Excavated soil reuse tools developed as part of the French soil management framework

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REUSE OF EXCAVATED SOILS / TOOLS DEVELOPED AS PART OF THE FRENCH SOIL MANAGEMENT FRAMEWORK

ABSTRACT

Following the revision and transposition of the EU Waste Framework Directive into the French legal framework, it has been essential to define guidance and methods for sustainable reuse of excavated soils which would ensure human health and environmental protection. One provision of the European Directive sets that excavated soils that are not reused on site should be considered as waste and managed as such under national policies. In order to clarify these rules and provide stakeholders with a common operational framework, the French Ministry for Environment called upon BRGM and INERIS to draft a guidance for the reuse of excavated soils in off-site locations (i.e. within road construction, or development projects) and to develop the necessary tools for its implementation at local / regional scale. Following a review of European countries practice in this field, methodological tools have been developed with the support of working groups which included a wide range of stakeholders (professional unions, environmental protection association, planners, lawyers, etc.). The tools are now freely available from the French Portal for contaminated land management (http://www.developpement-durable.gouv.fr/Guide-de-reutilisation-hors-site.html).

After a short presentation on the French Soil management framework, its aims and the general scheme, this paper will focus on the tools that have been developed in support to the implementation program.

The first developed tool is Hydrotex. It is used for groundwater risk assessments. It enables to assess whether the reuse of excavated soils in a specific off-site location will affect or not groundwater resource quality. Using the Hydrotex spreadsheet, a specific groundwater concentration is calculated from the excavated soil concentration. This concentration is determined for each off-site receiver site and for each substance of concern at the groundwater target to be protected.

To keep track of the excavated soils quality and their reuse, an information traceability system is implemented using the TERRASS database which is an interactive tool, available online. These traceability measures will allow for the monitoring of excavated soil volumes from a producer site to a receiver site. The receiver site can be a transit hub / cluster, a treatment center or directly a receiver site (for a development project or road construction). The database will also provide indicators.

Keywords: excavated soil reuse, French methodology, risk assessment, guidelines values

1. INTRODUCTION

While urban planning, developers often have to deal with abandoned, vacant or underused properties. Urban development projects mainly include mixed-use, residential, commercial or industrial developments served by urban infrastructures such as roads, pavements, and sometimes public open space such as urban open spaces, urban parks or gardens. One of the major problems that urban planners have to deal with is the discovery of contamination, whether on large or limited scale.

EU Waste Framework Directive (WFD) has defined as waste all excavated soil that will not be reused on the site from which it was excavated. Therefore, urban planners need to address issues such as remedial treatments and/or off-site disposal (e.g. to landfill) for their backfill, characterized by potentially huge volumes and highly variable quality, with all the waste management requirements. [1] [2]

The French contaminated soil management framework, updated in 2007 [3] [4], is based on a site specific risk assessment linked to the current use (or proposed use if it is already determined) of the site and does not provide any generic guidelines values (cf. Fig.1). Its aims are to ensure a high level of protection for the environment and public health by two main procedures based on the use of the site:

- If uses are still to be decided upon or the state of the environment can be improved, one should remediate the site and develop a Remediation Management Plan (RMP) to restore compatibility between uses and environmental background quality.
- If the future uses of the site have already been decided, one should determine whether this use is compatible with the state of the environment (Media Quality Assessment (MQA)) and depending on the results, this might lead to simple measures or a management plan.

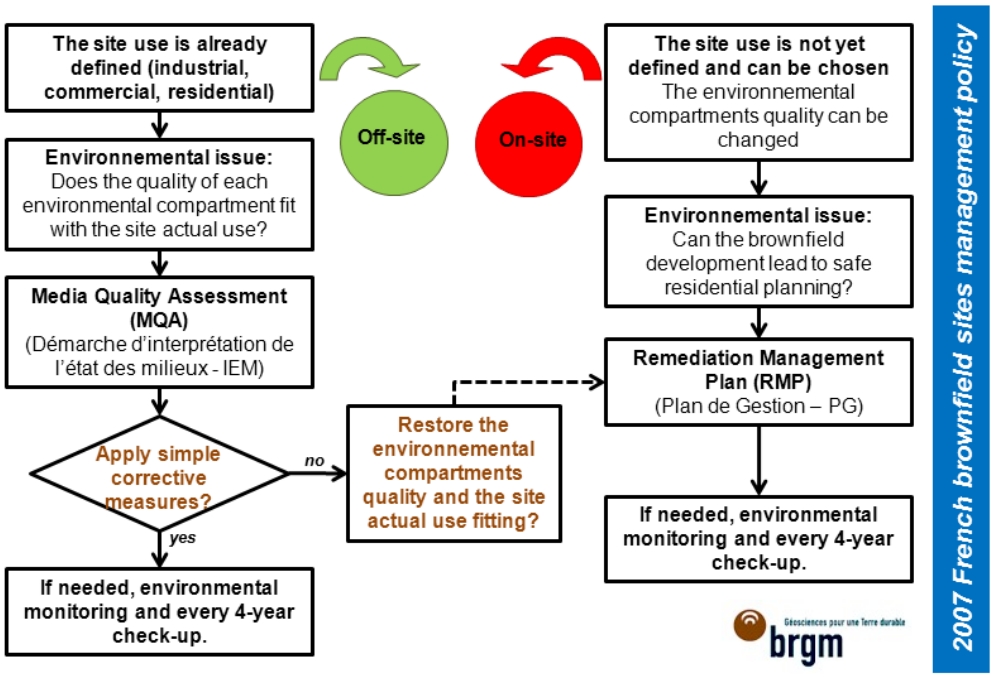

Fig. 1: The 2 main approach of 2007 French brownfield sites management policy

Source: [3].

Remediation techniques include reuse of contaminated soil on-site as part of a management plan solution but if on-site reuse is not possible in the redevelopment project, contaminated soil is actually disposed of at licensed landfill sites according to their quality.

Thus, actually most excavated contaminated soil that cannot be reused or treated on site due to site size constraints is disposed in licensed landfills, while the Waste Framework Directive also aims at European countries avoiding waste generation and to use waste as a

resource (recycling). Considering present difficulties for a waste treatment establishment to obtain a permit and the speed with which landfill voids get filled, a practical but secure way of reusing marginally contaminated soil needs to be defined in such way as to be flexible enough for all site applications, while ensuring a high level of protection for the environment and public health.

Therefore, the French Environment Ministry asked INERIS and BRGM, the two leading bodies for, respectively, health risk assessment and contaminated sites management, to write a Code of Practice that sets out all the necessary measures to ensure that the off-site reuse of marginally contaminated soil is carried out without endangering human health, or harming the environment. These methodological tools have been developed with the support of working groups composed of a wide range of stakeholders in this field (professional unions, environmental protection association, planners, lawyers ...).

Practical tools have been set up, on one hand, to ensure a high level of protection for the environment and public health and, on the other hand, to monitor the soil reuse activities, store the data and fulfill the need of material reuse traceability.

First, the following section will present the guidelines defined into the Code of Practice published on the French Environment ministry website. [5] Then the two next sections will focus on the two major tools: Hydrotex, the aim of which is to check the potential impact of contaminated soil reuse on groundwater resources [6] and TERRASS, the database and web application that will store all the data and keep track of all the contaminated soil reuse over the French metropolitan territory.

2. GUIDELINES FOR OFF-SITE REUSE OF MARGINALLY CONTAMINATED EXCAVATED SOIL

2.1. OBJECT AND GENERAL APPROACH

2.1.1. WHICH SITE AND EXCAVATED SOIL ARE CONCERNED?

The French methodology for the off-site reuse of marginally contaminated soil is completely integrated to the 2007 French brownfield sites management policy. [3] [4] Therefore, only soil excavated from a contaminated site that comes under the 2007 French brownfield sites management policy is likely to be reuse off-site. This means that it must have been through the first step of site characterization which concludes that the site is likely to be contaminated. The first step of site characterization includes a historic, memorial and documentary study that could be completed by on-site specific sampling and analysis.

That kind of site will now be referred as ***"producer site"*** and its marginally contaminated soil which is likely to be reused will be now referred just as ***"excavated soil".*** The site on which the soil, excavated from the producer site, is likely to be reused will be now referred as a ***"receiver site"***.

Concerning waste management liabilities, the excavated soil producer and the re-user share responsibility jointly as far as the excavated soil producer is responsible of its excavated soils quality and the re-user responsible for the check of the fit-for use on the receiver site.

2.1.2. MARGINALLY CONTAMINATED SOIL REUSE GENERAL APPROACH

The off-site reuse of excavated soil is based on a quality assessment (i.e. identification of contaminants and their concentrations through laboratory analysis) and soil classification that define which pathways can lead to optimal and authorized reuse (cf. Fig.2).

Therefore, excavated soils are characterized by looking for the pollutants that are the most likely to be found depending on the past known or supposed activities on site. This chemical characterization enables the owner (or its environmental analyst) to classify excavated soil into 3 categories:

- Natural excavated soil: the characteristics of which are similar to the known environmental background soil quality. This kind of excavated soil found on some parts of a contaminated site should be reused without any constraints on a nearby site (within a 30 km distance);
- Hazardous excavated soil (considered as hazardous waste): which cannot be reused without treatment that remove the contamination down to a non hazardous status. The hazardous status is defined by the French waste legislation (according to the EU Waste Framework Directive transposition). Thus non treated hazardous excavated soils are to be disposed of at specific licensed landfills for hazardous waste;
- Contaminated excavated soil can be called reusable, or marginally contaminated excavated soil, if their quality, with or without treatment, fulfills the requirements for the chosen reuse target presented below. If no reuse possibility can be found or defined after a cost/advantage study, it can be disposed of at licensed landfills for non-hazardous waste or, possibly, at transit hub/clusters or treatment centers. The guidance and tools, developed the French environment ministry, BRGM and INERIS and that are presented below, only concern these marginally contaminated excavated soils that will be now referred just as ***"excavated soil"***.

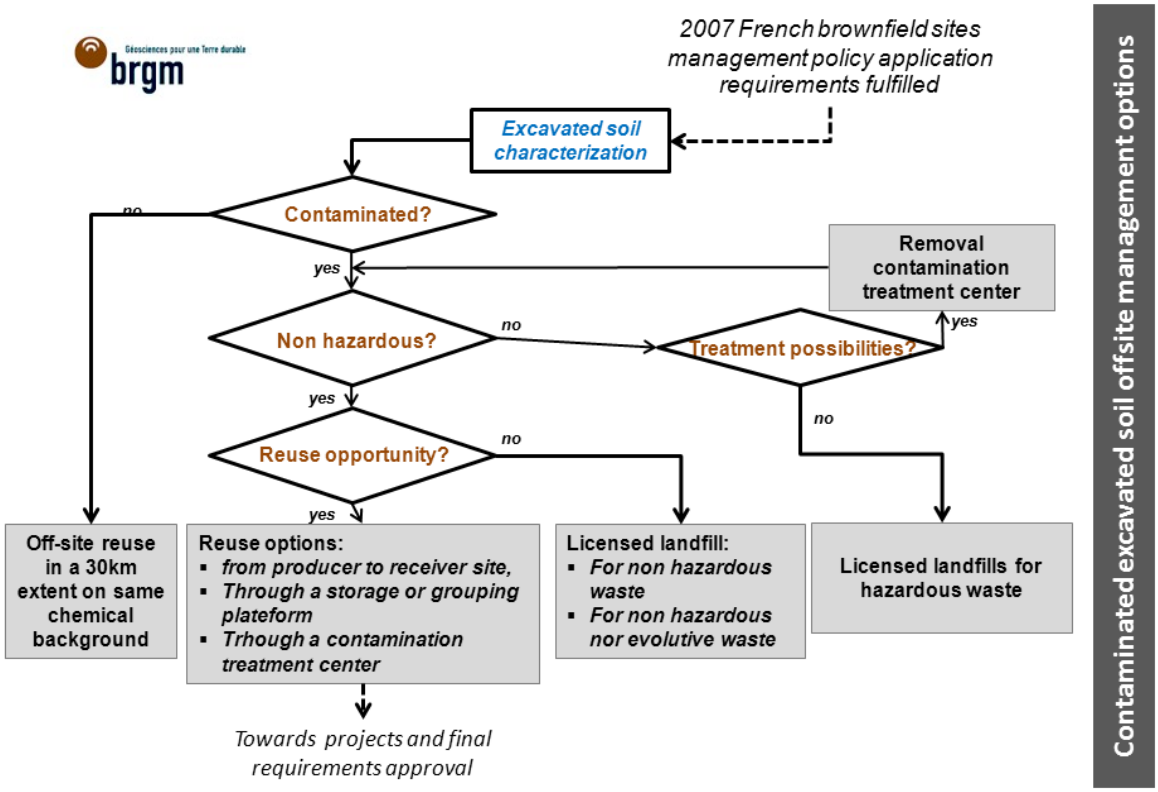

Fig. 2: Contaminated excavated soil off-site management options

Source: [5].

2.2. ENVIRONMENT PROTECTION AND HUMAN HEALTH RISK ASSESSMENT

2.2.1. REUSE TARGETS

Excavated soils can be reused within two domains:

- road construction according to the French national requirements;
- development projects for which a permit shall be granted by the competent authorities (for building, urban planning or in case of environmental impact risk assessment, according to the French urban or environmental legislation).

Road construction

Excavated soils can be used for all permanent road structures (embankments, general fill, etc.) as far as they are not in contact with, by any means, drainage or water control systems (cf. Fig3). The two following requirements shall be fulfilled:

- soil quality on the receiver site shall not be degraded (standstill policy);
- groundwater quality and aquatic ecosystems shall not be degraded.

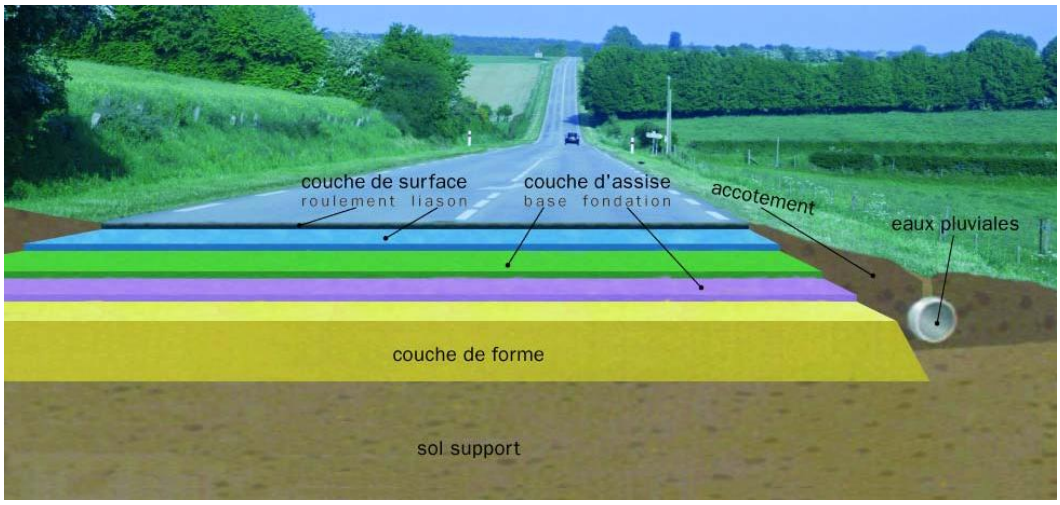

Fig. 3: Permanent road structures on which contaminated excavated soil can be reused

Source: [7].

Development projects

Excavated soils can be used:

- under buildings dedicated to offices, commercial or industrial uses; use under housing is strictly forbidden;
- for public urban park or garden as far as they are covered by at least 30 cm of non-contaminated materials; use under private gardens is strictly forbidden;

Reuse conditions for development projects are described on the following scheme (cf. Fig.4):

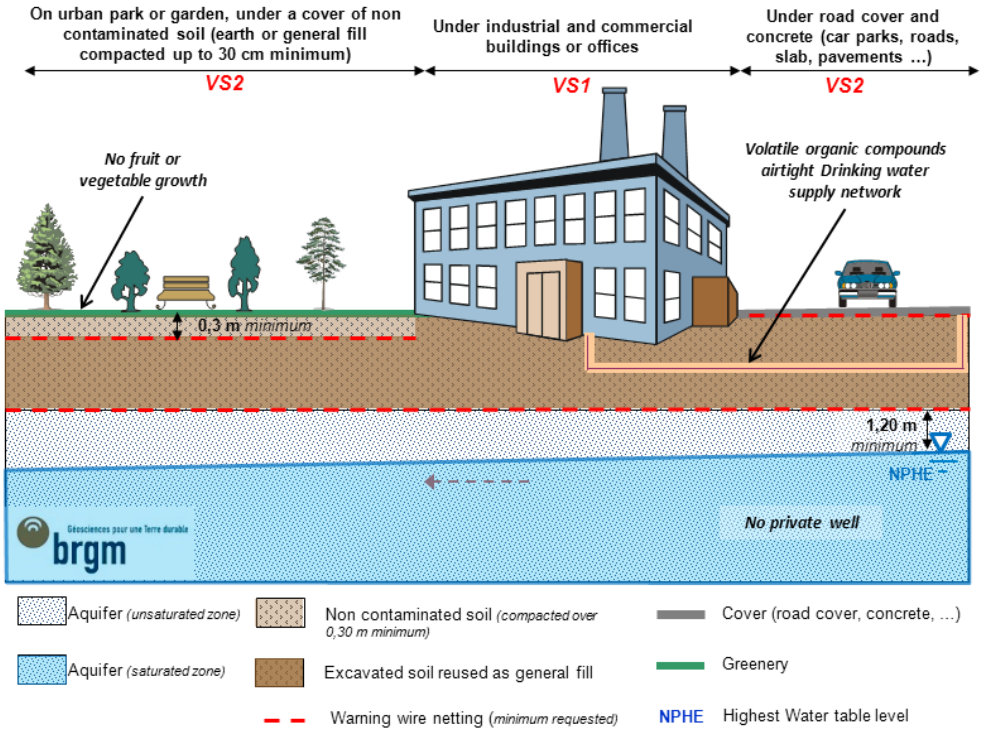

Fig. 4: example of excavated soil possible reuses in development projects

Source: [5].

The three following requirements shall be fulfilled:

- soil quality on the receiver site shall not be degraded (standstill policy);
- groundwater quality and aquatic ecosystems shall not be degraded;
- excavated soil quality shall not endanger human health regarding to the chosen use (under building or under gardens and covers) according to a specific site use risk assessment.

2.2.2. APPROVAL PROCEDURE AND TRACEABILITY

Reusable excavated soils can only be reused if the following criteria are respected according to the concerned domains of reuse.

Requirement 1: soil quality on the receiver site shall not be degraded (standstill policy)

Reusable soil quality should not degrade the receiver soil quality. Therefore the receiver site should also be characterized: the pollutants, detected in the reusable soil should be looked for on the receiver site ground, and each pollutant concentration should be lower in the reusable soil than in the receiver site ground.

Requirement 2: groundwater quality and aquatic ecosystems shall not be degraded

This requirement is based on a list of geographic constraints that should allow, or not, excavated soil reuse (i.e. absence of environmentally protected areas, distance to a river and surface water elements, depth of underground water table, etc.)

But the main and consequent criteria is the result of the Hydrotex risk assessment which aim is to check that the off-site reuse of excavated soil does not affect the groundwater resource quality, considering leachability and permeability of the in-situ and imported soils. The provided tool, Hydrotex, is presented in the next section.

Requirement 3: excavated soil quality shall not endanger human health regarding to the chosen use – fulfillment of this requirement is only requested for development projects

The excavated soil characterization leads to the discovery of some pollutant that might have an impact on human health. Therefore a human risk assessment is needed. Threshold values VS (for French "Valeurs Seuils") have been defined for the most common pollutants considering the two kinds of excavated soil possible use in development projects:

- Use under commercial and industrial building and office: Threshold values VS1 ;
- Use under cover (road, garden): Threshold values VS2.

These VS1 and VS2 values are based on a complete human health risk assessment managed by INERIS the French leading body for health risk assessment. [5] [8]

If the pollutants detected in reusable excavated soil do not have threshold values, a specific human health risk assessment is required and should be calculated by using the methods, parameters and values given into the guidelines document (annex 4) in order to keep its homogeneity with threshold values.

These requirements are cumulative and independent. They must be completely and totally fulfilled, according to the receiver site use, in order to proceed with the process of excavated soil off-site reuse (cf. Fig.5).

This process will be completely recorded into a specifically developed database that is available on-line through a web platform. This database is called TERRASS (French acronym for "Terres Excavées Réutilisées de façon Raisonnée dans des Aménagements en Sous-Structures") and is presented in the last section.

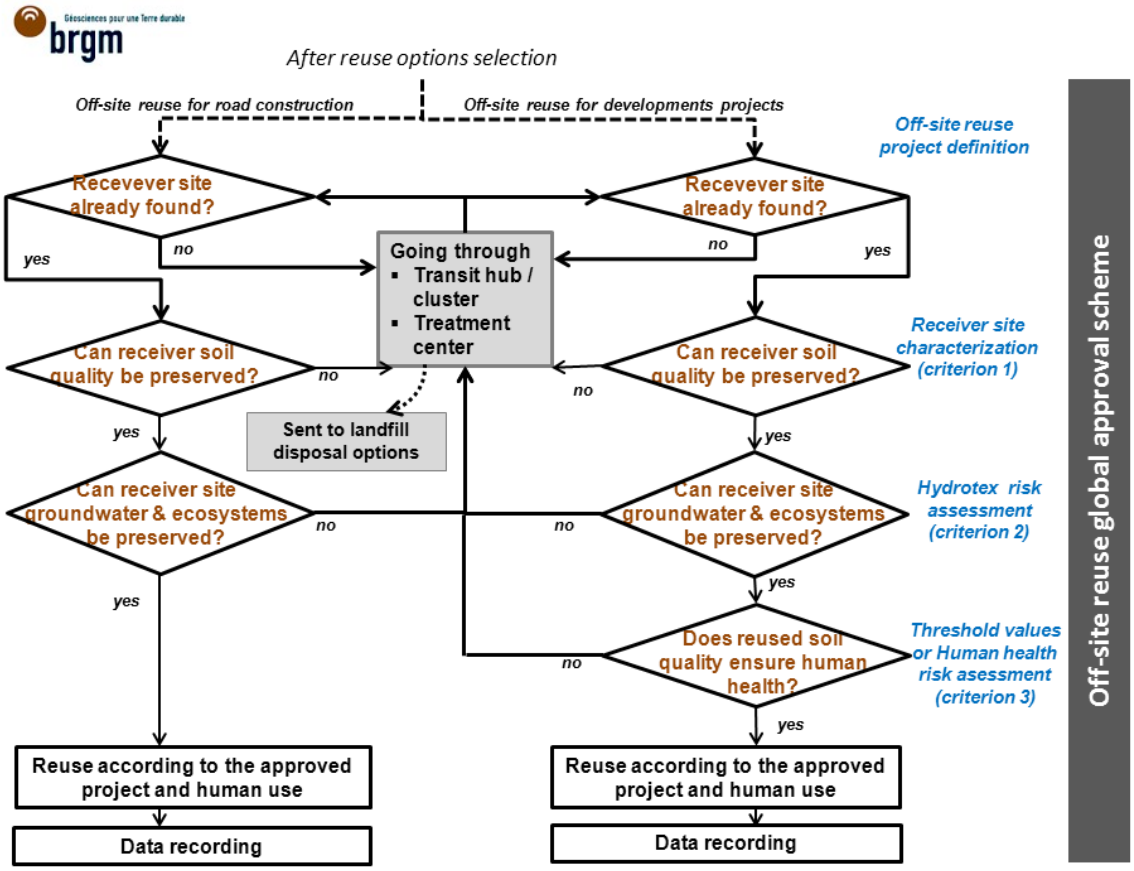

Fig. 5: Contaminated excavated soil off site reuse global approval scheme

Source: [5].

3. HYDROTEX: A GROUNDWATER RISK ASSESSMENT TOOL DEDICATED TO EXCAVATED SOIL REUSE

The Hydrotex tool concerns groundwater risk assessment. [6] It was developed to check that the off-site reuse of excavated soil does not affect the groundwater resource quality. Hydrotex is a spreadsheet which provides a specific result for each off-site reuse receiver site and for each substance. It must therefore be used substance by substance, for the same receiver site.

This groundwater risk assessment determines, for each relevant substance, the groundwater concentration at the protected target point, depending on the initial pollutant concentration in the reused excavated soil. The target point is chosen according to the groundwater uses on the downstream area (drinking water production, industrial needs …).

Three stages, each corresponding to a tab of the worksheet (Step 1, Step 2 and Step 3), enable the user to calculate, for different pollutant taken one by one, its groundwater concentration taking into account successively different attenuation phenomena in the saturated zone (cf. Fig.6). Each step is based on the results of the previous step by integrating additional mechanisms:

Step 1: calculation of the groundwater concentration which is supposed to be the same as the concentration in the pore water of the reuse soil,

Step 2: calculation of the groundwater concentration by taking into account the dilution in groundwater, to the right of the zone of reuse,

Step 3: in addition to the previous phenomena, calculation of the groundwater concentration at a given distance by considering the phenomena of dispersion, adsorption and degradation.

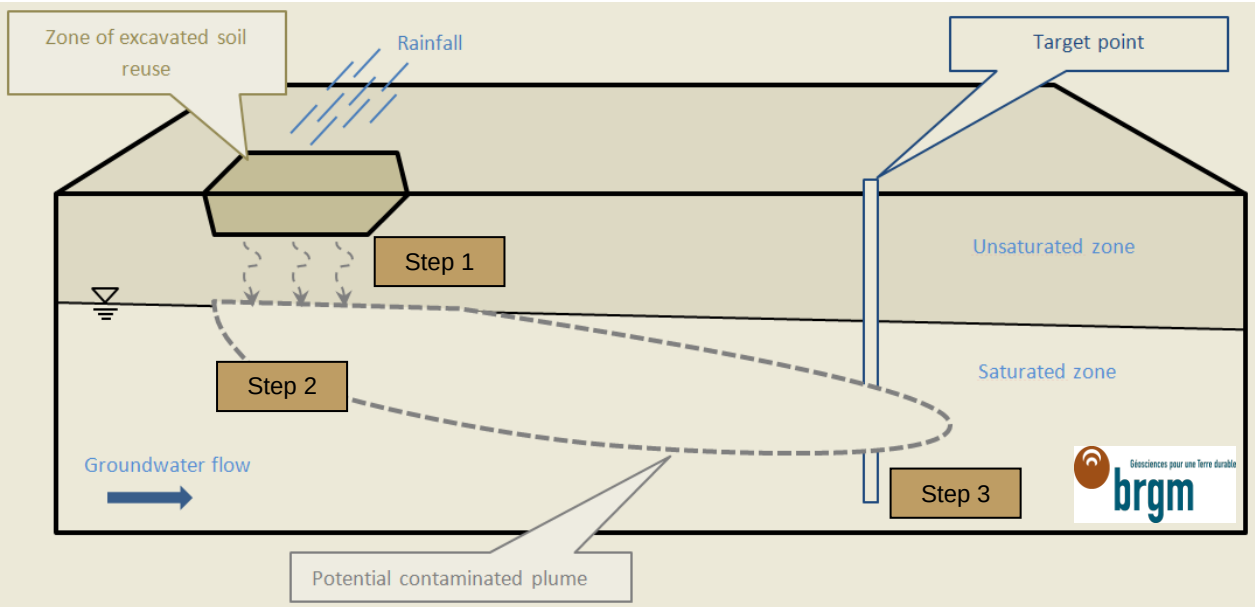

Fig. 6: Steps of the Hydrotex tool

Source: [6].

For each substance, a target concentration is chosen. The value of this target concentration is determined from regulatory values (i.e. drinking water standards), or from water management values (i.e. EU Water Framework Directive quality objectives), or from site specific human health risk calculation when no value is available. At the end of each step, the calculated groundwater concentration is compared to the target concentration and different situations are then possible:

- Off-site reuse of excavated soil may be considered in cases where the calculated concentration at the end of one of the steps (1, 2 or 3) is less than the target concentration.
- If the calculated concentration at the end of Step 1 (respectively Step 2) is greater than the target concentration, then it is necessary to move to Step 2 (respectively Step 3) in order to check that the off-site reuse of excavated soil does not affect the groundwater resource quality.
- If the calculated concentration at the end of Step 3 is higher than the target concentration and the input data is considered relevant, then the reuse has to be rejected.
- If the calculated concentration at the end of Step 3 is greater than the target concentration and the uncertainties of the input parameters seem too large, two scenarios must be considered:
    - either no reuse of excavated soil,
    - or implementation of investigations to reduce uncertainties related to the choice of input parameters and to choose less protective values, or development of a more realistic modeling to take into account the unsaturated zone for example.

The main advantage of this tool is the possibility to take into account the properties of the receiver site:

- the excavated soil reuse area (dimensions, material type, ...);
- the transfer medium (hydrogeology, rainfall recharge, conductivity, ...);
- the targets to be protected (water supply wells, industrial water ...).

Clear guidelines and most of the physical and chemistry parameters are defined in order to keep the use of this tool easy and to help all the competent authorities' controls.

4. TERRASS: AN INTERACTIVE WEBSITE AND DATABASE TO KEEP TRACK OF ALL EXCAVATED SOIL REUSE IN FRENCH METROPOLITAN TERRITORY

To keep information about excavated soil quality, a traceability system has been implemented through two tools: a Reusable Soils Recording Log (BSTR) and the TERRASS database, an interactive tool for excavated soil banking.

4.1. A REUSABLE MARGINALLY CONTAMINATED SOIL RECORDING LOG EDITOR

4.1.1. Waste management : Need for traceability

Marginally contaminated excavated soil, classed as waste arisings, needs to comply with all the regulatory requirements applied to waste management. One of the main consequences is that all movements of excavated soil from its excavation site to its reuse site have to be recorded with all its characteristics (producer, volume, quality, uses, and receivers).

A specific form, called BSTR ("Bordereau de Suivi de Terres Réutilisables" for Reusable Soil Recording Log) has been created to monitor the excavated soil volumes from a producer site to a receiver site. This receiver site can be a transit hub / cluster, a treatment center or directly a receiver site (for a development project or road construction).

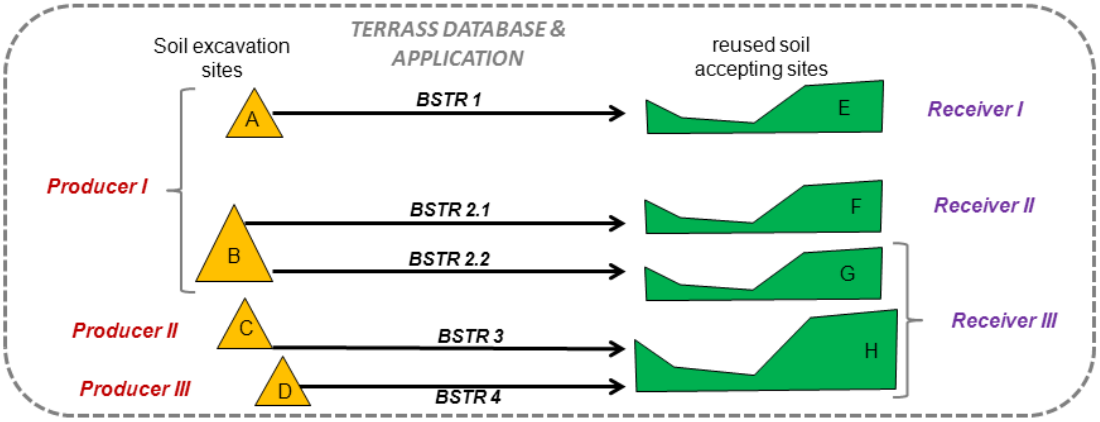

Fig. 7: Schematic diagram of excavated soil off-site reuse traceability

Source: [5].

To ensure traceability and control of off-site excavated soil movements, a shared and collaborative tool is being developed by BRGM. This tool, TERRASS, will:

- Ensure materials traceability from the excavation site to the receiver site,
- Deliver and manage the BSTR numbers,
- Record information on the status, location and quality of stocks,
- Facilitate contact between owners and users of excavated soil,
- Store all information and documents related to soil reuse,
- Enable the competent authorities to make their regulatory controls and manage their site inspections,
- Produce useful indicators through numbers, figures and diagrams.

This tool is already available online for all stakeholders (http://terrass.brgm.fr) and further functionalities are actually being developed and will probably be available online before the early beginnings of the summer 2013.

4.1.2. Registering and storing data

All the marginally contaminated soil reuse stakeholders will be able to log into the database by the online website. They will have to define under which kind of profile they want or need to access the database: e.g. producer, receiver or both, environmental authorities. Depending on their profile characterization they will be able to:

- edit a Reusable Soil Offer OTR (for “Offre de Terres Réutilisables”);
- read public OTR, or private OTR (with access given by the producer);
- edit a BSTR by using the OTR data to which it is linked;
- print a BSTR as a shipping document that should be traveling with reused soil quantities from the producer site to the receiver site.
- have access to the official regulatory data.

Reusable Soil Offers (OTR) specify the quantities, qualities (by giving characterization analysis results), locations of reusable soils. The producer giving the offer data is responsible for its quality and reliability.

Reusable Soil Recording Log (BSTR) specify the quantities, qualities, locations of reused soils, and all the documents needed to prove that all the requirements are fulfilled.

Mapping help tools will be integrated to the online forms to make origins and destinations clearly known and exact.

All the data stored in the TERRASS database will be kept online at least 3 years. Then this data will be archived and only available on request.

4.1.3. A tracking and controlling tool for the competent authorities

The competent authorities will be able to connect themselves to the database with a profile granting access to all the stored data about reusable soil offers and reused soil recorded logs so that they can achieve their regulatory controls.

Hydrotex and human health specific risk assessment studies, all the characterization results for reusable soil and receiver site, and the different planning documents and maps are to be downloaded from TERRASS for detailed examination.

Detailed listing of reused soil movements towards and from specific receiver sites as transit hub / cluster or treatment center will also help the competent authorities to organize and target their regulatory inspections.

4.1.4. Useful indicators and feedback information

All the registered data will be processed through indicators in order to produce a feedback experience on how and where marginally contaminated soil is being reuse. The major parameters implemented in the database are mainly the distribution of, on one hand, reusable soil quantities and, on the other hand, reused soil quantities, over time on regional and local scales, for different kind of producers or receivers, and also depending on the possible new use and qualities. Quantities will be counted on numbers of record logs that have been edited and also on the global volume. Therefore we will be able to know, where, when and how the marginally contaminated soil stock is being reused.

Statistics can also be worked out about: time needed for a reusable soil offer to find a receiver site, the average distance between a producer site and a receiver site, shipping uses (by boat, train, or road) but also how much and why some reusable soil offers were not able to find a fitting receiver site.

All this feedback information will enable us to review this new approach of managing marginally contaminated soil off-site reuse at the end of the one-year test period.

4.2. LEADING TO A MARGINALLY CONTAMINATED SOIL STOCK EXCHANGE MARKET

The database and application being developed currently are oriented towards integrating offers of reusable oil and generating the recording logs. But the next step for this tool is also to register the demands of reusable soils and to link automatically both offers to demands and therefore producers and potential receivers leading to an interactive stock exchange market place.

Further developments are also at stake, being discussed between the French Environment Ministry and actual private soil dealers and environmental consultants. These developments mainly deal with the possibility of adding some private applications to the database so that private stake holders can offer new services to their clients, which might include directly registering reusable soil offers and demands with all the fulfilled requirements watch tightly, supervise and report the fluctuations of the reusable soil stock market.

5. CONCLUSIONS

The reuse of marginally contaminated excavated soils is a new development of the French contaminated site framework management, but it is actually based on other European neighbor experiences such as Belgium and Netherlands' policies. Their feedback shows that the success of these kinds of guidelines and policies need different leverages such as: regulatory obligations, systematic controls and tax advantages at the same time as developing transit hub/cluster and treatment centers.

One main goal of the one year trial period is to define how and which leverages would be the most efficient to improve the reuse of marginally contaminated excavated soils in France.

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