates in table 1). We can therefore assume that some level of mineralisation has already occurred in each cell. As they were sealed at different times, they should nevertheless show different levels of mineralisation, which is a good opportunity to check whether such a contrast can be detected by geophysical methods. A second reason for concentrating the investigations in cells 1 to 4 is related to the different waste compositions of the cells which may result in a different geophysical signature (see Fig. 8). For example, cell 1 is of interest because it contains more industrial waste compared to the other cells. While cells 2 and 3 are rather similar in terms of composition, cell 4 contains mainly only 3 types of waste (i.e., industrial, household and bulky wastes). In that, it differs from the other cells which contain a non-negligible amount of contaminated soil or shredder residue. This discrepancy may also lead to a geophysical contrast.

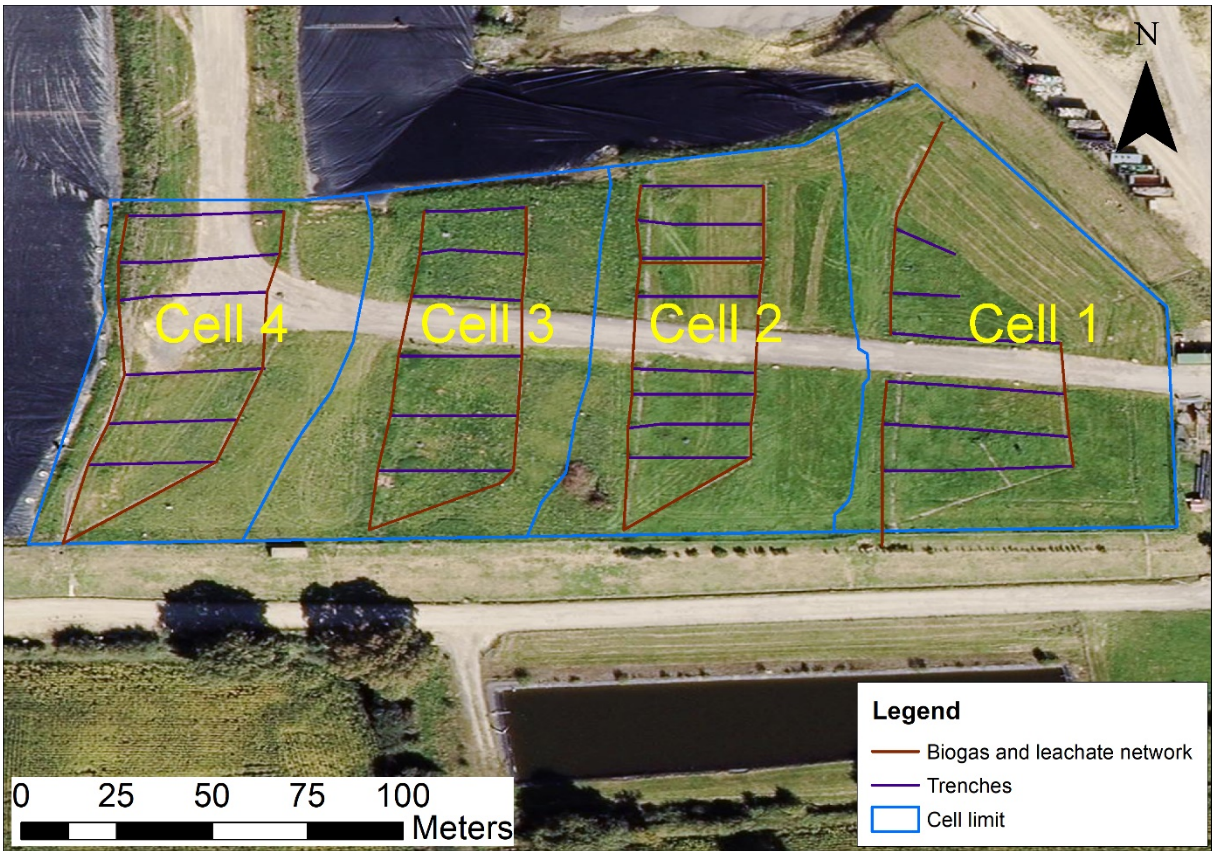

Figure 5: Cells 1 to 4 with the biogas extraction and leachate recirculation networks.

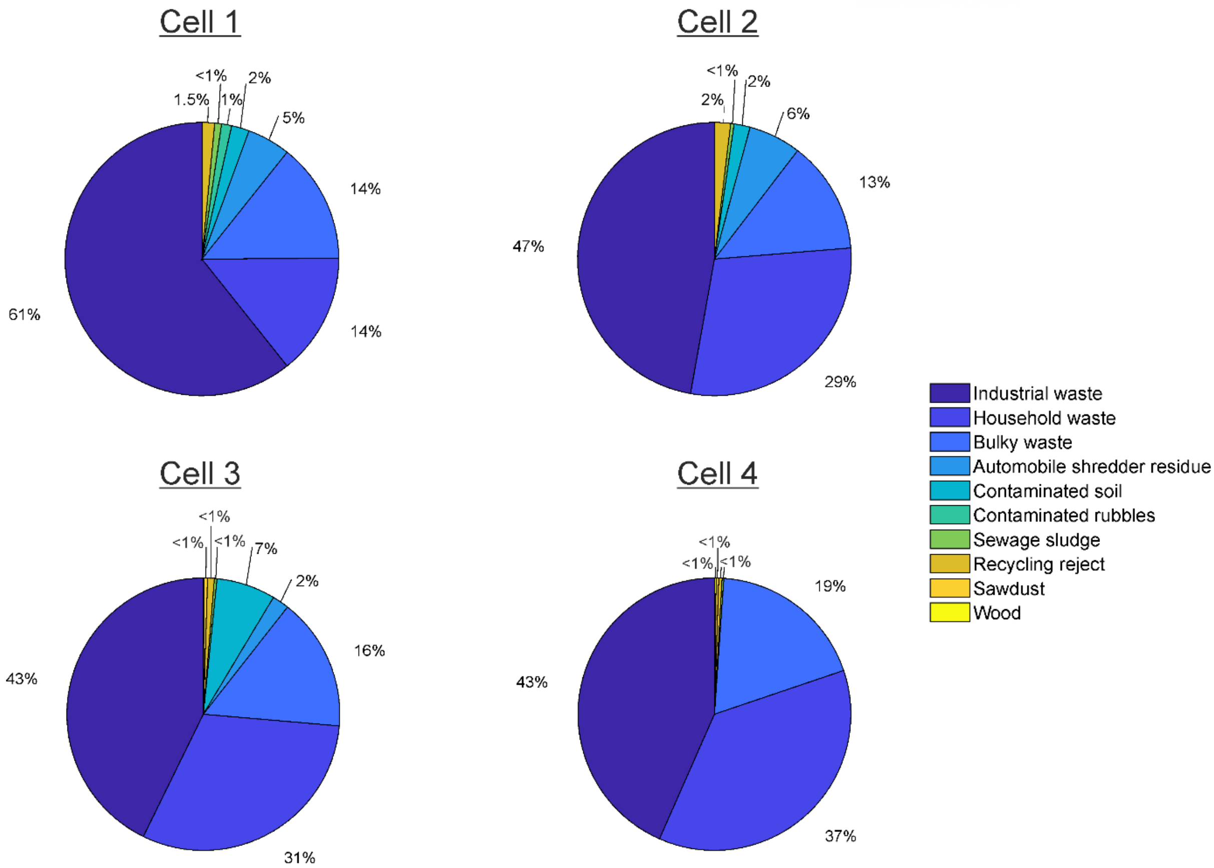

Figure 6: Distribution of waste stored in cells 1 to 4.

Table 1: Summary of main characteristics of cells 1 to 4.

	Cell 1	**Cell 2**	**Cell 3**	**Cell 4**
Start date	April 2009	April 2010	January 2011	September 2011
End date	April 2010	January 2011	September 2011	July 2012
Mass of waste stored (in Tons)	36043	50385	61331	64333
Area (m²)	3404	4304	4302	4306
Geophysical instrumentation (IRSTEA)	/	/	ERT/IP (3 lines)	- ERT/IP (4 lines) - 4 optical fibres - 15 thermistors - 4 resistivity rakes

Additional data available

Here below, we list the additional data that are available (or easily available) to help setting up the geophysical survey or interpret the data collected:

- detailed extension maps and construction plans of all cells;
- topographic data is measured every 2 months;
- volumes and density of each cell (measured just after compaction);
- aerial photographs of the site taken with a drone;
- for cells 1 & 2, biogas of individual pipes can be analysed separately with the possibility of indicating heterogeneity in waste composition;
- the amount of leachate per injection point is available but leachate extraction is only known as an overall quantity;
- leachate can be collected from each cell using the installed piezometers.

Site photos

We illustrate below the site of Les Champs Jouault with several photographs taken during the site visit that took place on August 29, 2017.

Figure 7: View from the entrance view towards cells 1 to 4 (view in SW direction)

Figure 8: View from cell 4 back onto cells 3, 2, 1 (view towards NE)

Figure 9: View from cell 4 back onto cells 3, 2, 1 (view towards N)

Figure 11: SE edge from cell 4, view towards cellst 8 and 9 in NW-direction

Figure 10: NW edge of cells 2 and 3 (view towards NE)

Figure 12: SE edge from cells 1, 2, 3 and 4 (view towards SW)

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