# LANDFILL OF WASTE IN WALLONIA: TRANSPOSITION OF 1999/31/EC GROUNDWATER PROTECTION PLAN AND TRIGGER LEVELS BASED ON LONG TERM MONITORING RESULTS

V. LEBRUN*, F. DELLOYE**, E. BIETLOT., O. LE BUSSY*, C. COLLART*

** ISSeP: Institut Scientifique du Service Public, Department of Environnemental Survey, rue du Chéra, 2000, Liège Belgium*
*** SPW-EWD-GD: Service Public de Wallonie, Environment and Water Department, Groundwater Direction, Namur, Belgium*

SUMMARY: The first transposition of Directive 1999/31/EC for Wallonia showed many imperfections. The most important one was that it failed to set trigger levels for groundwater. During the ten years that have elapsed since the issuance of this Directive, two very powerful analytical databases have been constituted. The first one is "landfill focused"; it includes leachates and groundwater samplings collected on and around 12 MSW landfills. The second one gathers geochemical results on regional groundwater bodies. Combining both databases made possible to fix appropriate trigger levels and to define an optimal protocol for designing groundwater protection plans. Recently, the transposition of 1999/31/EC has been deeply reviewed by adding a completely new version of the groundwater protection chapter. It uses two sets of monitoring parameters and two levels of control: sectoral "vigilance values", ensuring the equity of treatment for every landfill operator, and local "trigger values" complying with the EU recommendation to take account of the geochemical background and location specificities.

## 1. HISTORICAL CONTEXT

Wallonia is well known for its quarrying activities. Ornamental stones, building stones, aggregates and sands, limestones and chalk for cement and lime fabrication have been extracted for centuries from its rich subsoil. Filling these quarries with waste after their exploitation is a practice quite as old as the extraction itself and has been used for grading natural topographic depressions as well. As a consequence, until eighties, a large number of uncontrolled waste deposits have replaced quarries -and valleys everywhere in the region.

In the second half of the nineties, the Walloon authorities implemented the first "large scale integrated waste policies" (Gouvernement Wallon, 1998) with the aim for improving the recycling/landfilling rate and with a long term "sustainable development" vision. One of the key ideas of this "waste plan for Wallonia" was to reduce simultaneously the number of landfills and

*Proceedings Sardinia 2011, Thirteenth International Waste Management and Landfill Symposium*
*S. Margherita di Pula, Cagliari, Italy; 3 - 7 October 2011*

the quantity of waste that they received. Regarding the criterions to be used for the selection of landfill sites (Lox and Houtain, 1999), the basic principle was the following: the conversion of existing dumps towards sanitary landfills is preferred with the creation of new ones on "virgin sites". The motivation of such strategy was to seize the opportunity of cleaning up historical polluted areas by keeping industrial activity on place. Part of the benefits generated by the new sanitary landfills was used to improve monitoring devices and to implement remedial actions, including both old and new adverse environmental impacts.

More than twenty years after, this idea appears to be not so bad. The most critical problems have been observed on places that were closed at the end of the selection process. Without any financial provision, operators were less motivated, or even unable, to achieve remediation and aftercare works. On the other hand, municipal solid waste landfills operated during the two last decades on "old dumps sites" did not caused such serious environmental problems. Applying good waste management practices, achieving progressive rehabilitation works, implementing prevention and/or active remediation systems contributed to improve the environmental situation on these sites. Since 1999, ISSeP is in charge of a large-scale environmental monitoring program funded by Walloon ministry (Direction of environmental Policy and Control (DPC)) and including periodic campaigns of air and water quality control on 12 MSW landfills. Bietlot et al. (2011) present the overview of 10 years monitoring and conclude on a very positive global situation in groundwater around sanitary landfills. Van Vossen et al. (2007) demonstrated such a "low impact on groundwater from waste deposits" in the Netherlands.

Despite the fact that converting old dumps into sanitary landfills was satisfying, some problems related to this decision are still to be stressed:

- Many sanitary landfills in Wallonia comprise an old zone without any bottom protection.
- The sites where they were developed are seldom optimal regarding the risk of leachates spreading in aquifers.
- Groundwater was often polluted before the reconversion of the site into controlled waste deposit, pollutions that are not yet totally remediated now.
- As discussed in Danvers et al. (2007) the permitting procedure for the justification of the second life of these landfills has been quite difficult and continue to be so, as it needs justifying some derogations to the specifications of the Landfill Directive.

Until recently, the main challenge from regulator's point of view has been to comply with the EU request concerning the fixation of "trigger levels" both adapted to new and old landfills.

## 2. LEGAL CONTEXT

Directive, Annex III, section 4, (European Commission, 1999) gives recommendations about control and monitoring procedures to be followed by every landfill operator in the EU in order to ensure the protection of groundwater. As mentioned in Articles 12 and 13 of this Directive, "*significant adverse environmental effects*" should lead to "*corrective measures*". Regarding groundwater, "trigger levels" representative of a "*significant change in water quality*", must be set "*taking account of the specific hydrogeological formations in the location of the landfill and groundwater quality*". Observations have to be evaluated by means of control charts with established control rules and levels for each downgradient well.

The first transposition of this directive for the Walloon Region is AGW 23-02-2003 (Gouvernement Wallon, 2003) which edicts the sectoral conditions of exploitation for landfills. It sets the monitoring procedure to be followed by landfill owners, including periodical sampling of surface and groundwater as well as leacheates and tretment plant wastewater. It lists a set of parameters to be analysed in each of these categories of samples.

Although it includes many parameters, this list is not really optimal. For example, it does not include important tracers such as chlorides, sulphates, iron and manganese. In addition, regarding control parameters, no distinction is made between landfill classes (MSW, non hazardous industrial waste and hazardous waste). Such a separation would have been, of course, more efficient. Finally, due to several reasons - the most important one is probably rooted in the history of the Region explained above AGW 23-02-2003 did not include any trigger level for groundwater measurement.

The operating licenses granted since 2000 have progressively taken into account some of these shortcomings and imperfections by adding, case by case, some particular monitoring conditions. Only one of them, however, includes the "trigger levels" required for groundwater. Of course, the european infringement procedure was requiring a better adaptation of the directive into the walloon regulation but all these weaknesses in the 2003 text, together with increasing differences between permits, have finally forced the Walloon authorities to deeply review the sectoral legislation.

## 3. GROUNDWATER DATABASES

Since 2003, results of the regular surveys achieved according to the AGW 23-02-2003 have been communicated annually to the SPW ("*Service Public de Wallonie*"). This first set of data contains a very large number of groundwater samples and analyses, gathered at high and regular frequency on a wide selection of wells.

During the same period, ISSeP ("*Institut Scientifique de Service Public*") gathered its own analytical data within the framework of the environmental assessment program quoted above. This second set of results includes samples collected with lower and less regular frequencies and in a more limited selection of monitoring wells. Additionally, samples are submitted to a wider and better defined selection of analytical parameters.

In 2007, ISSeP start to gather its own data and those coming from operators with an important formatting problem. Results from operators were often only available as printed certificates and sometimes provided in electronic format but using different analytical methods and measuring units. After 3 years of collecting, (re)encoding and validating data, combined with a big database-programming work, ISSeP finally owns an operational "**landfill-focused groundwater database**". Among 2.500 groundwater samples and 95.000 single analytical results from 215 monitoring wells and 12 leachates treatment plants have been gathered. With such a tool, ISSeP is firstly able to produce representative statistics regarding the overall environmental situation of landfills in Wallonia (Bietlot et al., 2011). Secondly, the database constitutes an important part of the technical background that was necessary to review and improve the legal framework of the groundwater monitoring procedure around landfills. The statistics computed on the entire set of data have driven the selection of the best tracers, valid for every landfill (see section 3.1). Local statistics on the monitoring wells of each landfill are necessary to assess their environmental situations at a smaller scale. They are used to verify the existence of "endogenous persistent pollution" (see section 3.2). Time-space distributions of the same local results will be very helpful for the landfill operators and for the authorities respectively to realise the risk assessment studies needed for the elaboration of "*Groundwater Intervention and Protection Plans*" and to validate them (see section 4).

At a larger scale, the existing datasets comprising analyses from 450 groundwater production plants and chemical results from several hydrogeological studies was a first attempt to characterize the various aquifers found in Wallonia (Polo-Chiapolini and al., 2003). This first assessment of the groundwater qualities and variations was an important step but its results were unfortunately not enough representative of the locations of the landfills.

Table 1: control parameters and decision levels. Lines extracted from the table of the appendix 4B of the AGW 07-10-10 (Gouvernement Wallon, 2010)

| Parameters | | | | Aquifers Statistics | | Landfill categories (type o wastes) Class 1/5.1 Class 2/5.2 | | Class 3/5.3 | | Class 4 | | Thresholds | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | Label | Units | LOQ[2] | Med. | P95 | Trac. | Ext. | Trac. | Ext. | Trac. | Ext. | Vigil. | Trig. |
| **Metals** | | | | | | | | | | | | | |
| 3601 | As | µg/l | 1 | 0,3 | 1,7 | X | X | | X | | X | 10 | X |
| 3602 | Cd | µg/l | 0,05 | 0,1 | 0,4 | | X | | X | | X | 5 | X |
| 3603 | Cr | µg/l | 2 | 0,7 | 3,4 | X | X | | X | | X | 50 | X |
| 3503 | Cu | µg/l | 2 | 1,7 | 39 | X | X | X | X | X | X | 100 | X |
| 3604 | Hg | µg/l | 0,1 | 0 | 0,1 | | X | | | | X | 1 | X |
| 3605 | Ni | µg/l | 2 | 1 | 8,2 | X | X | X | X | X | X | 20 | X |
| 3606 | Pb | µg/l | 1 | 0,3 | 3,0 | X | X | | X | X | X | 10 | X |
| 3607 | Sb | µg/l | 1 | 0 | 0,3 | | X | | | | | 5 | X |
| 3608 | Se | µg/l | 1 | 0,7 | 3,2 | | X | | | | | 10 | X |
| 3504 | Zn | µg/l | 20 | 15 | 130 | X | X | X | X | X | X | 200 | X |
| 3501 | Fe-dis | µg/l | 20 | 6 | 988 | X | X | | X | | X | 1000 | - |
| 3502 | Mn-tot | µg/l | 5 | 2,5 | 315 | X | X | | X | | X | 250 | - |
| Others metals | | µg/l | | | | | X | | | | X | | X |
| **Oxidizable matters and eutrofying substances** | | | | | | | | | | | | | |
| 4002 | TOC | mg/l C | 0,3 | 0,7 | 2,5 | X | X | X | X | | X | 5 | - |
| 4012 | DOC | mg/l $O_2$ | 5 | | | | X | | | | X | - | - |
| 4013 | DBO5 | mg/l $O_2$ | 3 | | | | X | | | | X | - | - |
| 3003 | $NH_4^+$ | mg/l $NH_4^+$ | 0,05 | | 0,3 | X | X | | | X | X | 0,5 | - |
| 3005 | P | mg/l $P_20_5$ | 0,1 | | 0,9 | | X | | X | | X | 1,15 | - |

According 2000/60/CE Water Framework Directive (European Commission, 2000), the groundwater chemical status has been measured and monitored in a more extended way since 2005, by the Environment and Water Department (EWD) of SPW. This long term monitoring has fed another database of groundwater chemical analyses which is not focused, for its part, on the surroundings of landfills, but which characterizes the groundwaterbodies at the regional level. It includes annual analyses from 600 water production wells and 200 monitoring wells and sources in less productive zones. This "**regional groundwater database**" fully operational since 2007. The main statistics are accessible to the population from an internet portal, which makes them as transparent as easy to use. Within the framework of the Landfill Directive, it gives the local backgrounds to be taken into account for setting trigger levels.

## 4. A NEW VERSION OF THE GROUNDWATER CONTROL PROCEDURE

As explained above, with these two databases, it was finally possible to fix appropriate trigger levels and to define an optimal protocol for the working out of groundwater protection plans. Recently, the SPW and ISSeP have joined their expertise to write a better version of the chapter "protection of groundwater" of AGW 23-02-2003. This work has been translated into a new act, actually the AGW 07-10-2010 (Gouvernement Wallon, 2010).

### 4.1. Control parameters and decisional levels

The new monitoring procedure includes two sets of control parameters (“tracer-set” and “extended-set”) and two alarm levels ("vigilance" and "trigger"). Table 1 presents a part of the compulsory parameters to be analysed (heavy metals and oxidizable matters) - contained in the

appendix 4.B of the law. The complete table includes no less than 52 substances or parameters. Maximal limits of quantification as well as regional statistics on the aquifer geochemistry, when available, are given in the same table.
The first set of parameters only includes the most important *tracers* commonly used to recognise pollutions generated by leakages of leacheates in groundwater. These chemical compounds are analysed every six month in groundwater as well as in leacheates. The second set is *extended* to a more complete list of pollutants; it is applied every two year with the aim of updating the characterisation of the pollution and-or natural geochemical background. Both *tracers* and *extended* lists have been defined taking into account the type of landfill ("X" in Table 1):

- larger and more complete in terms of pollutant categories for *Class 1* (dangerous waste) *Class 2* (municipal solid waste) and *Class 5* (industrial waste) landfills ;
- smaller and more focused for *Class 3* (inert waste) and *Class 4* (dredging-mud).

Vigilance thresholds are set for quite every monitored compound. The values of this "first level of control" are the same whatever the location and/or the aquifer potentially impacted by the landfills are. As explained in the following section, exceeding a vigilance value does not constitute any sufficient condition to initiate remedial actions.

Conversely, the act does not impose any trigger value in the literal sense that would be applicable everywhere and under all circumstances. It only defines the parameters ("X" in the last column of Table 1) for which this fixation becomes necessary, at the end of a more complex decisional tree, which is developed hereafter.

### 4.2. Groundwater-monitoring procedure

The decisional tree governing the monitoring procedure is presented in flowchart form in figure 1. It is issued from the flowchart published in the 4.A appendix of the AGW 07-10-10 (Gouvernement Wallon, 2010), but it has been reworked a little, in order to regroup actions and decisions as a function of departments of the administration which have to pilot them.

As long as there is no exceeding of vigilance thresholds, standard monitoring may be pursued with semi-annual control of "tracers", and biennial checking of the "extended" set of parameters. When the concentration of any monitored compound, verified in 2 independent labs, exceeds vigilance value and is three times higher than the "upstream concentration", the monitoring is reinforced during a well defined period of time. The second condition must be understood broadly. The idea is to confirm that the pollution reaches a level significantly higher than the local geochemical background. In practice, it may happen that no "upstream checkpoint" is available or usable. Then, the condition of "3 times the upstream concentration" may be replaced by "3 times a value representative of the local background". This value can be computed from other not impacted wells, situated laterally or further downstream.

The phase of increased control is not only achieved on the couple check-point/parameter which satisfies the double condition. It can be extended to any "related compounds" (pollutants of the same family, biodegradation products …) and/or to the closest monitoring wells. All the strategic choices, driving the temporary phase of enhanced surveillance, are made with the aim of assessing the endogenous character of the pollution (is it well due to the landfill or to an external source/event?), as well as its persistency over time. The program of the phase must be validated previously by the *Department of environmental Police and Controls* (DPC) of SPW. Of course, the consultation of both "landfill focused" and "regional groundwater" databases will be essential to guide the interpretation of analytical results acquired during the increased control.
If the existence of any endogenous persistent contamination can be excluded, on-field investigations and risk assessment should not be taken further. However, it is necessary to adapt the routine monitoring program, particularly by adding to the list of *tracer*, every compound

having exceeded the vigilance value and to include any relevant additional wells in the monitoring program. If it is deemed necessary by the DPC, this update of the control program and monitoring could be laid down in the permit, which needs a request to the Department for Permits and Authorisations of the SPW.

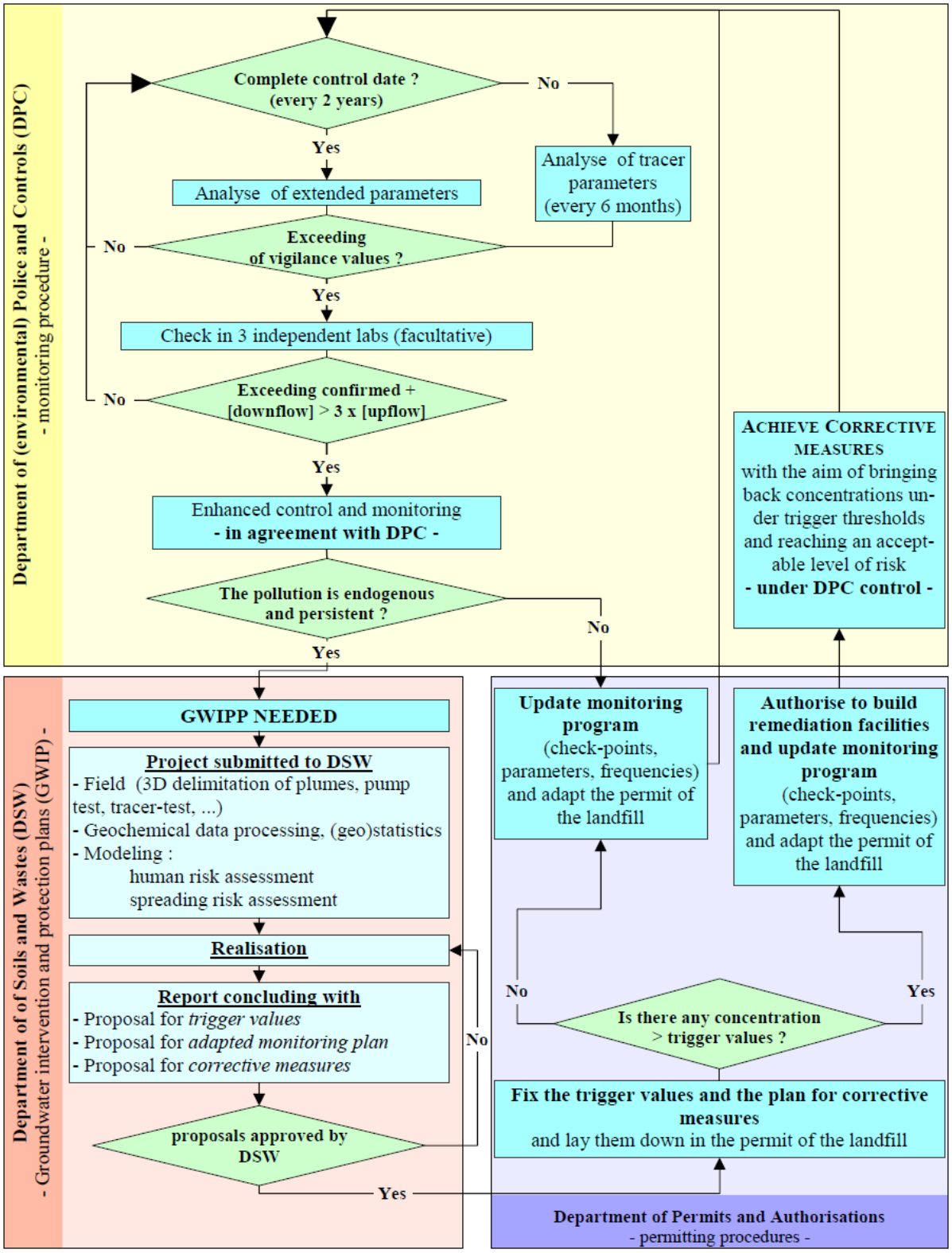


Figure 1. Decision tree of the new groundwater control procedure for MSW Sanitary landfills - reworked version of the 4.A annex of AGW 07-10-10 (Gouvernement Wallon, 2010)

### 4.3. Groundwater intervention and protection plan (GWIPP)

The realisation of "*groundwater intervention and protection plan*" (GWIPP) - second step of the new procedure - is required only if the monitoring confirms the existence of an endogenous persistent pollution, while immediate conservative measures can be dictated if necessary by the DPC. The GWIPP will condition the landfill future activity or post-management and this plan should include at least:

- the 3D-delineation of the pollution plumes;
- the estimation of local geochemical background;
- the lookout for any possible exogenous pollution;
- the distinction between historical and recent endogenous contaminations;
- the assessment of indirect risks for human health;
- the evaluation of direct risks for spreading into groundwater.

Only experts in groundwater pollution, certified by the SPW and working independently from operators may carry out these studies, whose content and quality should meet every requirement of the act governing the remediation of soil and groundwater pollution (Gouvernement Wallon, 2009). ISSeP and EWD are now working out a guideline document that will fix the best practices for the realisation of these studies included in every GWIPP. Adapted to all local specificities characterized, the GWIPP provides extensions of monitoring program, as well as the specific trigger values for every parameter listed in the table of appendix 4B. Consulting groundwater and landfill databases will be therefore an essential prerequisite. For this purpose, EWD and ISSeP will be able to provide, upon request, relevant statistics which would allow defining appropriate and optimised trigger values, in conformity with 1999/31/EC philosophy. The GWIPP finally indicates the corrective measures envisaged by the operator in case of crossing these thresholds. Triggers values may be fixed specifically for different monitoring wells. The GWIPP is submitted by operators to approval of the of the Authority within 3 months of the request.

The Department for Permits and Authorisations (DPA) must then, within 60 days, consult the other departments (SWD, EWD and DPC advised by ISSeP) in order to propose the endorsement of the GWIPP into the permit of the landfill. If any trigger value is exceeded, DPA authorises to build every remediation facilities needed to activate correctives measures in accordance with the GWIPP. Finally, these corrective measures, which aims at sustainably reducing concentrations in groundwater at values lower than the threshold, are performed by the operator. The task to follow-up the proper conduct of corrective measures and to verify if they allow reaching remediation objectives is, again, entrusted to the DPC.

## CONCLUSIONS

The transposition of 1999/31/EC for Wallonia (Belgium) has been deeply reviewed by adding a completely new version of the "groundwater protection chapter". The new act, currently the AGW 07-10-2010 is based on a multilevel decision tree which uses two set of monitoring parameters and two levels of control. "Vigilance values" are set to the same values, everywhere and for any type of landfill. These sectoral values ensure the equity of treatment for every landfill operator. The "Trigger values" are set case by case, after further field and lab investigations combined with risk assessment, both achieved considering site-specific parameters. Of course, the application of the procedure will be tested on the field within the following months. The Walloon government ruled a sophisticated groundwater protection procedure but a long and difficult period of adjustments and modifications of permits has just

started, which will surely reveal some imperfections in the new procedure. However, the adaptability of the law and its close links with field data is essential to make of it an effective tool that will help to improve waste management in Wallonia.

## ACKNOWLEDGEMENTS

The Authors wish to thank the Walloon Ministry - General Directorate for natural resources and environment - and especially to P. Nemry, Chief of DPC, which is supporting the work of ISSeP with the framework of the environmental monitoring program around landfills in Wallonia.

## REFERENCES

Bietlot E., Lebrun V., Collart C. (2011). Environmental monitoring on municipal solid waste landfills in wallonia: overview on 10 years of field measurements. Proceedings Sardinia 11, Thiertienth International landfill Symposium, CISA publisher, Cagliari.

Danvers C., Deed C. and Marshall R.W. (2007). Implementing the Landfill Directive in England and Wales . Proceedings Sardinia 07, Eleventh International landfill Symposium, CISA publisher, Cagliari.

European Commission (1999). Council Directive 1999/31/EC on the landfill of waste, Official Journal of European Commission (O.J.E.C.), L 182 of 16.07.1999, 26 pp.

European Commission (2000): Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Official Journal of European Commission (O.J.E.C.), L 327 of 12.22.2000 pp.

Lox A. and Houtain A. (1999). Landfill site selection in the Walloon Region (Belgium). Biotechnol. Agron. Soc. Environ. 3 (1), 49–56.

Gouvernement Wallon (1998). Arrêté du Gouvernement wallon du 15 janvier 1998 adoptant le plan wallon des déchets "horizon 2010". Moniteur Belge 21/04/1998, p 11806-11807.

Gouvernement Wallon (2003). Arrêté du Gouvernement wallon du 27 février 2003 portant conditions sectorielles d'exploitation des centres d'enfouissement technique. Moniteur Belge 18/02/2009, pp 14852-14868.

Gouvernement Wallon (2008). Décret du Gouvernement wallon du 5 décembre 2008 relatif à la Gestiond es sols., Moniteur Belge 13/03/2003, pp 12169-12188.

Gouvernement Wallon (2010) : Arrêté du Gouvernement wallon du 7 octobre 2010 modifiant l'Arrêté du Gouvernement wallon du 27 février 2003 portant conditions sectorielles d'exploitation des centres d'enfouissement technique, Moniteur Belge 23/11/2010, p 72224-72264.

Polo-Chiapolini C., Colon, D., Pirard, F. (2003) Fixation de normes relatives aux eaux souterraines aux alentours des C.E.T. et des dépotoirs en Région wallonne. Etude réalisée pour le compte de la DGATLP par le CEBEDEAU et les LGIH. réf -01/534/5, 265 p.

Van Vossen W.J., De Jong M., Driessen T. and Overzet D. (2007). New strategy for sustainable and cost-saving aftercare of closed landfills based on natural biochemical processes, a full scale demonstration project at the landfill Vlagheide in Schijndel (NL). Proceedings Sardinia 07, Eleventh International landfill Symposium, CISA publisher, Cagliari.