



Guidelines for the beneficial use of fertilizing residuals

Reference criteria and regulatory standards

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Direction du milieu rural

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Foreword

The *Guidelines for the Beneficial Use of Fertilizing Residuals* is a new version of the "*Interim Criteria for the Reclamation of Fertilizing Residuals,"* which was first published by the Ministry in April 1997 and modified in February 2001 and November 2002. It is a "third generation" document edited seventeen years after the first edition of the *Guide de bonnes pratiques de la valorisation agricole des boues municipales* (Guide to best management practices for biosolid reclamation) (MENV, 1987). This new guidelines, which includes the applicable standards and criteria, will be used to determine whether or not a certificate of authorization is required for the reclamation of specific fertilizing residuals.

The main changes from the 2002 edition of the "*Interim Criteria"* are as follows:

- Exemptions from the CA requirement: broadening of exemptions for products that are sold in small containers in accordance with federal legislation, and definition of the acceptable organic matter content for "mineral fertilizers."

- Nitrogen and phosphorus: harmonization with the general approach of the *Regulation respecting agricultural operations*.

- Trace elements in FRs: tightening of maximum permissible levels for arsenic and lead; relaxing of the maximum limit for copper; abrogation of a subcriterion for dioxin and furan content levels and maximum limits for aluminum and iron; adjustment of the maximum limit for cadmium and zinc based on neutralizing value; details on acceptable FR mixes.

- Toxicity: integration of toxicity tests and a risk assessment approach for contaminants that are not assayed during routine analyses or are not expected to be present.

- Pathogens: prohibition against spreading residuals containing pathogens on food crops intended for human consumption; modification of certain parameters and criteria to take account of analytical variability and microbial regrowth phenomena.

- Odours: olfactometry classification method and abrogation of the prohibition against the spreading of residuals in summer (municipal prerogative).

- Quality control: mandatory sampling of some FRs by an accredited sampling firm.

- On-site storage: relaxing of the provisions related to maximum volume, obligation to cover heaps and types of coverings.

- Soil mixes: revision of the maximum permissible levels for trace elements and establishment of alternative criteria for certain metals using the Mehlich-3 extractant.

- Occupational hazards (occupational health and safety): revision of several criteria.

- Communications: determination of variable requirements based on the type of FR, with a view to informing and protecting the public.

- New sections: stakeholder accountability; composting of FRs and manures; use of FRs for livestock bedding, mulching, erosion control, roadside enhancement, etc. The *Guidelines* no longer covers the revegetation of degraded sites such as sandpits and open-pit mines.

In addition, the document layout has been changed and restructured. Many hyperlinks have also been added, along with a glossary.

All of these modifications were made following consultations with various interest groups and are in keeping with the guiding principle presented in Section 2 of this document. However, like the 1997 "*Interim Criteria*," the purpose of this document is to provide the criteria, technical requirements and regulatory standards applicable to the reclamation of a multitude of FRs and composts for as many uses as possible (agriculture, silviculture, horticulture, etc.). The *Guidelines* is also intended as a work in progress, and it will be updated to reflect advances in knowledge and amendments to the laws and regulations.

The authors wish to thank all of the Ministère de l'Environnement employees who participated directly or indirectly in the revision of the "*Interim Criteria*," as well as the many external collaborators who over the years have provided comments on the document and thus contributed to the advancement of knowledge and practices in the field.

NOTES:

Beginning May 1, 2004, the *Guidelines* will be used by the regional offices of the Ministère de l'Environnement du Québec to review applications for certificates of authorization.

Further information on FRs can be obtained by visiting the Ministry's website at: http://www.menv.gouv.qc.ca/matieres/mat_res-en/fertilisantes/index.htm or by contacting a regional office.

Unless otherwise specified, the term *Guidelines* as used in this document refers to the *Guidelines for the Beneficial Use of Fertilizing Residuals*.

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1 INTRODUCTION

This document is intended primarily for the Ministère de l'Environnement (MENV) staff located in the regional offices for regulatory enforcement purposes and for professionals involved in fertilizing residual (FR) beneficial use projects. The context for the reclamation of FRs is outlined beginning in Section 2, which provides general information on fertilizing residuals, and Section 3, which presents the main regulatory bodies.

Sections 4 to 15 describe the requirements set out by the Ministry to prevent pollution as defined in section 20 of the *Environment Quality Act* (EQA), which stipulates that:

> "No one may emit, deposit, issue or discharge or allow the emission, deposit, issuance or discharge into the environment of a contaminant in a greater quantity or concentration than that provided for by regulation of the Government.
>
> The same prohibition applies to the emission, deposit, issuance or discharge of any contaminant the presence of which in the environment is prohibited by regulation of the Government or is likely to affect the life, health, safety, welfare or comfort of human beings, or to cause damage to or otherwise impair the quality of the soil, vegetation, wildlife or property."

Section 4 of the *Guidelines* outlines the conditions for determining whether a particular FR reclamation activity requires a certificate of authorization (CA) under section 22 of the EQA, which specifies that:

> "No one may erect or alter a structure, undertake to operate an industry, carry on an activity or use an industrial process or increase the production of any goods or services if it seems likely that this will result in an emission, deposit, issuance or discharge of contaminants into the environment or a change in the quality of the environment, unless he first obtains from the Minister a certificate of authorization."

Sections 5 through 15 of the *Guidelines* cover the requirements related to applying for a CA, according to the type of activity involved.

The second half of the *Guidelines* (after section 15) contains a list of acronyms and abbreviations, a glossary and seven appendices with useful complementary information.

The aspects of FR beneficial use dealt with in this document are:

- temporary on-site storage;
- FR and compost application on soils for agricultural, silvicultural, roadside enhancement and other purposes, etc.;
- the manufacture and use of horticultural soil mixes;
- composting in the field of less than 1 500 m^3/establishment per year (including on-farm composting of manure);

- other uses: mulch, livestock bedding, sediment barriers.

FR beneficial use activities not covered in this document are:

- the storage and spreading of manure (animal residuals),
    - for information consult the *Regulation respecting agricultural operations* (RRAO) and the *Regulation respecting groundwater catchment* (RRGC);
- the revegetation of degraded sites, such as sandpits and open-pit mines,
    - for information consult the *Critères préventifs pour la restauration de la couverture végétale de lieux dégradés par l'utilisation de MRF* (MENV, 2003);
- the environmental management of permanent municipal and industrial composting sites,
    - consult the *Guide sur les actes statutaires et les critères d'aménagement et d'exploitation de divers lieux de valorisation de matières fermentescibles ou infermentescibles* (MENV, 1999a, draft);
- the environmental management of soil mix manufacturing sites;
- the reclamation of contaminated soils,
    - consult the *Soil Protection and Contaminated Sites Rehabilitation Policy* (MENV, 1999b).

It should be noted that the regulatory standards governing the FRs contained in this *Guidelines* must be complied with fully. This includes separation distances as defined in the RRGC and the standards concerning phosphorus set out in the RRAO.

In addition to these regulatory standards, reference criteria are also provided for aspects that are not covered in regulations. In specific circumstances, the regional office may modify these criteria in response to a request from a CA applicant (see Glossary). Such a request must, however, be accompanied by appropriate supporting documents providing assurance of full compliance with section 20 of the EQA.

To obtain certificates of authorization and additional information, however, applicants and stakeholders should always contact the regional offices of the Ministry.

Legal texts prevail at all times over the interpretations contained in this document.

2 GENERAL

2.1 Definition of fertilizing residuals (FRs)

FRs are "residual materials that can be used to maintain or improve, separately or simultaneously, plant nutrition, as well as the physical and chemical properties and biological activity of soils." This definition combines the expression "residual materials," as defined in section 1 of the *Environment Quality Act* (EQA), and the concept of "fertilizers and soil conditioners[1]," as defined by the International Organization for Standardization (ISO, 1984).

Hence FRs are a subgroup of "fertilizing materials" which, according to international terminology (see Glossary), include both fertilizers and soil amendments. For example, a FR that is high in organic matter and low in nitrogen and phosphorus would be considered a "fertilizing material" in the soil amendment subcategory, even though it does not have any significant fertilizing properties.

By convention, livestock waste (manure) and other "farm residuals" are not considered to be FRs, even though they are residual materials and comprise fertilizing and soil amendment properties.

Soils, by convention, are not considered to be FRs, either. However, sandy deposits and soils may be blended with FRs to make commercial soil mixes.

2.2 Types and uses of FRs

FRs come in a variety of solid and liquid forms, determined notably by their dryness (dry matter content). Some are intended as plant fertilizers, while others are used mainly as soil amendments. The main types of FRs are "biosolids," liming materials and composts.

Biosolids, traditionally called "sludges," result from the primary treatment (primary biosolids) or secondary treatment (secondary biosolids) of wastewater. They are often mixed together (mixed biosolids) and come from municipal and industrial wastewater treatment plants. Biosolids are used as organic soil amendments and as a source of fertilizing components.

Liming materials include ashes, cement kiln dust, lime mud from paper mills and other alkaline mineral residuals used mainly for raising soil pH. By convention, composts are considered to be FRs within the context of this document, since they are made from

[1] Translator's note: For the sake of simplicity, this expression has been subsumed under the term "fertilizing materials" in the remainder of this document.

residual materials. However, commercially, they are also considered "products," and are mainly used as organic soil amendments.

In Québec, FRs are chiefly used for:

- land application on farms;
- transformation into compost;
- the manufacture of commercial soil mixes (including compost or non-composted FRs);
- revegetation of degraded sites;
- application on forest soils.

Other methods of reclamation are also being developed, in Québec and elsewhere:

- distribution of FRs to the public ("open house" events),
- use in mulching and hydroseeding,
- use as livestock bedding, etc.

Uses and application rates are determined based on the physico-chemical and microbiological properties of the fertilizing residuals, which vary widely from one FR to another (Charbonneau et al., 2001; Désilets, 2003).

In Québec, approximately 1.8 million wet tonnes of residuals are reclaimed annually as fertilizing material, with roughly 60% of this being used for land application and 40% for composting (Table 2.1). This figure is 20% higher than that for 1999 (Charbonneau et al., 2000), indicating an overall increase in FR reclamation. This is not the case, however, for the reclamation of municipal biosolids (RECYC-QUÉBEC, 2003; Hébert, 2004).

TABLE 2.1 FR RECLAMATION THROUGH LAND APPLICATION OR COMPOSTING IN 2001-2002 (WET TONNES)

FR	Land Application	Composting	Total	
			(wet tonnes)	%
Paper mill biosolids	720 000	250 000	970 000	54
Abattoir biosolids	46 000	54 000	100 000	6
Other agri-food biosolids	20 000	n/a	20 000	1
Municipal biosolids	70 000	96 000	166 000	9
Forestry residuals	n/a	250 000	250 000	14
Various types of organic matter	n/a	65 000	65 000	4
Cement kiln dust	50 000	n/a	50 000	3
Ashes	60 000	5 000	65 000	4
Lime residuals	25 000	n/a	25 000	1
Alkaline residuals from paper mills	37 000	23 000	60 000	3
Other liming materials	25 000	n/a	25 000	1
Total	**1 053 000**	**743 000**	**1 796 000**	**100**

Data adapted from various sources. n/a: data not available

2.3 Basis for FR reclamation

2.3.1 Agri-environmental approach

Only part of the residuals generated by industries and municipalities can become FRs. The residual materials used in Québec must have recognized fertilizing or amendment properties. Research conducted by universities, the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Agriculture and Agri-Food Canada, and industry has demonstrated the positive effects of several residual materials on crops and soils, when used appropriately. Québec studies corroborate the research conducted in other countries, particularly in the United States (see Bibliography). Biosolids, compost and liming materials are each dealt with in separate sections of the *Guide de référence en fertilisation,* published by the Centre de référence en agriculture et agroalimentaire du Québec (CRAAQ, 2003). It is the main reference tool available on fertilization.

Agronomic properties alone do not suffice, however. Analyses must prove that the residual is environmentally beneficial and that it complies with maximum limits, which are also established on the basis of research. Once agronomic and environmental prerequisites have been met, FR reclamation is possible and even desirable from a sustainable development perspective. Moreover, a study conducted under the auspices of the European Commission (2002) showed that agricultural reclamation of municipal biosolids is preferable, both environmentally and economically, compared with disposal through landfilling or incineration (for more information, visit: http://europa.eu.int/comm/environment/waste/sludge/sludge_disposal.htm).

In the United States, following an exhaustive literature review, the National Academy of Sciences (2002) concluded there was no scientific evidence that reclamation of municipal biosolids in compliance with applicable standards is harmful to human health. However, the Academy did recommend that research continue in order to clarify areas of uncertainty (for more information, visit: http://stills.nap.edu/books/0309084865/html/).

2.3.2 Public consultations

In 1996, the Bureau d'audiences publiques sur l'environnement du Québec (BAPE) held extensive consultations on waste management, including separate sessions on FR composting and spreading. The final report underscored the need to restrict landfilling of residual materials and increase reclamation in various forms.

Subsequently, the Ministère de l'Environnement (1998) submitted its FR reclamation criteria to its main partners, including the Union des producteurs agricoles (UPA), the Ordre des agronomes du Québec (OAQ), the Ministère de l'Agriculture, des Pêcheries

et de l'Alimentation du Québec (MAPAQ) and the Ministère de la Santé et des Services sociaux (MSSS), for consultation. Acting on their recommendations, the Ministère de l'Environnement made numerous changes to the criteria. Another public consultation, held in 2001 focussed on the maximum permissible levels for cadmium and dioxins/furans in fertilizing residuals (Hébert, 2003).

Furthermore, the *Guidelines* incorporates three of the Bureau de normalisation du Québec (BNQ) standards, which were developed following public consultations in Québec and Canada.

Thus, the principle of reclaiming fertilizing residuals through land application and the basis for the reclamation criteria in force in Québec have been the object of extensive consultations with external stakeholders and the public at large.

2.3.3 Québec Residual Materials Management Policy 1998-2008

Following up on the BAPE recommendations, the *Québec Residual Materials Management Policy 1998-2008* (Québec, 2000) set reclamation objectives for the development of the agricultural reclamation and composting system. Section 5.6.8 of the Policy states: "The ultimate goal is to ensure that no sludge is landfilled until it has been demonstrated that recovery is not an economically viable option." (For more information, visit: http://www.menv.gouv.qc.ca/matieres/mat_res-en/index.htm). In practice, this is an extension of the approach adopted by the Ministry in 1987 to promote the reclamation of quality municipal sludge (MENV, 1987).

FR composting and spreading prevents nearly 1.8 million wet tonnes of residuals from being landfilled or incinerated annually (Table 2.1). This system allows for the recovery of larger quantities of residuals as compared with the majority of other systems covered by the Policy (paper, metal, plastic, etc.). Based on the data contained in the *Bilan 2002 de la gestion des matières résiduelles au Québec* published by RECYC-QUÉBEC (2003) (visit http://www.recyc-quebec.gouv.qc.ca/upload/Publications/zzBilan2557.pdf), only the recovery of demolition and construction residuals is on a par with FR reclamation. It is estimated that FR reclamation contributes more than $55M a year to the economy.

2.3.4 Guiding principles

This *Guidelines* is based on a number of guiding principles (Table 2.2) which were retained following a public consultation process (MENV, 1998). These principles were approved by representatives from various administrative units of the Ministry (Table sectorielle agricole) in September 2001.

TABLE 2.2 GUIDING PRINCIPLES RETAINED FOR THE *GUIDELINES*

Guiding Principles	Examples
1. Residual materials spread on soil must have agricultural value.	➢ Fertilizing properties (fertilizer or soil amendment) proven by agronomic studies, by the content of fertilizing elements (MRI), etc.
2. Achieve government goals and objectives set out in the *Québec Residual Materials Management Policy 1998-2008* and related regulations.	➢ 60% recovery of organic matter and 70% of recyclable wood fibre ➢ Reclamation of sludges, except if not economically possible ➢ Composting of household waste (three-stream collection), etc.
3. Aim for harmonization with regulatory standards, namely the RRAO and the RRGC. Amend the regulations, when necessary.	➢ Setbacks from wells ➢ Phosphorus, nitrogen management, etc.
4. Conservative criteria to foster social acceptance on an international level and protect markets for farmers.	➢ Dioxins and furans ➢ Pathogens, etc.
5. The criteria should be part of a Canada-wide standards harmonization process involving the BNQ, the Canadian Council of Ministers of the Environment (CCME) and the Canadian Food Inspection Agency (CFIA).	➢ BNQ standards for composts and liming materials ➢ CCME compost quality guidelines ➢ Federal *Fertilizers Act* (administered by the CFIA)
6. The criteria must be scientifically based in order to minimize environmental and health risks.	➢ No quality criteria for FRs should be more permissive than the USEPA's "exceptional quality" criterion for municipal sludges (risk analysis) ➢ Biotests, etc.
7. Usage restrictions must be commensurate with the risks, according to the quality of the FRs and their use.	➢ Establishment of quality classes (C-P-O categories), some with few, others with more, restrictions.
8. Empower certified professionals and reduce the administrative burden of the regional offices, especially for the low-risk FRs.	➢ Agrologists ➢ Forest engineers ➢ Engineers
9. Have the FR promoter bear the cost of independent quality control.	➢ BNQ certification ➢ Sampling firms accredited by the CEAEQ ➢ Accredited laboratories
10. On livestock farms, prioritize the use of farm manure.	➢ Achieved through AEFPs
11. Documents must be user friendly.	➢ Simplify and clarify the *Guidelines.*
12. Requirements and procedures must be practical to verify.	➢ Some parameters must be re-evaluated. E.g. the location of underground agricultural drains.
13. The criteria must cover multiple uses associated with fertilization and soil amendment.	➢ Agriculture, silviculture, soil mixes, domestic use ➢ Other uses (bedding, mulching, roadsides) ➢ On-site storage/composting
14. FRs exclude manures (solid and liquid).	➢ Manures are governed by the RRAO. ➢ The treatment of manures by composting is covered in the *Guidelines*.
15. FRs exclude contaminated soils.	➢ The management of these soils is covered by the *Soil Protection and Rehabilitation of Contaminated Sites Policy,* although it does not address agricultural activities or soils.

Note: The principles are not listed in order of priority.

All of the criteria in the *Guidelines* were reviewed in keeping with the guiding principles. The importance of the principles was carefully weighed in cases where they might lead to contradictory choices. For example, some scientific studies show that the maximum limits could be raised for several contaminants. Such modifications were justifiable based on guiding principles 2 and 6. Conversely, more restrictive criteria were maintained in several cases based on principles 4 and 5.

2.3.5 Reference works

For more information on the underpinnings of the *Guidelines*, readers are invited to visit the Ministry's website: http://www.menv.gouv.qc.ca/matieres/mat_res-en/fertilisantes/faq.htm. The *Agricultural Utilization of Fertilizing Residual Materials: Questions and Answers* leaflet provides answers to the most frequently asked questions. For example:

- Does reclamation hinder surplus manure management?
- Do FRMs[2] contain contaminants?
- Can FRMs harm crops?
- Can spreading residuals contaminate well water?
- Will FRM application contaminate agricultural soils?
- Is it possible for an unknown contaminant to be present in FRMs and cause irreversible damage to soil over time?
- Can FRM utilization cause health problems in farmers or consumers?
- Can FRMs be used in organic farming?

The Bibliography of the *Guidelines* also presents numerous information sources, including works available at the Ministry's documentation centre and in many university libraries.

[2] FRM: fertilizing residual materials (expression used in the leaflet).

3 MAIN REGULATORY BODIES

This section provides an overview of the main stakeholders responsible for applying the standards and regulations pertaining to FR reclamation enacted at the federal, provincial and municipal levels.

3.1 Canadian Food Inspection Agency (CFIA)

The CFIA administers the *Fertilizers Act* and the *Fertilizer Regulations*. Products sold or imported, such as fertilizers and supplements (soil amendments), must comply with federal labelling and safety standards. The federal standards governing chemical contaminants and pathogens are very similar to the criteria applied by the Ministère de l'Environnement du Québec, as they have the same origins.

However, the federal regulations only govern products that are sold or imported. They do not cover the FRs that generators provide to farmers, except for FRs from the United States. If necessary, such cases can be brought to the attention of the CFIA. With some exceptions, the *Fertilizers Act* and the *Fertilizer Regulations* do not cover soil mixes, either.

For more information on the CFIA, visit:
http://www.inspection.gc.ca/english/plaveg/fereng/ferenge.shtml

3.2 Ministère de l'Environnement du Québec (MENV)

In its *Declaration of Services to the Public*, the Ministry notes that its mission is "to ensure environmental protection with a view to achieving sustainable development." In the case of FRs, the Ministry must promote the achievement of the environmental objectives for reclamation set out in the *Québec Residual Materials Management Policy 1998-2008* (MENV, 2000), while ensuring that these activities are carried out in a manner that respects the environment and human health

The MENV therefore exercises control prior to authorization and during activities to ensure that CA applicants, their agents and farmers comply with the Act, the regulatory standards and requisite certificates of authorization (CA). Section 5 outlines the specific responsibilities of the Ministry and other stakeholders with regard to the certificates of authorization issued by the Ministry.

Contact information for the regional offices of the Ministry is available online at:
http://www.menv.gouv.qc.ca/regions/index.htm.

3.3 Commission de protection du territoire agricole (CPTAQ)

The CPTAQ administers the laws and regulations related to the protection of agricultural land and activities. The term "agricultural activities" as defined in the *Act respecting the preservation of agricultural land and agricultural activities* administered by the CPTAQ means:

"The practice of agriculture including the practice of allowing the land to lie fallow, the storage and use, on a farm, of chemical, organic or mineral products and of farm machinery and equipment for agricultural purposes.

Where carried out by a producer on his farm with respect to farm products from his operation or, secondarily, from the operations of other producers, activities relating to the storage, packaging, processing and sale of farm products are considered to be agricultural activities."

FR reclamation in agricultural zones is therefore considered to be an agricultural activity by the CPTAQ. There are some exceptions, however. In the case of activities deemed not to be agricultural, section 97 of the *Act respecting the preservation of agricultural land and agricultural activities* stipulates that CPTAQ authorization must be obtained before a CA can be issued under the EQA. See sections 9 and 14 on temporary storage and composting.

Concerning the application of the EQA, jurisprudence has established that the expression "agricultural activities" must be defined according to the *Petit Robert* dictionary (see Glossary), which offers a different definition than the one used by the CPTAQ.

3.4 Ordre des agronomes du Québec (OAQ)

The OAQ plays a role in protecting the public in keeping with the *Professional Code* and the *Agrologists Act*. It is responsible for ensuring the competency of agrologists and their compliance with the *Code of Ethics*.

The OAQ's oversight role is an important one, since agrologists are required to develop agro-environmental reclamation plans (AERP) for FR-receiving parcels on agricultural lands. As a rule, agrologists also develop agro-environmental fertilization plans (AEFP) for farms in accordance with the *Regulation respecting agricultural operations* (RRAO).

For more information on the OAQ, visit: http://www.oaq.qc.ca/historique.asp.

3.5 Other professional orders

FR reclamation projects often require the services of various types of professionals, and therefore several professional associations may have an oversight role to play in relation

to the involvement of their members. Table 3.2 presents various situations requiring the participation of professionals or technologists who belong to a professional order.

TABLE 3.1 PROFESSIONALS AND TECHNOLOGISTS BELONGING TO A PROFESSIONAL ORDER WHO ARE INVOLVED IN FR RECLAMATION ACTIVITIES

Professional/Technologist	Activities
Agrologist	AEFP - agriculture
Agrologist	AERP - agriculture
Forest engineer	AERP- silviculture
Engineer or agrologist	Storage/composting
Agrologist or vet	Bedding
Chemist (or agrologist for agricultural analyses)	FR/soil analyses
Technologists	Various tasks under the supervision of a professional

3.6 Bureau de normalisation du Québec (BNQ)

3.6.1 Development of commercial standards

The BNQ is a standards development organization certified by the Standards Council of Canada and authorized to draw up commercial standards for fertilizing materials in Canada. BNQ standards are developed in keeping with ISO principles and methods. They are approved through a consensus-based approach involving manufacturers, consumers (users) and other stakeholders serving on a standards writing committee. At present, there are three BNQ standards pertaining to FRs:

- Organic Soil Conditioners – Composts (CAN/BNQ 0413-200; BNQ, 1997a) – revised version expected in summer 2004;
- Organic Soil Conditioners – Granulated Municipal Biosolids (CAN/BNQ 0413-400; BNQ, 2002);
- Liming Materials from Industrial Processes (NQ 0419-090; BNQ, 1997b).

The BNQ standards deal with the agronomic properties of FR products and related environment and health considerations, for example, maximum contaminant limits and the products' directions for use. These standards are harmonized with federal regulations pertaining to fertilizers and, in many instances, they are more restrictive. The BNQ standard concerning composts is, for the most part, in line with the CCME's *Guidelines for Compost Quality* (1996) and with this *Guidelines*.

The BNQ standards can be ordered online at: http://www.bnq.qc.ca.

3.6.2 Certification of compliance

In addition to developing commercial standards, the BNQ may, as an independent organization, certify that a given FR complies with its standards. In 2003, ten FRs were certified by the BNQ. They included four composts, five liming materials and one granulated municipal biosolids product, collectively representing approximately 150 000 tonnes/year or roughly 10%, by volume, of all the FRs and composts reclaimed in Québec. The certification costs are borne by the generator, i.e. the plant or municipality.

A BNQ-certified FR may be land applied according to the directions for use, without a certificate of authorization from the Ministry (see Section 4). In the case of BNQ-certified FRs, the *Regulation respecting groundwater catchment* is more flexible with regard to separation distances for FR storage and spreading (see sections 9 and 10).

Certification of compliance with a BNQ standard can also be carried out by some other agency, whether Canadian or foreign, that is recognized by the Standards Council of Canada.

3.7 Municipalities

With respect to FR reclamation, municipalities and regional county municipalities (RCMs) exercise the following functions and powers:

- manage the residual materials produced by the municipality (municipal sludges, leaves and lawn cuttings, urban compost, etc.);
- develop a Residual Materials Management Plan in accordance with the *Québec Residual Materials Management Policy 1998-2008*;
- issue attestations of compliance with municipal regulations for CA applications;
- regulate spreading prohibition dates in accordance with the *Municipal Code* and the *Cities and Towns Act* (maximum of 8 days per year).

It should be noted that municipalities are not responsible for establishing separation distances for FR odours in agricultural zones, as they are in connection with the reclamation of farm manure. FR reclamation is not included in the "odours resulting from agricultural activities" under section 19.1 of the EQA. Furthermore, FRs are not covered by the *Guidelines respecting odours caused by manure from agricultural activities* (Québec, 2003). Municipalities may establish odour-related distance constraints for non-agricultural applications of FRs, (see also Appendix 1 for further details on odour-related responsibilities).

Municipalities can establish separation distances to protect groundwater, but only to the extent of the authority conferred on them under the *Regulation respecting groundwater catchment* (RRGC).

4 RECLAMATION ACTIVITIES REQUIRING A CA

4.1 General

A CA is required in the following cases:

- for activities that are likely to alter environmental quality within the meaning of section 22 of the EQA;
- when authorization is required under a specific industry regulation.

Owing to the way the laws and regulations are structured, it is often easier to proceed by determining whether a given activity is exempt from a CA. Exemptions fall into three categories:

- regulatory
- administrative
- environmental (activities that present a low environmental risk).

4.2 Regulatory exemptions

These exemptions are set out in the *Regulation respecting the application of the EQA* (Q-2, r.1.001) (visit: http://www.menv.gouv.qc.ca/publications/lois-reglem-en.htm). They concern research and development activities, agricultural activities and forest management activities (Table 4.1).

TABLE 4.1 ACTIVITIES EXEMPT FROM SECTION 22 OF THE ACT PURSUANT TO THE *REGULATION RESPECTING THE APPLICATION OF THE ENVIRONMENT QUALITY ACT* (Q-2, R.1.001)

Reference in Q-2, R.1.001	Exempted Activities
Section 2.5	Preliminary investigation, drilling, exploration, experiments outside a mill or technical readings prior to any project.
Section 2.12	**Agricultural activities**(1), unless otherwise provided for in the *Regulation respecting the prevention of water pollution in livestock operations*, **except**: a) any operation to transform(2) substances to be used in the cultivation of plants, except an operation to transform only manure(3) or farm products(1) whose volume is less than 500 m³(4); b) the spreading of substances other than manure3), liquid dairy wastes, mineral fertilizers(1), liming materials(1) that meet the standards of the BNQ(5) and compost prepared on a farm(1), using only farm products(1).
Section 2.13	**Forest management activities**(1) within the meaning of section 3 of the *Forest Act* (R.S.Q., c. F-4.1), whether such activities are carried out in forests in the public domain or in private forests, **except**: a) the spreading of substances other than manure, mineral fertilizers(1), logging debris from cutting areas and liming materials(1) that meet the standards of the BNQ(5).

(1) See Glossary.

(2) Transformation: this term refers in particular to composting.

(3) The term "manure" is not explicitly defined in this regulation, or in the RRAO. The manure may come from another farm.

(4) The volume of 500 m³ is not an annual volume, but an aggregate maximum volume measured on-site during an inspection.

(5) Compliance with BNQ standards: see Glossary and Section 3.6.

4.2.1 Research and development

In general, all FR research projects must fulfill the following requirements, which are derived and adapted from instruction note 95-16:

- research activities must be supervised by a research expert (a M.Sc. is often required);
- research activities must be limited in time and space, according to the project scale (laboratory or bench scale, pilot project, prototype, etc.);
- the aim of the project must be to measure one or more aspects on which there is little or no knowledge, under conditions peculiar to Québec;
- there must be a document that sets out the hypotheses, objectives and detailed scientific protocol established according to rigorous scientific methods, and it must include an adequate experimental design. It must also identify the technical team assigned to the research activities and the drafting of required documents;
- the document describing the project must specify the parameters to be observed or measured. It must also set out the procedures to be followed for FR characterization (sampling protocol and analytical methods), and the effects on each component of the environment (water, air, soil, plants, wildlife, humans, etc.) covered in the study;

- all technical documents related to the project (protocol, progress report, final report, etc.) must be signed by the professional in charge.

Although in principle research activities are exempt from a CA, the promoter must inform the regional office of the project and provide the above-mentioned documents. The promoter must also ensure compliance with section 20 of the EQA (see Section 1). Upon completion of the project, a report describing the water-air-soil impacts must also be submitted to the regional office.

Projects that do not meet these requirements are considered to be reclamation projects and therefore require a CA.

4.2.2 Agricultural activities – Spreading

The regulation (Table 4.1) indicates that some agricultural activities are exempt from a CA. These exemptions are mainly concerned with the spreading of FRs in the form of:

- mineral fertilizers
- manure
- farm compost
- BNQ-compliant calcareous amendments.

It should be noted that mineral fertilizers, for example, may contain up to 15% organic matter (see Glossary). This means that a granulated mineral fertilizer can contain a certain amount of organic granules, such as treated manure or granulated municipal biosolids. These mixtures must, however, be manufactured at a plant.

Manure that is blended with FRs may no longer qualify as "manure" and, consequently, may lose its CA exemption for agricultural application. Until the Ministry has ruled on the definition of the term "manure" within the meaning of the *Regulation respecting the application of the EQA*, these types of mixtures will be evaluated on a case-by-case basis by the regional offices. However, where the FR is used as livestock bedding, the resulting bedding and livestock waste mixture is considered to be manure, since the RRAO includes "bedding" in its definition of the term "livestock waste."

With respect to farm compost, other than absorbents used as bedding, some FRs added during composting such as sawdust are considered, by analogy, to be "farm products" (see Glossary).

A few FRs are considered to be "calcareous amendments" according to the definition retained (see Glossary). These are part of the broader group of liming materials (Section 2.2). For the difference between "compliant" and "certified," see Section 3.6.

As mentioned earlier, jurisprudence has established that the expression "agricultural activity" as used in the *Regulation respecting the application of the EQA* must be interpreted in accordance with the everyday meaning of the terms (*Petit Robert),* and not according to the definition provided in the *Act respecting the preservation of agricultural land and agricultural activities*.

4.2.3 Agricultural activities – Temporary storage

For regulatory purposes, temporary storage at the application site is considered an integral part of the spreading activity. If the spreading activity is exempt from a CA pursuant to the regulation, storage of the FR is likewise exempted.

4.2.4 Agricultural activities – Transformation (composting)

The transformation of manure and other farm waste by composting and some other treatments is exempt from a CA by regulation. By analogy, absorbents traditionally used in agriculture, such as sawmill residuals (sawdust, wood chips, bark, etc.) and peat, are considered to be "farm products" (see Glossary).

It should be noted that the full treatment of manure by composting is governed by specific regulatory provisions (see Section 14.2).

4.2.5 Agricultural activities – Livestock bedding

The use of FRs as livestock bedding is not mentioned in section 2.12 of the *Regulation respecting the application of the EQA*. Therefore, this activity is exempt from a CA on account of its status as an agricultural activity, which differs from "spreading" and "transformation." However, this is not the case for bedding made from paper mill residuals given that section 95 of the *Regulation respecting pulp and paper mills* (2004 version) states that a CA is required for the reclamation of paper mill residuals. While the use of other types of residuals as livestock bedding in an agricultural context may be exempt from a CA, this use may be deemed to alter environmental quality if the criteria related to maximum contaminant limits listed in Section 15 are not met.

A mixture of livestock bedding and livestock waste is considered to be manure (see Section 4.2.2).

4.2.6 Forest management activities - Spreading

These exemptions are similar to those applying to agricultural spreading activities. The exemption for mineral fertilizers presupposes that forest fertilization operations are considered to be a forest management activity.

4.3 Administrative exemptions

These are exemptions adopted by the Ministry between 1994 and 1996 (Table 4.2).

TABLE 4.2 ADMINISTRATIVE EXEMPTIONS UNDER SECTION 22 OF THE *ENVIRONMENT QUALITY ACT*

Spreading (agriculture)	➢ Sludges from fish farming[1]. ➢ Plant matter that is neither transformed nor mixed with other types of residuals, provided that these residuals come solely from the farm[1].
Composting	➢ Composting[1, 2] of plant matter (leaves, grass[3], pruning debris, wood chips, sawdust, garden waste, etc.), sorted at the source and comprising a volume of less than 150 m³ per year, provided that these products do not derive from an industrial process and are not contaminated with pesticides[4] or any other contaminant[5]. ➢ Agricultural composting of a mixture of less than 150 m³[6] of dead leaves and manure[7, 8].
Final disposal or storage	➢ Tree pruning debris that has not been mixed with other residuals and has not been treated[9].

(1) Taken from the *Directive sur les exclusions administratives à l'application de l'article 22 de la LQE*, Politiques et directives – Québec.

(2) The exemption for the composting of green residuals presupposes that the use of these compost products is also exempt from a CA.

(3) Theoretically, grass can only be composted if it is mixed with a carbon-rich bulking agent such as bark and tree leaves.

(4) "Contaminated with pesticides" does not refer to grass clippings, which generally contain traces of pesticides, but to such items as wood chips treated with pentachlorophenol or copper chromium arsenate.

(5) "Any other contaminant" refers mainly to human fecal matter or manures (pathogens).

(6) In this case, the maximum volume (150 m³) is not an annual limit, but an aggregate maximum volume which must never be exceeded and which is measurable in the field at any given time.

(7) The compost produced may be spread without a CA on farms only.

(8) Taken from the directive *Compostage de fumier et de feuilles mortes*, March 11, 1994.

(9) Taken from Decision No. 93.09.03.01 – *Utilisation des résidus d'élagage*. Comité de direction des opérations régionales.

4.4 Exemptions for low environmental risk activities

Low environmental risk activities are not likely to "alter the quality of the environment" within the meaning of sections 20 and 22 of the EQA (see Section 1 of the *Guidelines*). These exemptions from a CA were established on the basis of scientific evidence, and most of them were adopted in 1999 by virtue of instruction note 99-06. Furthermore, they take into account existing regulatory standards for the protection of water, notably those set out in the *Regulation respecting agricultural operations* and the *Regulation respecting groundwater catchment*.

Table 4.3 presents the exemptions from a CA for spreading. Table 4.4 lists the exemptions for the storage of FRs and for the manufacture and use of soil mixes. The basis for these exemptions is discussed in Appendix 1.

TABLE 4.3 SPREADING – LOW ENVIRONMENTAL RISK ACTIVITIES EXEMPT FROM A CA [1]

Products	Fertilizers and other fertilizing materials: ➢ that comply with the federal *Fertilizers Act*; ➢ and are **sold** in bags or individual containers of less than 50 litres[2]; ➢ with the labelling required by federal law.
Natural plant residuals	Leaves, tree pruning debris, bark and other wood residuals that are not contaminated and do not come from a paper mill, applied in a volume less than 250 m³/ha/year on cultivated land or less than 1 000 m³/ha/year when used as mulch in tree farms or for growing perennials[3].
Products and compost certified by the BNQ[4]	Products certified by the BNQ and used as directed.
Other composts	Composts from: ➢ domestic composters; ➢ community gardens; ➢ food services (cafeterias) or other establishments, only when the compost consists solely of food residuals sorted at the source or plant residuals not contaminated with manure, human fecal matter, abattoir residuals or meats that are unfit for consumption[5]; ➢ Class C1-P1-O1 compost from a composting activity producing less than 5 000 t/year under a CA with a quality control commitment[5].

[1] Notwithstanding the exemption from a CA, the standards set forth in the RRAO and RRGC are applicable at all times in the case of agricultural activities or activities carried out near groundwater catchment works (see Section 10).

[2] This includes bags of fertilizer, compost or soil amendments sold by garden centres or mineral fertilizer manufacturers. The bags may be sold separately or in batches (pallets). The containers can be easily traced by the CFIA. Products provided or sold in bulk in larger containers or in unlabelled containers are not exempt from a CA.

[3] This is an annual volume. It is roughly equivalent to an average soil coverage of 2.5 cm for 250 m³/ha of residuals and 10 cm for 1 000 m³/ha of land applied residuals.

[4] See Section 3.6.2.

[5] If a CA is required for a composting activity, it must comprise a quality control commitment to ensure compliance with the C1-P1-O1criteria. See sections 8 and 14.

TABLE 4.4 MANUFACTURE OF SOIL MIX AND STORAGE AT THE APPLICATION SITE – LOW ENVIRONMENTAL RISK ACTIVITIES EXEMPT FROM A CA

Manufacture and use of soil mix	**Manufacture** Exemption from a CA if < 150 m³ of soil mix per year, except products made from the following materials: ➢ human fecal matter (including municipal biosolids that are not certified by the BNQ), ➢ matter contaminated with human fecal matter, ➢ abattoir residuals, ➢ livestock waste, ➢ meats that are unfit for consumption, ➢ paper mill biosolids, ➢ composts not certified by the BNQ produced from the above-mentioned matter.
	Use ➢ Soil mixes deriving from a manufacturing activity that is not subject to a CA may be distributed or used without a CA. ➢ When a CA is required to manufacture a soil mix, quality control of the product is necessary to allow subsequent use of the soil mix without a CA (Section 13).
Temporary storage at the application site (maximum of 6 months for any given heap)	➢ Products and composts that are certified by the BNQ and stored as directed. ➢ Storage of all FRs in leak-proof containers (bins, manufactured containers and small volume tanks). If the residuals have a strong odour (categories O2-O3), the containers must be closed or covered. ➢ Heaps of tree leaves, soil mixes, bark and other wood residuals(1) that are not contaminated(2) and do not come from paper mills, in a volume of less than 50 m³/establishment (< 150 m³ for farms(3)).

(1) Storage of tree pruning debris is covered by an administrative exemption (Table 4.2).

(2) Examples of contaminated material: wood chips treated with pentachlorophenol (PCP) or copper chromium arsenate, or soiled by livestock waste or human fecal matter.

(3) This is not an annual volume, but the aggregate volume at any given time. The establishment is an agricultural operation, a nursery, etc.

4.5 Summary of CA exemptions

Any FR reclamation activity not listed in the exemptions in Tables 4.1, 4.2, 4.3 or 4.4 requires a CA, unless the Ministry decides, after review, that the activity is not likely to alter environmental quality.

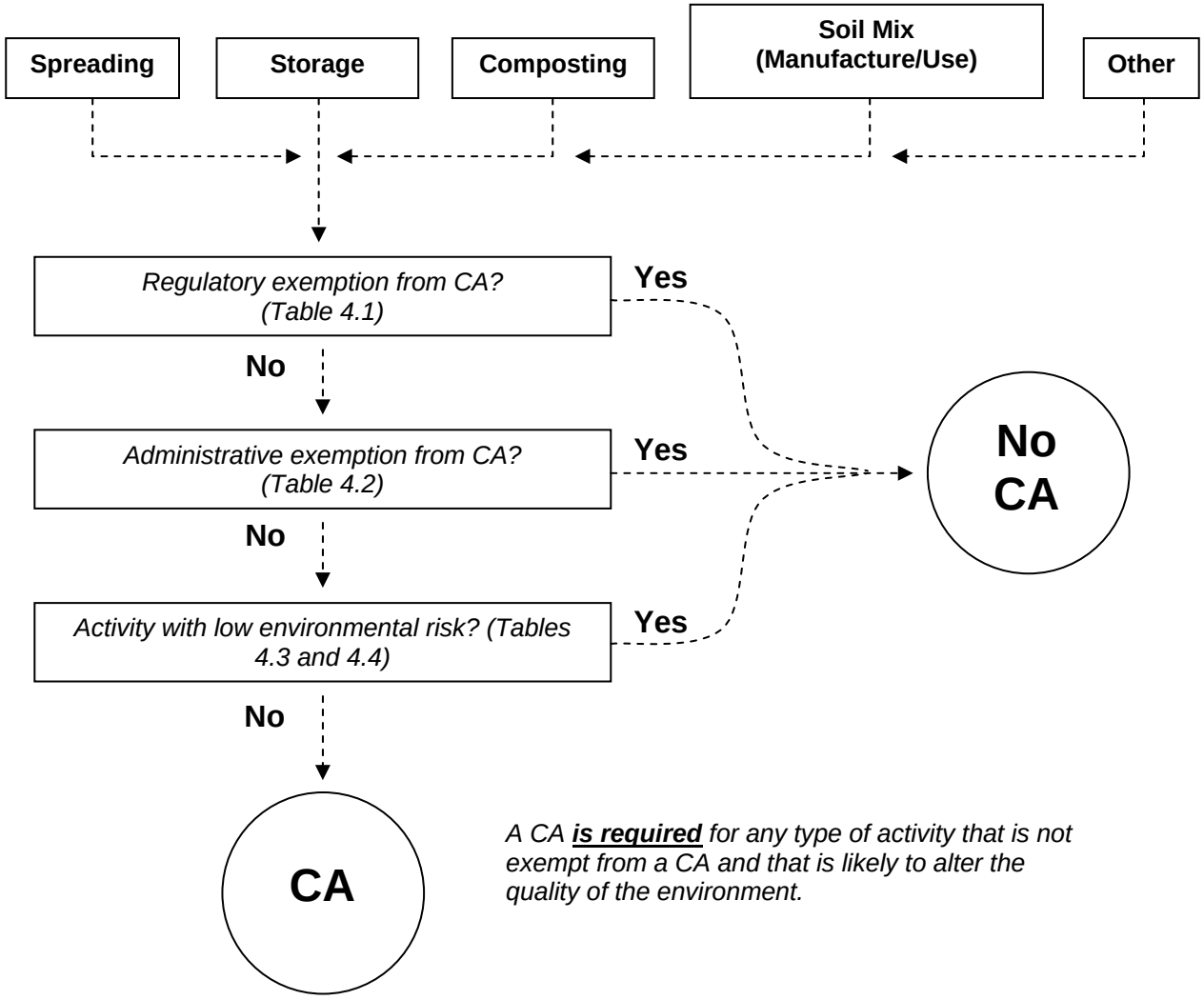
The flowchart in Figure 4.1 can be used to determine whether a particular FR reclamation activity requires a CA. It illustrates the situation for each of the following activities:

- temporary storage
- spreading
- composting
- soil mix manufacture
- soil mix use
- other activities.

For example, the reclamation of compost produced from the residuals of a large cafeteria yields the following results:

- composting: CA required;
- storage of the compost: CA required;
- spreading of the compost: exempt from a CA;
- manufacture of soil mixes from the compost: CA required;
- use of soil mixes: exempt from a CA.

FIGURE 4.1 FLOWCHART FOR DETERMINING WHICH ACTIVITIES REQUIRE A CERTIFICATE OF AUTHORIZATION



When a CA is required for a given activity (no exemption from a CA), the reader should consult the corresponding sections of the *Guidelines* (see sections 5 to 15). Any activity exempt from a CA must nevertheless be carried out in accordance with section 20 of the EQA and the regulatory standards, notably those set out in the RRAO and the RRGC.

5 CA APPLICATION

5.1 CA application forms

Application forms can be obtained from the Ministry's regional offices for FR reclamation projects requiring a CA.

5.2 Responsibilities of the applicant and his partners

5.2.1 CA applicant

The applicant is the legal or natural person who signs the application (see Glossary). This person may be:

- the FR user, e.g. a farmer
- the FR generator, e.g. an industrial company or a municipality
- a brokerage firm
- a specialized promoter.

The applicant must sign the CA application form. If the signatory is an agent, the mandate must be appended to the CA application.

An applicant must submit a separate CA application for each receiving operation. Thus, more than one certificate of authorization for the agricultural reclamation of FRs can be issued to the same applicant. However, a separate CA application must be completed for each receiving agricultural operation subject to an agro-environmental fertilization plan (AEFP) and a phosphorus report (if required). When a CA is issued, the applicant becomes the holder of the CA (see Glossary).

In the event of failure to comply with a CA, the holder (CA applicant) is liable to receive a violation notice from the Ministry and to legal proceedings. Applicants must therefore make sure that any responsibilities they share with partners are clearly set out in their contractual agreements. Regardless, any individual who violates a specific regulatory standard is liable to receive a violation notice from the Ministry. An example would be a farmer who, in carrying out a spreading operation, failed to comply with the separation distances for ditches and watercourses stipulated in the *Regulation respecting agricultural operations*.

5.2.2 Agrologist

The agrologist's main role is to attest that all the requirements set out in the *Guidelines* have been addressed in the CA application. More specifically, agrologists must ensure that the agro-environmental reclamation plan (AERP) requirements have been met (see Section 10). Should they find any discrepancies, they must make sure

that they are justified and that supporting documents are included. Agrologists must also make sure that the other professionals or stakeholders involved have supplied the necessary information or letters of undertaking, for example, for FR analyses. This type of attestation of compliance is made directly on the CA application form.

An agrologist often acts on behalf of the applicant or his agent, and oversees the preparation of CA applications. In such cases, agrologists must provide their OAQ membership number to be entered on the form.

For land application on farms, the agrologist must verify whether the agricultural operation in question is required to have an AEFP pursuant to the RRAO, in addition to an AERP for the receiving parcels. Where applicable, the agrologist responsible for the AERP and the agrologist responsible for the AEFP must ensure that the two documents are in agreement. The OAQ has described the respective responsibilities of the agrologists involved in this type of situation at: http://www.oaq.qc.ca/.

After a CA has been issued and the project starts, the agrologist must fulfill his responsibilities by taking the necessary steps, such as making visits to the site to ensure that the farmer or the person carrying out the land application is well aware of the applicable separation distances.

5.2.3 Other professionals belonging to a professional order

In the case of silvicultural reclamation of FRs, a forest engineer must fulfill the responsibilities mentioned in Section 5.2.2. Other professionals belonging to a professional order may be called on to help prepare CA applications or take part in reclamation activities (Table 3.1).

5.2.4 FR generator

FR generators are primarily paper mills, agri-food plants, composting centres and municipal wastewater treatment plants.

Generators are responsible for:

- providing information related to the FR generating process;
- producing the required analyses (Section 6):
    - parameters,
    - sampling method,
    - sampling frequency,
    - accredited laboratories,
    - independent quality control or quality control performed by an accredited sampler;
- providing specific attestations (e.g. domestic sewage and industrial wastewater streams are kept separate);

- supplying a FR that meets the quality requirements contained in this document;
- ensuring that the delivery of FRs to the site occurs under the proper conditions;
- informing the agrologist (or authorized professional) in the following situations:
    - significant modification of the process/change in inputs,
    - process breakdowns/problems,
    - toxicity of liquid effluents discharged into a watercourse (paper mills).

Although these responsibilities may be entrusted to an agent under a contractual agreement, the generator should ideally be the one to sensitize and inform the public (Section 10.5), since he is often perceived as the responsible party.

5.2.5 Receiver

The receiving party, whether an agricultural or other operation, must assume its obligations, which generally include the following:

- compliance with separation distances and other regulatory standards;
    - RRAO
    - RRGC
- provision of the AEFP to the applicant (in accordance with RRAO requirements);
- compliance with the other storage and spreading criteria set out in the *Guidelines* (sections 9 and 10);
- implementation of measures to inform the public and raise awareness (Section 10.4);
- authorization from the owner if the spreading is to be done on leased parcels of land.

5.2.6 Undertakings by participants

The applicant, the professional and the receiver must sign the CA application form, thus indicating that they agree to the basic commitments. The generator's undertakings must be appended to the application form. The responsibilities of each participant may be spelled out in separate private contractual agreements and appended, as needed.

5.3 Responsibilities of the Ministère de l'Environnement du Québec

The Ministry exercises a number of responsibilities related to CAs, which are described in the following subsections.

5.3.1 Development of standards, criteria, guidelines and forms

The Ministry must develop standards and criteria related to reclamation activities. In cases of uncertainty, it must determine what research and information is needed in order to have the necessary studies carried out by either itself, the public sector, universities or private institutions.

The Ministry must also create and update reference guidelines and CA application forms.

5.3.2 Processing of CA applications

The regional offices process CA applications in accordance with the Ministry's *Declaration of Services to the Public*, which includes the following commitments (consult: http://www.menv.gouv.qc.ca/ministere/declaration-en.htm):

- "To send you, in the five working days following receipt of your application, an acknowledgement of receipt indicating the name of the person responsible for your file;
- To respond to your application within 90 days… except in special situations;
- To inform you, where applicable, of any delay in the processing of your file."

It should be noted that the 90-day time frame begins upon receipt of a duly completed application form. The applicant must therefore make sure that the application is complete and fully compliant, and that it includes a certificate attesting that the project does not contravene any municipal by-laws (see Table 5.1). An incomplete application form will be returned to the sender.

Ministry statistics show that in 2002, in cases where these conditions were met, 97% of CA applications for FR reclamation were processed within the time frames stated in the *Declaration of Services to the Public*.

The regional offices issue either a CA or a notice of refusal, as the case may be.

5.3.3 On-site verification

The Ministry verifies compliance with the standards set out in the following laws and regulations:

- *Environment Quality Act* (EQA), section 20 (Québec, 2003);
- *Regulation respecting agricultural operations* (RRAO) (Québec, 2002a);
- *Regulation respecting groundwater catchment* (RRGC) (Québec, 2002b).

The Ministry also verifies the compliance of activities that are subject to a CA under the *Act* and regulations:

- section 22 of the EQA;
- the *Regulation respecting the application of the EQA*;
- the *Regulation respecting pulp and paper mills*.

These laws and regulations may be consulted online at: http://www.menv.gouv.qc.ca/publications/lois-reglem-en.htm.

Should the Ministry note any situations of non-compliance with the regulatory standards or with the provisions of certificates of authorization, it may take the following action:

- support or violation notice
- revocation of the CA
- investigation
- legal proceedings.

During the administrative year 2002-2003, the Ministry carried out 75 inspections and issued 19 violation notices related to FR reclamation.

5.3.4 Information/awareness

Because the Ministry promotes sustainable development within the government as well as among Quebecers, (consult the annual management report, *Rapport annuel de gestion 2002-2003*, p. 14, at http://www.menv.gouv.qc.ca/ministere/rapports_annuels/index.htm), it informs and raises awareness among specific target groups and the general public. Note, however, that support programs for reclamation activities are administered by RECYC-QUÉBEC http://www.recyc-quebec.gouv.qc.ca/client/fr/accueil.asp.

5.3.5 Processing of complaints

Any citizen who notices a deterioration in air, water or soil quality caused by the reclamation of fertilizing residuals may file a complaint with the nearest regional office of the Ministère de l'Environnement. The Ministry will inform that person within five working days after receipt of the complaint of the steps being taken to deal with the complaint, including any action aimed at rectifying the situation reported.

The Ministère de l'Environnement set up the Bureau des plaintes (Complaints Office) to offer its clientele recourse to a neutral and impartial body in the event of disagreement or dissatisfaction with the processing of a file. However, before turning to the Bureau des plaintes, the complainant should first contact the director of the administrative unit responsible for the file to attempt to resolve the problem raised. The Protecteur du citoyen (ombudsman) is also authorized to handle complaints related to MENV activities.

For more information, visit:
http://www.menv.gouv.qc.ca/ministere/rejoindr/plaintes-en.htm.

5.4 General requirements

5.4.1 Basic regulatory requirements

Table 5.1 describes the basic regulatory requirements for every CA application pursuant to section 22 of the EQA and the *Regulation respecting the application of the EQA* (RRAEQA).

TABLE 5.1 EXCERPTS FROM THE *ENVIRONMENT QUALITY ACT* AND THE *REGULATION RESPECTING THE APPLICATION OF THE EQA*

EQA, section 22, paragraph 3	**The application for authorization must include** the plans and specifications of the structure or project to use the industrial process, operate the industry or increase production and must contain **a description of the apparatus or activity contemplated, indicate its precise location and include a detailed evaluation in accordance with the regulations of the Government of the quantity or concentration of contaminants expected to be emitted, deposited, issued or discharged into the environment through the proposed activity**(1).
EQA, section 22, paragraph 4	**The Minister may also require from the applicant any supplementary information, research or assessment statement he may consider necessary** to understand the impact the project will have on the environment and to decide on its acceptability, unless the project has already been the subject of a certificate under section 31.5, 31.6, 154 or 189, of an authorization issued under section 167 or 203 or of a certificate of exemption from the assessment and review procedure issued under section 154 or 189.
RRAEQA, section 7 (excerpt)	Every application for a certificate of authorization shall be submitted in writing to the Minister of the Environment and Wildlife and, in addition to meeting the requirements of section 22 of the Act and any provision in another regulation made under the Act, shall contain the following information and documents: 1° in the case of a natural person, his name, address and telephone number. 2° in the case of a legal person, partnership or association, its name, the address of its head office, the position of the signatory of the application and a certified copy of a document issued by the board of directors, the partners or the members and authorizing the signatory of the application to submit it to the Minister; 3° the registration number in the central file of enterprises, assigned to the applicant's business by the Inspector General of Financial Institutions; 4° in the case of a municipality, a certified copy of a council resolution authorizing the signatory of the application to submit it to the Minister; 5° the cadastral designation of the lots on which the project is to be carried out; 6° a description of the project's technical aspects; 7° a plan of the site on which the project is to be carried out, specifically indicating the zoning of the land in question; 8° an indication as to the type and volume of contaminants liable to be emitted, discharged, issued or deposited into or in the environment, as well as their points of emission, discharge, issuance or deposit(1).
RRAEQA, section 8 (excerpt)	A person who applies for a certificate of authorization shall also submit to the Minister a certificate attesting that the project does not contravene any municipal by-law. The certificate shall be issued by the clerk or the secretary-treasurer of a local municipality or, in the case of an unorganized territory, of a regional county municipality.

(1) As part of the description of the project, the applicant must provide a location plan identifying the parcels of land (storage, composting and spreading sites), lot numbers, cadastral designations, municipality and RCM, as well as zoning, property owners, surface area, crops and sensitive zones (lakes, watercourses, etc.) and establishments within a 500-metre radius. The application must conform to all of the standards and criteria set out in the *Guidelines*.

5.4.2 CA duration and activities covered

A CA application may cover spreading activities, composting in the field or storage with a view to spreading on the parcels of land of one or more establishments. CA applications should not cover periods of more than one year (one growing season), except in special cases. These include highly foreseeable reclamation activities (little chance of a change in crop, and the FR batch or quality).

5.4.3 CA modification

A project may need to be modified after a CA has been issued by the Ministry. In such a case, the CA holder must contact the regional office so it can be determined whether the CA needs to be modified.

5.4.4 Need for an agro-environmental fertilization plan (AEFP)

The majority of farms in Québec are required to have an AEFP in accordance with the provisions of the *Regulation respecting agricultural operations*. This plan must cover all of the fertilizing materials used on every parcel of land that is part of the agricultural operation. Except as provided for in the RRAO, the AEFP is drawn up by an agrologist.

If the agricultural operation requires an AEFP at the time slated for FR spreading, the regional offices have two options.

1. Ask the agrologist who signed the AEFP to:
    - attest in writing that the AEFP for the operation is up to date and that the farmer has a copy;
    - attest in writing that the AEFP covers the FRs in accordance with RRAO standards;
    - append an up-to-date phosphorus report for the operation.
2. Ask that the AEFP be submitted with the CA application.

The applicant must contact the regional office to determine which option is being implemented. However, if no AEFP is required under the RRAO at the time slated for FR spreading, it is not necessary to include the AEFP with the CA application. Moreover, for the first option, an applicant may be released from the obligation to provide a phosphorus report with the CA application by the regional office in the case of FRs low in phosphorus:

- primary paper mill biosolids, primary paper mill deinking biosolids, bark, wood chips, sawdust;
- other FRs containing < 0.25% P_2O_5, dry weight (d.w.).

5.4.5 Activities in public forests

For reclamation activities in public forests, the applicant must provide written authorization from the Ministère des Ressources naturelles, de la Faune et des Parcs.

6 ANALYSES REQUIRED

The determination of FR status and the preparation of agro-environmental reclamation plans (AERP) are based on the proper characterization of the reclaimed residuals and the receiving soils. This section provides detailed information on these aspects.

6.1 Parameters to be analyzed

The chemical parameters to be analyzed, which are listed in Table 6.1, are divided into three groups: agri-environmental (e.g. nitrogen and phosphorus), agronomic (e.g. potassium) and environmental (e.g. cadmium). The number of parameters to be analyzed varies with the type of residual; this number has been established on the basis of characterization analyses carried out by the Ministry and other organizations over the years. One example is the paper mill residual characterization campaign (H. C. Lavallée inc., 1996).

The microbiological parameters consist of pathogenic microorganisms or pathogen indicators (salmonella and *E. coli*), as well as other parameters indicating biological, physical or chemical stabilization that would reduce pathogenic vector attraction (flies, vermin, etc.).

Given the many microbiological parameters to be analyzed, which vary with the type of residual, the category and the option, they have been grouped with the criteria in Table 8.3.

TABLE 6.1 CHEMICAL PARAMETERS TO BE ANALYZED ACCORDING TO THE TYPE OF RESIDUAL

	Dry matter	Total N	N-NH_4	Total P_2O_5	Total K_2O	Organic matter	Neutralizing value[1]	C:N ratio	pH	Aluminium	Arsenic	Boron	Cadmium	Cobalt	Chromium	Copper	Iron	Mercury	Manganese	Molybdenum	Sodium	Nickel	Lead	Selenium	Zinc	Dioxins and furans	Pathogens
Uncontaminated bark and wood[2]	✓																										
Grass and leaves	✓	✓	✓	✓	✓	✓		✓																			
Other non-woody plants[2]	✓	✓	✓	✓	✓	✓		✓																			
Paper mill biosolids	✓	3	3	3	3	✓	4	✓	✓	5	✓	6	✓	✓	✓	✓	5	✓	✓	✓		✓	✓	✓	✓	7	
Paper mill lime residuals	✓			✓	✓		✓		✓		✓		✓		✓	✓			✓	✓	✓	✓	✓	✓	✓		
Ashes from paper mills or sawmills[8]	✓			✓	✓		✓		✓	5	✓	6	✓	✓	✓	✓	5	✓	✓	✓	✓	✓	✓	✓	✓	9	
Municipal biosolids[10]	✓	✓	✓	✓	✓	✓	4	✓	4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	7	16
Septic tank residuals[10]	✓	✓	✓	✓	✓	✓	4	✓	4	5	✓	✓	✓	✓	✓	✓	5	✓	✓	✓		✓	✓	✓	✓		
Abattoir biosolids and residuals[11]	✓	✓	✓	✓	✓	✓	4	✓	4	5						12	5										
Agri-food biosolids	✓	✓	✓	✓	✓	✓	4	✓	4	5						✓	5				✓						
Declassified milk, whey and derivatives	✓	✓	✓	✓	✓																✓						
Composts	✓	✓	✓	✓	✓	✓		✓		5	✓	6	✓	✓	✓	✓	5	✓	✓	✓	✓	✓	✓	✓	✓	13	
Other residuals	✓	✓	✓	✓	✓	✓	14	✓	✓	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	
Unit of measure	%	% d.w.								mg/kg d.w.																15	

(1) Unit of measure: calcium carbonate equivalents (CCE).
(2) The category “uncontaminated bark and wood” denotes woody plants with a high C:N ratio, such as bark, sawdust, ramial wood chips, etc. “Non-woody plants” denotes plants that are not woody perennial plants, i.e. trees, such as vegetable residuals. Contaminated examples of these residuals include wood treated with PCP or copper chromium arsenate or residuals that have come in contact with livestock waste or human fecal matter.
(3) Analysis required for secondary biosolids, alone or combined with primary residuals.
(4) Analysis or calculation required for residuals treated with lime.
(5) Analysis required for municipal biosolids and residuals resulting from a treatment process for raw water or wastewater that uses aluminum (Al) or iron (Fe) salts.
(6) Analysis required if the residuals are from a cardboard manufacturing process or any other process requiring the addition of boron (B).
(7) Analysis required for any residual from a municipal wastewater treatment process, textile mill or tannery, or from a pulp and paper manufacturing process that uses an oxidizing chlorine in the pulping, bleaching or wastewater treatment process. For municipal and paper mill biosolids, if analytical results are unavailable, assume that the residual contains between 18 and 50 ng TEQ/kg of dioxins and furans.
(8) Mixtures with agricultural lime are permitted. See Table 7.2.
(9) Analysis required if the ash comes from the incineration of paper mill biosolids or wood containing sodium chloride (contact with seawater).
(10) Screening material and other residuals are excluded.
(11) Land application of unmixed abattoir source manures does not require a CA. See Table 4.1.
(12) Analysis required for hog abattoirs.
(13) Analysis required if the compost is made from wood treated with PCP, textile mill or tannery residuals, certain types of ash (see note 9) or municipal biosolids not separated at source (separation/composting). In the case of composts from a separation/composting process, if analytical results are unavailable, assume that the compost contains between 18 and 50 ng TEQ/kg of dioxins and furans.
(14) Parameters for analysis will be based on inputs and determined on a case-by-case basis. Biotests may be required (Section 8.2.3).
(15) Unit of measure: ng TEQ/kg, dry weight, toxic equivalents (TEQ). NATO/CCME (1998).
(16) See Table 8.3.

6.2 Number of samples

Table 6.2 indicates the number of samples to be collected and analyzed over the twelve months preceding the CA application. This number varies with the volume of residuals produced and the parameters to be analyzed. The sampling period varies according to the type of generating process (batch or continuous). Samples taken by an accredited sampling firm in accordance with the requirements in Section 6.6 may count towards the minimum number of samples referred to in Table 6.2.

TABLE 6.2 MINIMUM NUMBER OF SAMPLES REQUIRED ACCORDING TO THE QUANTITY OF RESIDUALS PRODUCED AND THE PARAMETER TO BE ANALYZED

Quantity produced or accumulated yearly by type of residual [1] and production site[2] (metric tons, d.w.)	**Minimum number of composite samples over the 12 months preceding the CA application[3]**		
	Dioxins and Furans	*E. coli* and Salmonella[4]	Other Parameters
0 - 300	1[5]	2	2
301 – 1 500	2[5]	4	4
1 501 – 15 000	3[5]	6	6
> 15 000	4[5]	12	12

(1) This is the total quantity produced or accumulated annually (lagoons), regardless of the amount actually reclaimed.

(2) The production site is the place where the residuals are generated (plant, municipality, etc.). For a wastewater treatment lagoon, the amount of biosolids accumulated in the lagoon is substituted for the amount of biosolids produced.

(3) For continuous processes, the samples should be taken at equal time intervals (e.g. one sample/month). For batch processes, sampling frequency is determined on a case-by-case basis. If necessary, all the composite samples may be taken at the same time. However, each sample must be collected separately.

(4) For *E. coli* and salmonella analyses, a grab sample (continuous process) or a spot sample (static environments) is substituted for the composite sample. Spot sampling involves taking a set of samples representative of a particular sector or batch during a time period generally of less than 15 minutes. The number of samples may vary in these particular cases (see Section 8.3.2).

(5) The number of dioxin and furan analyses may be reduced to one every two years, if over the course of 36 months of analysis the levels obtained are consistently below the criterion limit for the category indicated in the CA application (C1 or C2). Dioxin and furan analyses are only required for certain types of residuals (Table 6.1).

6.3 Sampling methods

The sampling methods suitable for obtaining a representative sample vary with the type of residual and the production process. Table 6.3 lists the suggested or mandatory methods, as applicable.

TABLE 6.3 SUGGESTED OR MANDATORY SAMPLING METHODS FOR RESIDUALS

Residuals	Methods
➢ Paper mill biosolids and other solid paper mill residuals	**CEAEQ** ➢ Protocole d'échantillonnage des matières résiduelles fertilisantes - Fabriques de pâtes et papiers (mandatory)[1]
➢ Composts ➢ Granular residuals ➢ Soil mixes ➢ Other non paste-like solid materials	**BNQ[2]** ➢ Organic Soil Conditioners – Composts (CAN/BNQ 0413-200) ➢ Organic Soil Conditioners – Granulated Municipal Biosolids (CAN/BNQ 0413-400) ➢ Liming Materials from Industrial Processes (NQ 0419-090)
	CFIA ➢ Trade Memorandum T-4-114[3]
➢ Liquids	**USEPA** ➢ Control of Pathogens and Vector Attraction in Sewage Sludge. Chapter 9, Sampling Procedures and Analytical Methods[4].

(1) Can be obtained from the Centre d'expertise en analyse environnementale du Québec (CEAEQ) http://www.menv.gouv.qc.ca/ceaeq/index-en.htm

(2) The NQ and CAN/BNQ standards can be purchased from the BNQ. Telephone: (418) 652-2238 or 1-800-386-5114 or http://www.bnq.qc.ca/

(3) http://www.inspection.gc.ca/english/plaveg/fereng/tmemo/t-4-0e.shtml

(4) United States Environmental Protection Agency (USEPA) http://www.epa.gov/ordntrnt/ORD/NRMRL/Pubs/1992/625R92013.html

6.4 Analytical methods for residual materials and laboratories

Analyses must be performed by CEAEQ-accredited laboratories when the target parameters require such certification. This is true for measurements of *E. coli* and salmonella.

For further information on accredited laboratories and their areas of expertise, visit: http://www.menv.gouv.qc.ca/ceaeq/index-en.htm#who.

If there is no CEAEQ-accredited laboratory in Québec for a given parameter, the analyses must be done at a BNQ-accredited lab, e.g. oxygen uptake rates. Parameters for which there are no CEAEQ- or BNQ-accredited labs must nevertheless be analyzed by a laboratory accredited by the CEAEQ for other analyses or related areas of expertise.

Additional technical information on analytical and calculation methods for the various parameters is given in Table 6.4. Appendix 2 provides details on the analytical methods for *E. coli* and salmonella.

TABLE 6.4 ANALYSES OF RESIDUALS AND CALCULATION METHODS – COMMENTS

Parameters	Comments
Oxygen uptake rate	➢ The reference method for composts is CAN/BNQ 0413-220 (BNQ, 1996). There is a BNQ-accredited lab for this analysis. ➢ For liquid residuals, use the EPA Method 1683 Specific Oxygen Uptake Rate in Biosolids. ➢ The methods do not work if the pH is too acid or too alkaline, or if a biocide or any other microflora-inhibiting substance is present.
Neutralizing value - analyses	➢ The CRIQ lab is BNQ accredited.
Neutralizing value – calculation	➢ The neutralizing value (NV) of ash and lime residuals with an alkaline pH can usually be estimated using the following empirically validated equation: NV (% CCE) = (% Ca x 2.5) + (% Mg x 4.17) + (% K x 1.28); ➢ For organic residuals that have been treated with lime, the NV can also be estimated using the following equation: NV (%, d.w.) = lime in mixture (%, d.w.) x NV of lime (%, d.w.).
Organic matter	➢ Organic matter is easily measured by combustion (total volatile solids), except when a significant amount of carbonates are present (which are volatile at high temperatures).
C:N	➢ To calculate the C:N ratio, the organic carbon in residuals that show little biodegradation is estimated by dividing total organic matter by 2 (not by 1.724 as for soils).
Conversion of P and K to P_2O_5 and K_2O	➢ P_2O_5 = P x 2.29 ➢ K_2O = K x 1.20
Dioxins and furans	➢ Total TEQ values are calculated for 17 congeners based on NATO toxicity equivalency factors (1988). ➢ For undetected congeners, assuming a value of 0 or dividing the detection limit by two will have little effect on the results of high resolution methods, given the criteria that must be met (Groeneveld and Hébert, 2004).
E. coli	➢ In this *Guidelines*, *E. coli* are analyzed instead of fecal coliforms, because there is less likelihood of "false-positives" and because CEAEQ-accredited labs exist for *E. coli*. ➢ Regrowth of coliform bacteria may occur in samples that have not been properly preserved prior to analysis. Preservation instructions and timelines for sending samples to labs must therefore be scrupulously observed to prevent errors in results.
Molybdenum	➢ Overestimation of molybdenum can occur in alkaline matrices.
Biosolid stabilization processes	➢ The appropriate measurements and calculations (pH, sludge age, temperature, dates, etc.) must be recorded and checked by a qualified professional (chemist, engineer, etc.). The formula for calculating "sludge age" is provided in Appendix 3.

6.5 Compilation and presentation of analytical results for residual materials

A compilation of the following statistics must be provided for all the analyses performed over the 12 months preceding the CA application:

- arithmetic mean;
- geometric mean for *E. coli*, for the P2 category;

  $G = \sqrt[k]{x_1 x_2 ... x_k}$;
- median for *E. coli*, for the P1 category;
- presence/absence of salmonella, for the P1 category;
- maximum value;
- number of samples.

The results must be expressed in dry weight, except for dryness, as well as pH and the C:N ratio, which are unitless.

Where a parameter is not detected in the analyses, the statistics are calculated by dividing the detection limit by two. For dioxins and furans, a value of 0 may be used alternatively (see Table 6.4). When a parameter is detected but not quantified, an estimated detection limit is used.

Analytical reports must be signed by a chemist or any other qualified professional, and appended to the statistical compilation.

Both the applicant and generator must advise the regional office of any change in the classification of a FR.

6.6 Quality control of residual materials

6.6.1 Need for independent verification or quality control by an accredited sampling firm

The validity and representativeness of the residual materials characterization submitted by the applicant is based on the following assumptions:

- the analytical results and resulting classification provided by the applicant are reliable;
- the levels of fertilizing elements and contaminants measured in residuals that will be delivered to farms in the near future (within a few weeks or a few months) are similar to the values recorded over the preceding 12 months.

The validity of these assumptions depends on compliance with the following conditions:

- the variability of levels of contaminants and fertilizing elements is limited in time for a given residual;
- the applicant performs sampling in an appropriate and unbiased manner;

- the analysis of samples is done by reliable accredited labs.

The independent quality control tests done to date show that the analytical results for chemical parameters submitted by applicants are generally very reliable (Hébert et al., 2002). However, the results for microbiological analyses are more variable (Hébert et al., 2003). It is important to conduct independent quality control of sampling with a view to maintaining public confidence in FR reclamation. It is therefore incumbent on the Ministry to periodically conduct quality control itself on FRs, or to ensure that this function is performed by an independent third party or a sampling firm accredited by the CEAEQ or the BNQ, particularly for pathogens

6.6.2 Sampling firms accredited by the CEAEQ

In this case, quality control is performed by a sampling firm accredited under a new CEAEQ program in accordance with the document: *Processus et exigences d'accréditation – Matières résiduelles fertilisantes – Secteur agricole*. For more information, visit:

http://www.menv.gouv.qc.ca/ceaeq/accreditation/paee/index.htm.

This type of quality control must be carried out at least once during the 12 months preceding the CA application; it applies to all CA applications received starting in January 2005 for:

- all paper mill biosolids;
- ash produced by paper mills in quantities greater than 1 500 t/yr/mill (dry weight).

Beginning in January 2006, these measures will also apply to:

- all category P1 organic FRs (see Section 8), produced in quantities greater than 1 500 t/yr/plant (dry weight), e.g. certain composts and municipal biosolids;
- all inorganic FRs produced in quantities greater than 1 500 t/year;
- horticultural soil mixes produced in quantities greater than 5 000 t/year per type of soil mix.

This sampling is done at the expense of the applicant or the residual generator.

The sampling firm is required to produce a report and submit a copy to the client and to the regional offices involved in processing the CA application for FR reclamation. The content of the report must meet CEAEQ requirements. In particular, it must compare the chemical and pathogen contaminant categories (C-P categories, see Section 8) of the residual sampled with the C-P categories declared in the CA application. The analytical data supplied by the firm will be interpreted according to the criteria provided in Appendix 4.

6.6.3 BNQ-accredited inspection and testing facilities

As an alternative to CEAEQ-accredited sampling firms, BNQ-accredited inspection and testing facilities can be used, such as the CRIQ (Centre de recherche industrielle du Québec) laboratory. This applies to FRs covered by BNQ standards and certification protocols, namely:

- composts
- liming materials
- granulated municipal biosolids.

6.6.4 Verification by the Ministry

When necessary, the regional office of the Ministry may conduct periodic sampling, particularly for organic FRs classified as P1 in a CA application. Since the spreading of these FRs is not subject to special protective measures for pathogens (Section 10), it is important to ensure that they are indeed free of pathogens (in compliance with P1 criteria, Section 8).

6.7 Soil sampling and analysis

Sampling of agricultural soils must be carried out according to generally accepted methods and comply with the provisions of the RRAO as well as best agronomic practices. In the case of forest soils that have never been disturbed, the soil sample should be taken from horizon B rather than from the surface horizon.

The soil analyses required by the Ministry are listed in Table 6.5. They must be performed by a laboratory that is CEAEQ accredited for agricultural analyses (http://www.menv.gouv.qc.ca/ceaeq/accreditation/palaa/index.htm). Soil analysis reports must be appended to the AEFP or to the CA application if there is no AEFP.

TABLE 6.5 SOIL ANALYSES - MINIMUM REQUIRED BY THE MINISTRY

FR Characteristic	Required Analysis for the Receiving Soil [1]
All types of FRs	➢ Available P and extractable Al (Mehlich 3)[2] ➢ Calculation of P saturation[2]
Neutralizing value ≥ 25% CCE (d.w.), or pH ≥ 10	➢ Water pH ➢ Buffer pH
Municipal biosolid or residual that derives from a treatment process for raw water or wastewater that uses iron-based salts (Fe) and that contains > 25 000 mg Fe/kg (d.w.)	➢ Extractable Fe (Mehlich III), only if the soil previously had an FR application with a high Fe level (> 25 000 mg Fe/kg)

(1) Other soil analyses may be determined as appropriate by the agrologist or forest engineer according to best practices. Refer to the analyses covered by the program for agricultural analysis laboratories: http://www.menv.gouv.qc.ca/ceaeq/index.htm#programmes.

(2) Analyses required for agricultural soils under the RRAO.

7 AGRICULTURAL VALUE OF RESIDUALS (FR STATUS)

7.1 Conditions for determining FR status

Only residuals with fertilizing or soil amendment properties are considered to be FRs. To qualify for FR status, fertilizing residuals must satisfy at least one of the six conditions described in Table 7.1.

TABLE 7.1 CONDITIONS FOR DETERMINING WHETHER A RESIDUAL HAS FR VALUE

Condition[1]	Criteria
Designated as an FR on the basis of R&D work	a) Be included in the list of FRs in Table 6.1[2]. b) An agronomic study by a recognized research institution shows that land application or use of the residual improves plant or soil productivity or quality in a statistically significant manner under conditions peculiar to Québec or in a similar context.
Barley germination/growth test	c) Demonstrate an absence of toxicity and an increase in dry biomass production as compared with non-amended soil, according to the CEAEQ method[3].
Neutralizing value	d) Have a neutralizing value ≥ 25% CCE on a dry weight basis[4].
Multiple reclamation index (MRI)	e) Have a MRI equal to or greater than 1 based on the following equation[5]: *MRI = (dry matter (%) ÷ 100) X [(organic matter (% d.w.) ÷ 15) + (neutralizing value (% CCE d.w.) ÷ 25) + (N + P_2O_5 + K_2O (% d.w.)) ÷ 2]*
Irrigation	f) Liquid residual that can be spread on soil covered with vegetation during the period of greatest risk for water stress, i.e. June 15 to August 15.

(1) At least one of these six conditions must be met.

(2) For whey, the nitrogen, phosphorus and potassium (N-P-K) levels may vary widely, depending on the procedure.

(3) See the CEAEQ method: http://www.menv.gouv.qc.ca/ceaeq/publications.htm#scientifiques

(4) Criteria for the BNQ Standard on Liming Materials from Industrial Processes (NQ 0419-090).

(5) The MRI is above all a practical tool that allows rapid and objective identification of residuals that clearly have minimal agricultural value in terms of fertilizing or soil amendment properties. The MRI equation and criteria of 1 were established using the minimum fertilizing values defined by different organizations for organic matter (Canadian Food Inspection Agency), the neutralizing value of liming materials (BNQ) and fertilizing elements (ISO). Calculation example: An industrial residual has the following characteristics: 80% dry matter, 20% organic matter (d.w.), 1.5% P_2O_5 (d.w.), 3% K_2O (d.w.) and NV = 50% CCE (d.w.). MRI = 80 ÷ 100 x [(20/15) + (50/25) + (0 + 1.5 + 3)/2] = 4.46. From an agronomic standpoint, this residual appears to have value. For example, wastewater often has a MRI < 1 and quality ash may have a MRI up to 7.

A residual that does not satisfy at least one of the conditions listed in Table 7.1 (or Table 7.2 concerning mixes) is not considered to be a FR. Its use is therefore not governed by this *Guidelines*, which is aimed at reclamation activities.

Note: Although some residuals may not be considered FRs according to the conditions in Table 7.1, their use as soil amendments may be environmentally beneficial. An example would be the use of cannery wastewater to irrigate cultivated land. Similarly, residuals rich in reactive aluminum and iron could be applied to soils that are highly saturated with phosphorus to reduce the risk of watercourses becoming contaminated by

phosphorus runoff. However, the efficiency and potential short- and long-term risks of such projects must be evaluated on a case-by-case basis.

7.2 Mixes

Fertilizing residuals that have been blended with other FRs, or other fertilizing materials, may offer agronomic benefits. For example, ash/lime mixes can provide a more balanced liming amendment for quickly neutralizing soil acidity, owing to the presence of both carbonates and hydroxides. These mixes also help to reduce the risk of overdosing with fertilizing elements, such as phosphorus and potassium, which are present in high concentrations in ash. Moreover, some studies (Seekins, 1986) have shown that ash/lime mixes have a greater impact on alfalfa productivity compared with the use of lime alone. That is why the BNQ standard (1997) on liming materials permits the use of these mixes.

Other mixes can also be used to enhance product quality and ensure compliance with environmental requirements. An example would be malodorous residuals blended with liming residuals or commercial hydrated lime to control odours, through composting or alkali treatment. Furthermore, improving the environmental quality of a residual facilitates its reclamation (fewer spreading constraints) and helps to raise its selling price (e.g. composts vs non-composted biosolids).

Conversely, other types of mixes, such as biosolids blended with sand, would not improve the agronomic or environmental quality of the resulting product, except when the goal is to manufacture a soil mix.

Consequently, the blending of residuals with other residual or non-residual materials is permitted for any of the seven options described in Table 7.2. The resulting mix must likewise meet the environmental C-P-O quality criteria for FRs (Section 8) or, in the case of a soil mix, the quality criteria for horticultural mixes (Section 13). Furthermore, the mix must be manufactured at the plant or by a specialized promoter who can guarantee its consistency and quality for spreading. Failing this, the mix will be deemed a mere dilution and rejected.

TABLE 7.2 MIXES OF RESIDUALS – POSSIBLE OPTIONS[1]

	Possible Options	Examples
a)	A mix of various types of liming materials with a neutralizing value ≥ 25% CCE (dry weight).	Ash + lime
b)	Mix of various residuals for composting[2].	Organic sludge + bark
c)	Mix of various organic residuals mentioned in tables 6.1 and 7.1 with residuals or alkaline products in order to hygienize or deodorize. This option includes the co-treatment of several organic residuals.	Abattoir sludge + commercial hydrated lime
d)	Mix for the manufacture of a horticultural soil mix.	Primary biosolid + peat moss + sand
e)	Other FR mixes mentioned in tables 6.1 and 7.1, including justification by an agrologist that the mix improves the overall agricultural value in comparison with the unmixed residual, for a specific purpose, with supporting scientific references.	
f)	Other FR mixes listed in tables 6.1 and 7.1, including justification by an agrologist that the mix improves the pathogen (P category) or odour (O category) classification.	Alkaline paper mill residual + paper mill biosolids
g)	Other FR mixes listed in tables 6.1 and 7.1 permitting the improvement of category C contaminants that are micronutrients (Cu, Co, Mo, Zn) essential for plants. **This option is not permitted if the resulting mix would result in an "out-of-category" reclassification of a residual due to concentrations of elements deemed non-essential for plants or animals (Cd, Hg, Pb).**	

(1) The resulting mix must satisfy the environmental C-P-O quality criteria for FRs (Section 8) or, for a soil mix, the quality criteria for horticultural soil mixes (Section 13). In addition, the mix must be made at the plant or by a specialized promoter who can guarantee its consistency and quality.

(2) Composting: see Section 14.

FRs blended with manures tend to be somewhat more complicated from a legal standpoint. For instance, although the agricultural use of manures does not require a CA, this is not the case for many FR/manure mixes as they would not be considered "manure" within the meaning of the regulations (Section 4.2.2).

The successive application of residuals on the same parcel of land, for example, the spreading of manure followed by an application of ash, followed by the spreading of primary paper mill biosolids, is not considered to be a mix.

8 ENVIRONMENTAL QUALITY OF FRs

8.1 C-P-O classification

In order to qualify as a reclaimable FR, a residual must have fertilizing properties (Section 7) and satisfy the criteria developed to protect the quality of the environment.

Every FR is therefore classified according to chemical contaminant content (C category), pathogen content (P category) and odour (O category). This is called C-P-O classification.

Since there are two C categories (C1 and C2), three P categories (P1, P2 and P3) and three O categories (O1, O2 and O3), this means there are 18 possible classifications for FRs:

- C1-P1-O1,
- C1-P1-O2,
- C1-P1-O3,
- C1-P2-O1,
- C1-P2-O2,
- C1-P2-O3,
- C1-P3-O1,
- C1-P3-O2,
- C1-P3-O3,
- C2-P1-O1,
- C2-P1-O2,
- C2-P1-O3,
- C2-P2-O1,
- C2-P2-O2,
- C2-P2-O3,
- C2-P3-O1,
- C2-P3-O2,
- C2-P3-O3.

Agricultural applications and other possible uses vary with the classification of the FR (Table 8.1).

TABLE 8.1 POSSIBLE USES OF FRS ACCORDING TO THEIR CLASSIFICATION (NON-EXHAUSTIVE LIST)

Crop/Use	C1-P1-Ox[1]	C2-P1-Ox	C1-P2/P3-Ox	C2-P2/P3-Ox
Food crops (for humans)	Yes	Yes	No	No
Distribution to citizens (open house events)	Yes	Yes	No	No
Pasture	Yes	Yes	No	No
Forage or grain crops (for animal feed)	Yes	Yes	Yes	Yes
Ornamental horticulture/landscaping	Yes	Yes	No	No
Silviculture	Yes	Yes	Yes [2]	Yes [2]
Mulching/hydroseeding	Yes [3]	Yes [3]	No	No
Roadside enhancement	Yes [3]	Yes [3]	No	No
Manufacture of horticultural soil mixes	Yes	Yes	No	No
Livestock bedding	Yes	Yes	No	No
Revegetation of degraded sites	(4)	(4)	(4)	(4)

(1) The odour category does not directly influence the crop type that may receive a fertilizing residual; however, certain uses may be affected (note 3).
(2) Restrictions on the harvesting of edible products, e.g. fruit, mushrooms (Section 10.4).
(3) Not permitted with O2/O3.
(4) Consult the document entitled: *Critères préventifs pour la restauration de la couverture végétale de lieux dégradés par l'utilisation de matières résiduelles fertilisantes* (MENV, 2003).

In addition to the restrictions concerning crop type and uses, there are other restrictions aimed at protecting the environment and human health, for example, application rates and separation distances from dwellings and watercourses. The higher the C-P-O index (1, 2 or 3), the tighter the restrictions will be. Accordingly, C1-P1-O1 class FRs do not pose a significant risk for chemical contaminants, pathogens or odours, and therefore, spreading constraints are minimal. On the other hand, there are many usage constraints for C2-P3-O3 class FRs. The main spreading constraints are described in Section 10.

Paradoxically, FRs with a more restrictive C-P-O classification often have significant or, in some cases, even superior fertilizing properties. For example, mixed paper mill biosolids are generally much more malodorous than primary biosolids, but their high nitrogen content makes them more beneficial for increasing plant productivity.

A residual that does not meet the minimum C2-P3-O3 requirements is considered "out of category," and may not be used for agricultural or silvicultural purposes, except in special cases where specific mitigation measures apply. It should also be noted that FRs which meet the Ministry's quality criteria may be prohibited by organic certification organizations. A list of products generally accepted in organic agriculture, prepared by Duval (2003), is available free of charge at the following online address: www.agrireseau.qc.ca/agriculturebiologique/.

The following subsections show how to establish the C, P and O categories of a given FR based on the analytical results. The underpinnings of the C-P-O criteria are presented in Appendix 1.

8.2 C categories – Chemical contaminants

8.2.1 Parameters and criteria

"Chemical contaminants" encompass metals, such as cadmium, and other inorganic trace elements such as selenium, as well as organic contaminants such as dioxins and furans. In excessive quantities, these chemical contaminants can be toxic to plants, animals and humans.

Some "contaminants," however, such as copper, cobalt, molybdenum and zinc, are "micronutrients," and are beneficial to plants. Like nitrogen and phosphorus, their presence in FRs is generally useful, but in limited quantities to avoid overdosing. Furthermore, although they too are considered to be "contaminants," nitrogen and phosphorus are not taken into account when determining C categories. They are managed on the basis of application rate alone (sections 10 and 11).

Table 8.2 lists the maximum limits for chemical contaminants in FRs. To qualify for C1 category status, all parameters must comply with the C1 maximum limits. For an FR to be classified as C2, all parameters must meet the C2 category limits, and at least one parameter must exceed the C1 limit.

TABLE 8.2 MAXIMUM LIMITS FOR CHEMICAL CONTAMINANTS (C CATEGORIES)

Contaminants	Units	Maximum Limits	
		C1 Category[1]	C2 Category[1,2]
Elements deemed essential or beneficial to plants or animals			
Arsenic (As)	mg/kg (d.w.)	13	40
Cobalt (Co)	mg/kg (d.w.)	34	150
Chromium (Cr)	mg/kg (d.w.)	210	1 060
Copper (Cu)	mg/kg (d.w.)	400	1 000[3]
Molybdenum (Mo)	mg/kg (d.w.)	5.0	20
Nickel (Ni)	mg/kg (d.w.)	62	180
Selenium (Se)	mg/kg (d.w.)	2.0	14
Zinc (Zn)	mg/kg (d.w.)	700	1 850[4]
Other elements			
Cadmium (Cd)	mg/kg (d.w.)	3.0	10[4]
Mercury (Hg)	mg/kg (d.w.)	0.8	5
Lead (Pb)	mg/kg (d.w.)	150	300
Dioxins and furans	ng TEQ/kg (d.w.)[5]	17	50[6]

(1) For an FR to qualify as C1, all parameters must meet the C1 criteria. For inclusion in the C2 category, all the parameters must meet the C2 criteria and at least one parameter must exceed the C1 criteria. When no analysis is required for a chemical contaminant in Table 6.1, the level is considered to be less than the C1 limit. Classification is based on the mean value of the analyses performed over the previous 12 months.

(2) The loading limit for C2 residuals is 22 t (d.w.)/ha/5 years.

(3) The maximum limit has been raised to 1 500 mg Cu/kg for residuals > 2.5 % P_2O_5, d.w., and for biosolids from municipal lagoons.

(4) Liming materials with a NV:Zn ratio > 0.027 or a NV:Cd ratio > 2.5 (% CCE/mg metal/kg) are also considered C2, according to the criteria in the BNQ standard (1997) on liming materials.

(5) NATO toxic equivalents (TEQ) (NATO/CCMS, 1988).

(6) A FR containing between 51 and 100 ng TEQ/kg of dioxins and furans can be used in non-agricultural applications.

C categories are determined using the mean value of analytical results for the twelve months preceding the CA application. If the maximum level for a parameter analyzed during this period exceeds the C2 limit by 50%, but the mean value meets the C2 criteria, the variation is considered abnormal. The applicant or his agents must explain this exceedance and the measures that will be taken to minimize this variability in the future.

In the case of permitted mixes (Section 7.2), the individual inputs are not subject to the maximum limits for chemical contaminants. However, the resulting mix must be compliant. Alternatively, if analytical results are unavailable for the mix, it may be assumed that the C category of the mixture corresponds to the C category of the most contaminated input. For example, a C1 FR blended with a C2 FR would be classified in the C2 category (conservative approach). However, the effects on the P and O categories must also be taken into account, as well as fertilizing element concentrations resulting from the mixture. This approach is therefore used only in exceptional circumstances.

8.2.2 Confirmation of C category declared by the promoter

In the case of FRs that need to be quality controlled by an accredited sampling firm (Section 6.6), a decision will be made to confirm or deny the promoter's declared C category compliance based on the written report from the sampling firm and the criteria outlined in Appendix 4.

8.2.3 Specific contaminants – Long-term risk assessment

The list of chemical contaminants that must be measured in routine analyses (Table 6.1) is based on FR characterization data from Québec studies and the available scientific research. However, it is possible for an FR to contain an abnormally high concentration of a chemical contaminant that is not assayed in routine analyses. This may happen with municipal biosolids from a small municipality that treats industrial effluents from a plant that generates discharges containing silver, tin, lanthanum or cerium. The applicant must inform the regional office accordingly and assess the long-term impacts.

The following method can be used to evaluate the effects of long-term accumulation of a known inorganic chemical contaminant:

- determine the level of the contaminant in the FR through several samples;
- use a value greater than the mean for the calculations (e.g. mean + 1 standard deviation);
- determine the initial contaminant level (background) of the soil, in mg/kg, based on the available literature or specific analyses;
- establish a conservative yet likely agronomic dose for the FR, based on fertilization recommendations (e.g. use 1.5 times the normal agronomic dose according to the fertilizing element levels);
- determine a realistic number of land applications over the long term (i.e. 25 or 100 years);
- determine the total loading of the contaminant for this period, in kg/ha;
- consider that the residual will be mixed into the soil to a depth of 25 cm through tillage and the activity of earthworms (in the long term);
- calculate the additional levels of the contaminant in the soil (mg/kg), taking into account soil bulk density (approximately 1.2-1.3 g (d.w.)/cm^3).
- calculate the final contaminant content of the soil in mg/kg (initial level + additional level);
- make any necessary adjustments for outputs (erosion, leaching, uptake by crops);
- compare the projected final level with soil quality toxicological criteria (possible references: Kabata-Pendias (2001), CCME (1997);
- if soil quality toxicological criteria are unavailable, compare with background soil concentrations (98th percentile);

- if these statistical values are unavailable, use criterion A from the *Soil Protection and Contaminated Sites Rehabilitation Policy* (1999).

If the long-term soil contaminant level is lower than the toxicological criterion, the activity is not automatically deemed to pose a risk. If toxicological criteria are unavailable, the contaminant level should be compared with background soil levels to determine whether there is an abnormal accumulation relative to the natural environmental risk. If necessary, the regional office may request a more in-depth assessment of this first approximation of the long-term risk, or have it verified by the Ministry's central units.

With respect to organic contaminants, only those that are very persistent in soil (half-life $>$ 5 years) are likely to accumulate in soil over the long term. The approach used for inorganic contaminants should be used, taking into account their half-life, which is generally lower in biologically active soil, such as agricultural soils, compared to soils with lower microflora populations (Nagpal, 1993).

In recent years, the Direction du milieu rural has carried out summary risk assessments for various FRs using the above-mentioned approach. These assessments covered barium, beryllium, cerium, lanthanum, total polycyclic aromatic hydrocarbons (PAHs) and petroleum hydrocarbons. None of the studies revealed any long-term risks.

8.2.4 Unexpected or unknown contaminants –Toxicity tests

The residual generator must inform the professional if a residual-generating process has been modified in the previous 12 months, especially if any new or unconventional chemicals have been introduced. This could result in the presence of unexpected chemical contaminants that are not assayed during routine analyses and contaminants that are difficult to identify.

Paper mills must also inform the professional when the biotests performed at the plant on liquid effluents that are discharged into watercourses in accordance with provincial and federal regulations come back positive (the toxicity level of the liquid effluent exceeds the criteria). If a liquid effluent that is discharged into a watercourse is found to contain toxic levels of a contaminant, toxic levels may still be present in the biosolids after pressing.

In cases of uncertainty, and for newer, lesser known FRs, the regional office may ask the applicant to have toxicological testing done according to the CEAEQ method for FRs (visit the online address provided below) or according to another method proposed by an independent expert (toxicologist or environmental toxicologist). These tests can also be used in cases where phytotoxicity of unknown origin is observed at a site.
(http://www.menv.gouv.qc.ca/ceaeq/publications.htm#scientifiques).

8.3 P categories – Pathogens

8.3.1 Parameters and criteria

Different parameter options and criteria (Table 8.3) are used based on the type of residual and the target pathogen category (P1, P2 or P3). For example, a municipal biosolid that contains less than 2 000 000 *E. coli*/g (geometric mean) and sludge that is more than 20 days old is classified as P3. However, if it is incorporated into the soil in less than 6 hours, it may be considered P2 (Option C in Table 8.3).

As noted in Section 6.5, the statistic chosen to evaluate compliance with the maximum limits for *E. coli* is not the arithmetic mean, but the median (P1 category) or the geometric mean (P2 category). For other hygiene quality parameters, the arithmetic mean is used.

Any FR declared as a P1 category residual in a CA application that is found to have a maximum value greater than 2 500 *E. coli*/g will be temporarily reclassified as a P2 category FR, even if the annual median complies with the maximum limits for *E. coli*. **In such a case, the CA holder and the generator must notify the Ministry as soon as possible**. They will be required to take appropriate measures (Section 8.3.2).

TABLE 8.3 RESIDUAL QUALITY CRITERIA FOR P CATEGORIES

Residual	Category P1 Option	Category P2 and P3 Options
Residual contaminated with: ➢ domestic sewage ➢ human fecal matter ➢ manure ➢ abattoir residuals or manure[1] ➢ dead animals ➢ egg residuals	a) *E. coli* <1 000 MPN/g (d.w.)[2], **and** salmonella undetected with a detection limit of < 3 MPN/4 g (d.w.), **and** drying at a minimum temperature of 80^0C, **and** dryness > 90%. b) *Any* other combination that meets the USEPA Class A requirements for the reduction of pathogens and vector attraction (including analysis of fecal coliforms (*E. coli*) **and** salmonella). http://www.epa.gov/owm/mtb/biosolids/503pe/index.htm	**P2**: a) Lime to pH ≥ 12 for at least 2 hours **and** maintain at pH ≥ 11.5 for at least 22 hours[3]. b) *E. coli* < 2 000 000 MPN[2]/g (d.w.) **and** aerobic biological treatment **and** O_2 uptake rate of ≤ 1 500 mg O_2/kg organic matter/hour. c) *E. coli* < 2 000 000 MPN[2]/g (d.w.) and incorporation of residual into soil in less than 6 hours[4]. d) Any other USEPA-approved combination that meets Class B requirements for the reduction of pathogens and vector attraction. http://www.epa.gov/owm/mtb/biosolids/503pe/index.htm e) *E. coli* < 1 000 MPN/g (d.w.) **and** salmonella undetected with a detection limit of < 3 MPN/4 g (d.w.)[2]. **P3**: Fecal coliforms < 2 000 000 MPN/g (d.w.)[2] **and** biological treatment with sludge age ≥ 20 days old[5].
Composts	*E. coli* < 1 000 MPN/g (d.w.)[2], **and** undetected salmonella with a detection limit of < 3 MPN/4g (d.w.), **and** O_2 uptake rate of ≤ 400 mg/kg organic matter/hour.	**P2**: *E. coli* < 2 000 000 MPN/g (d.w.)[2], **and** O_2 uptake rate of ≤ 1 500 mg/kg[6] organic matter/hour, **and** the product must have been composted.
Paper mill biosolids (not contaminated with human fecal matter)	*E. coli* < 1 000 MPN/g (d.w.)[2], **and** undetected salmonella with a detection limit of < 3 MPN/4g (d.w.), **and** written attestation from the paper mill's environmental officer stating that no domestic sewage is discharged into the wastewater treatment system.	**P2**: Written attestation from the paper mill's environmental officer stating that no domestic sewage is discharged into the wastewater treatment system.
Other residuals (not contaminated with human fecal matter)	Written attestation from the residual generator stating that the residuals are not contaminated with human fecal matter or manure.	Not applicable

(1) For manures, agricultural and silvicultural applications are not subject to a CA (see Table 4.1).

(2) MPN: most probable number. Use the median value (and not the arithmetic mean) to compare with maximum limit of 1000 *E. coli* /g. Use the geometric mean (and not the arithmetic mean) to compare with maximum limit of 2 000 000 *E. coli* /g. The FR may be sampled at the plant or after composting (in the case of composts). Only this value will be considered for *E. coli*, even if *E. coli* regrowth occurs during field storage.

(3) All residuals must have been exposed to a pH of 12. It is possible for the pH to subsequently decrease. This may lead to new microbial growth and foul odours. It is therefore recommended that liming be done as soon as possible and that pH be kept high afterwards. See Section 8.4 on odour categories.

(4) The proper tillage implement must be used to ensure adequate incorporation. The chisel plow is not recommended in this case.

(5) See the formula in Appendix 3.

(6) If the O_2 uptake rate is > 400 mg/g organic matter/hour, the product is immature.

8.3.2 Special cases

The results of microbiological analyses are much more variable than those for chemical analyses. That is why the median is used for comparison with the P1 criterion of 1000 *E. coli*/g, instead of the arithmetic mean. However, the Ministry considers a maximum value greater than 2 500 *E. coli*/g to be indicative of a content likely exceeding 1 000 *E. coli*/g statistically.

In such a case, a FR that was previously classified as P1 will automatically be reclassified as P2 and must be managed according to the P2 category criteria, which prohibit use in crops intended for human consumption.

The FR may regain its P1 status if it meets one of the following conditions:

- the results of three new consecutive weekly analyses show a level of < 2 500 *E. coli*/g;
    - the median of *E. coli* samples collected over the past 12 months consistently meets P1 criteria.
- a recognized research institute provides scientific evidence of the absence of specific pathogens (salmonella, *Yersinia,* Cryptosporidium, *E. coli* O157:H7, etc.) and microbial regrowth of non pathogenic *E. coli*.

8.3.3 Abattoir residuals and bovine spongiform encephalopathy

In Québec, there have been no reported cases of bovine spongiform encephalopathy (BSE), commonly called “mad cow disease.” An outbreak of BSE is also quite unlikely, given the measures implemented by the different levels of government in Canada since 1990. Nevertheless, if one or more cases of BSE are ever detected in cattle raised or slaughtered in Québec, the reclamation of biosolids and other cattle slaughterhouse residuals would be banned until further notice, as a precautionary measure. The infectious agent of BSE could theoretically be present in biosolids resulting from wastewater treatment or in other animal residuals produced at the abattoir.

Nevertheless, it should be noted that the ingestion of contaminated tissue is the main method of transmission of BSE to humans. Furthermore, the *Guidelines* already prohibits the use of limed slaughterhouse biosolids (P2 category) to fertilize crops intended for human consumption and pastures (Section 10). Composting of dead animals is prohibited under the *Regulation respecting food* administered by the Ministère de l’Agriculture, des Pêcheries et de l’Alimentation (MAPAQ). Studies currently under way in various countries will eventually determine whether composting and liming are effective in destroying the BSE agent. The standards and criteria concerned will be revised accordingly.

8.3.4 Confirmation of P category declared by the promoter

In the case of FRs that need to be quality controlled by an accredited sampling firm (Section 6.6), a decision will be made to confirm or deny the promoter's declared P category compliance based on the written report from the sampling firm and the criteria outlined in Appendix 4.

8.4 O categories – Odours

8.4.1 Criteria

A survey conducted among various experts in Québec has provided a picture of how FR and manure odours are perceived (Groeneveld and Hébert, 2002). The odour scores assigned by the experts corresponded to the theoretical potential of the FR to release offensive odours when stored under anaerobic conditions. Odour emission is linked to moisture content (effect on oxygen diffusion rate), C:N ratio, sulphur levels, pH, etc.

The Ministry has established the following odour categories for the various FRs (Table 8.4) based on the survey results:

- FRs with a mean odour score below that for solid dairy cattle manure are classified as O1;
- FRs with an odour score comparable to that for solid dairy cattle manure (plus or minus 1 standard deviation) are classified as O2;
- FRs with higher odour scores, but lower than the average for hog slurry, are classified as O3.

Given the variability in the odour scores assigned by the respondents, some FRs have been rated O3 even though the mean odour score met the O2 criteria. Odour categories for abattoir biosolids, on the other hand, were determined based on technological treatment requirements (Table 8.5), since these residuals can give off especially offensive odours if they are not properly limed (Fortin, 2000).

"Out-of-category" FRs cannot be used for agricultural purposes or in populated areas unless they have been properly deodorized or reclassified (Section 8.4.2). In 2003, Désilets reviewed the possibility of using various deodorization treatments for paper mill biosolids.

TABLE 8.4 ODOUR CATEGORIES

O1 (low odour) [1, 2]	O2 (malodorous) [1, 3]	O3 (strongly malodorous) [1, 4]
➢ Cement kiln dust ➢ Wood ashes ➢ Magnesium residuals ➢ Lime mud from paper mills ➢ Other non-putrescible liming amendments ➢ Compost (mature) ➢ Bark ➢ Dead leaves ➢ Paper mill biosolids C:N $\geq$ 70	➢ Municipal biosolids – lagoons ➢ Paper mill biosolids – acid treated ➢ Municipal biosolids – limed ➢ Municipal biosolids – dried[5] ➢ Limed abattoir biosolids - see Table 8.5	➢ Municipal biosolids – biological treatment in a plant ➢ Paper mill biosolids, C:N < 70, not acid treated, not resulting from kraft processes[6] ➢ Grass clippings ➢ Potato residuals ➢ Limed abattoir biosolids – see Table 8.5 ➢ Whey ➢ Declassified milk

(1) The categories may be revised in some cases according to olfactometry test results (Table 8.6). For FRs not in the table, the category will be determined by olfactometry or by analogy, on a case-by-case basis by the regional office.

(2) O1: odour score < solid dairy cattle manure.

(3) O2: odour score similar to that for solid dairy cattle manure.

(4) O3: odour score > solid dairy cattle manure, but < hog slurry.

(5) Dried or granulated municipal biosolids must be protected from moisture to prevent microbial regrowth and to maintain their O2 status.

(6) Paper mill biosolids from kraft processes, not acid treated, and with a C:N < 70 are deemed “out of category,” except those specified in note 1 of Table 8.4.

TABLE 8.5 CRITERIA FOR LIMING ABATTOIR BIOSOLIDS

Target Category	At the Abattoir	During Storage
O2	➢ Maintenance of aerobic conditions for stored wastewater, ➢ **and** liming at the plant no less than 6 hours after extraction of the biosolids or 6 hours after dehydration, ➢ **and** compliance with P2 category (pH ≥ 12 for 2 hours and pH ≥ 11.5 for 22 hours), ➢ **and** calcium ≥ 20% (d.w.), or ≥ 10% if dryness ≥ 25%, ➢ **and** recording of daily measurements of the pH of biosolids, available on request.	➢ Prohibition on storage with other types of residuals, ➢ **and** maintenance of pH ≥ 10 at all times (sampled in the 0-20 cm layer), ➢ **and** recording of weekly measurements of the pH of stored biosolids, available on request.
O3(1)	➢ Liming at the plant no later than 12 hours after extraction of the biosolids or 12 hours after dehydration, ➢ **and** compliance with P2 category (pH ≥ 12 for 2 hours and pH ≥ 11.5 for 22 hours), ➢ **and** calcium ≥ 10% (d.w.), ➢ **and** recording of daily measurements of the pH of biosolids, available on request.	➢ Prohibition on storage in a facility containing other residuals with a pH < 11.5 (2), ➢ **and** maintenance of pH ≥ 10 at all times (sampled at a depth of 0-20 cm), ➢ **and** recording of weekly measurements of the pH of stored biosolids, available on request.

(1) Exceptionally, for certain reclamation activities using abattoir biosolids limed in a different manner, which in the past elicited few or no odour complaints, the residual may be considered O3. However, the reclamation conditions (liming, storage, spreading, etc.) must be similar or comparable, in terms of impact on odours, to those that prevailed in the past.

(2) Once the limed biosolids have been poured into the storage facility, another type of organic residual may be added provided that the mixture meets the criteria in Section 7. However, the mixture must be limed within 2 hours to ensure compliance with P2 category criteria.

8.4.2 Classification by olfactometry or by analogy

Because a single type of FR can emit a variety of odours, and since not all FRs are listed in Table 8.4, the odour category for a given FR can be determined by olfactometry tests. The cost of these tests is borne by the generator.

Olfactometry involves having a group of panelists smell the gases released by manure and FR samples, according to a standardized scientific procedure. Odour units are determined for each item based on odour detection limits. This procedure is used to objectively determine whether the odour of a given FR is more or less intensive than manure. Olfactometry was used in the early 1990s to assess the effectiveness of liming abattoir biosolids (Kodsi and Cournoyer, 1992). More recently, a standardized protocol was developed to assess various FRs (Urgel Delisle and Associates/Odotech, 2002).

Table 8.6 presents the method and the criteria retained for classification by olfactometry. The method will be revised in 2005, following a large scale validation process. A classification may be revoked in cases where the plant process has been

modified, resulting in a significant increase in odours. The odour classification for a given FR applies throughout Québec.

It should be noted that municipalities or groups of individuals seeking to contest an odour classification category listed in Table 8.4 for a particular FR may also employ olfactometry.

The regional office may determine the odour category of new FRs that are not listed in Table 8.4 on a case-by-case basis through comparisons with manure odours (by analogy) or by requiring olfactometry tests.

TABLE 8.6 CLASSIFICATION BY OLFACTOMETRY

Method	
➢ Applicable to all residuals, except for limed abattoir biosolids. ➢ The tests must be carried out according to the protocol developed by Urgel Delisle and Associates/Odotech (2002) http://www.odotech.com/fr/entreprise/mrf.html. However, the FR that is sampled must be held under anaerobic conditions for at least 4 weeks at 25°C, to simulate conditions of maximum odour generation. ➢ At least two representative farm manures (2 cattle manures, or 2 hog slurries, or 1 cattle manure + 1 hog slurry) are also sampled and simultaneously subjected to the same sample preparation and olfactometry test procedures (same panel). ➢ All sampling must be carried out by a sampling firm operating independently from the generator. ➢ Following the olfactometry analysis, classification is determined according to odour units (O.U.).	
Category	**Criteria**
O1	➢ FR O.U. x 2.5 < O.U. for cattle manure (mean value; there must be at least 2 manure samples).
O2	➢ FR O.U. x 1.5 < O.U. for cattle manure (if there is only one cattle manure sample) ➢ **or** FR O.U. ≤ O.U. for cattle manure (mean value, if there is more than one cattle manure sample).
O3	➢ FR O.U. x 1.5 < O.U. for hog slurry (if there is only one hog slurry sample). ➢ **or** FR O.U. ≤ O.U. hog slurry (slurry mean value, if there is more than one hog slurry sample).

9 TEMPORARY STORAGE

9.1 Duration

This section deals with temporary on-site storage of FRs before land application. FRs may be stored for up to six months in the case of heaps on the ground, and up to 12 months in leak-proof storage facilities.

9.2 Storage of heaps on the ground or in the field (non leak-proof)

9.2.1 Separation distances

Table 9.1 lists the separation distances prescribed to protect surface water, groundwater, and air quality. These distances vary with the FR's C-P-O classification. The location plan required for CA applications (Table 5.1) should illustrate compliance with separation distances (except for drainage furrow).

TABLE 9.1 SEPARATION DISTANCES FOR THE GROUND STORAGE OF FRS TO PROTECT WATER AND AIR QUALITY

Environment to Protect	Location	Basic Requirements (protection vs nitrogen and phosphorus)	Additional Requirements	
			P2/P3	O2/O3
Groundwater	Groundwater catchment works intended for human consumption	300 m[1,2]	300 m[1,2]	
	Rock outcrop	100 m		
Surface water	Agricultural[3] or non-agricultural ditch	15 m		
	Drainage furrow (swale, outlet rill)[4]		5 m	
	Watercourses[3, 5]	50 m	150 m	
	Lake, swamp, pond or natural marsh[3, 5]	50 m	150 m	
	20-year flood zone	outside		
Air (bioaerosols)	Dwelling[4]		100 m	
Air (odours)	Dwelling[4]			O2: 75 m[6] O3: 500 m[6]

(1) This is a regulatory standard pursuant to section 30 of the *Regulation respecting groundwater catchment* (RRGC). This distance is also designed to protect water from microbial contamination.

(2) For certain collective catchment works, the RRGC stipulates that storage must be done outside the virological protection area of a groundwater catchment site if the FR has been contaminated by human fecal matter, with the exception of BNQ-certified products. Until June 15, 2006, the default radius is 300 m.

(3) The RRAO does not contain any standards pertaining to field storage of FRs. It only prescribes standards for solid manures. See the notes in Table 10.2.

(4) See Glossary.

(5) Terms defined by the RRAO. Under the RRAO, the total flow area of a watercourse is > 2m². In the context of FR storage, however, irrigation ponds for crops must be treated in the same manner as other ponds in order to ensure the safety of crops.

(6) The risk of odour release is higher during handling (during stacking, etc.). The distance may be reduced where written consent has been obtained from the owner or tenant of the neighbouring dwelling.

9.2.2 Other preventive measures

Table 9.2 provides additional requirements that must be met in order to minimize the production and transport of leachate water, which can contain high levels of nitrogen and phosphorus.

For residuals that will be blended, the mixing must be done at the plant or on site by a specialized promoter. Precautions must be taken to limit leaching during the blending process.

For winter storage of FRs, where permitted, the following additional measures are recommended to prevent freezing at depth and to minimize nitrogen and phosphorus losses during thawing:

- heaps must be as high and large as possible, to reduce the surface-to-volume ratio;
- heaps must be placed along an east-west axis to reduce wind cooling.

For further information on best field storage practices, consult the U. S. Environmental Protection Agency website (USEPA): http://www.epa.gov/owm/mtb/biosolids/fsguide/index.htm.

9.2.3 Verification by the professional

The professional, or a technician working under his supervision, must make at least one verification visit at the start of the storage activity to ensure compliance with the criteria in tables 9.1 and 9.2.

TABLE 9.2 PREVENTIVE MEASURES TO REDUCE NITROGEN AND PHOSPHORUS LOSSES DURING TEMPORARY GROUND STORAGE OF FRs (≤ 6 MONTHS) AND THEIR RUNOFF INTO SURFACE OR GROUND WATER

FR Dryness (alone or mixed)	Maximum Volume per Establishment[1]	Winter Storage Restrictions According to CHU Zone[2]	Waterproof Covering (sheeting, tarpaulin, roof, capping, etc.)[3]	Other Restrictions
Liquid or < 15% dryness	Heaps on ground not permitted	Not applicable (n/a)	n/a	n/a
Non liquid **and** > 15% but < 20% dryness	< 250 m³[4]	➢ **CHU 1**: Dec. 1 to Feb. 28 ➢ **CHU 2 and 3**: Nov. 15 to Mar. 15 ➢ **CHU 4 to 7**: Nov. 1 to Mar. 31 ➢ **Exception**: these restrictions do not apply to paper mill biosolids.	For winter storage of paper mill biosolids	a) Location has not been used to store FRs or manure in the past 2 years b) Heaps must not be placed on snow-covered soil c) Protection from surface runoff and snow melt d) Location slope ≤ 5% e) Sowing should be done as soon as possible after the removal of heaps; soil must be decompacted where necessary.
Non liquid **and** > 20% but ≤ 25% dryness	According to the AERP	Ibid (above)	For storage from September to May, **except** if < 350 m³/establishment **or** if < 21 days	
Non liquid **and** > 25% but ≤ 30% dryness	According to the AERP	Ibid (above)	Ibid (above) Not required for paper mill biosolids with C:N ≥ 30	
Non liquid **and** > 30% dryness	According to the AERP	No restrictions	Ibid (above) Not required if: ➢ paper mill biosolids ≥ 30% dryness (at the mill), ➢ **or** ashes ≥ 50% dryness[5], ➢ **or** if total N + total P_2O_5 < 1% (d.w.). Mandatory for granulated municipal biosolids[6]	

(1) The establishment is an agricultural operation, nursery, community garden, etc.

(2) CHU = corn heat unit. For the location of CHU zones, visit: http://wms1.agr.gc.ca/cgi-bin/mapcropheat?mode=browse&layer=crop_heat&Layer=water_poly&layer=water_lines&layer=cities.

(3) The "capping" of a FR with a primary paper mill biosolid (deinking or from another process) is acceptable if carried out by a specialized promoter using a snowblower. The capping layer must be at least 30 cm thick and the residual used must have a minimum dryness of 40%. Heaps should be large to reduce the total surface to be capped.

(4) This is not an annual volume, but the volume at any given point in time. For example, two successive heaps of 250 m³ on the same site, one in May and the other in June, count as 250 m³ at a given time.

(5) Ashes and other pulverulent materials must be moistened or otherwise treated to prevent their dissemination by the wind.

(6) Dry organic matter, such as granulated municipal biosolids, must be stored in leak-proof structures. This prevents further fermentation, which would increase the release of odours and the risk of spontaneous combustion.

9.3 Leak-proof storage facilities

These include abandoned manure pits or facilities built specifically for FR storage.

Readers should consult reference documents for criteria concerning leak-proofing and the location of storage facilities to protect surface and ground water, namely:

- the *Guide technique d'entreposage des fumiers* (2002)
- the RRGC
- the RRAO.

To ensure the protection of air quality relative to odours and bioaerosols, separation distances for field storage of category O2 and O3 FRs can be applied (Table 9.1). The storage conditions for limed abattoir biosolids must also be met (Table 8.5).

A CA is required, in many cases, for the storage and application of manure/FR mixtures (Section 4.2). Furthermore, storage of FR mixes must meet the requirements of Section 7.2. The construction of a new FR storage facility may also require a CA.

9.4 Special cases

In some cases, an activity that does not meet all the storage criteria may still be authorized. The CA application must, however, contain compensatory measures to ensure compliance with section 20 of the EQA and, where applicable, a specific research protocol for validating these measures. See Section 4.2.1 concerning research and development activities.

The storage of dry organic matter, such as granulated municipal biosolids, presents a risk for spontaneous combustion (if it becomes moist) or explosion (presence of dust in a confined space).

9.5 CPTAQ

In a statement made on November 13, 2003, Michel Blais of the CPTAQ clarified the scope of the law administered by the CPTAQ:

> "…nothing in the current wording of the law prohibits a farmer from storing, on his farm, fertilizing materials that will be used on his land or on a neighbouring farm."

Therefore, CPTAQ authorization is not required for this type of project.

10 APPLICATION ON AGRICULTURAL LAND AND AERP

10.1 Agri-environmental parameters – N and P

Nitrogen (N) and phosphorus (P) are fertilizing elements for plants. However, runoff, erosion or leaching of these elements from fertilizing residuals or the soil can result in contamination of surface or ground water and lead to the loss of water uses. In principle, as long as inputs are calculated on the basis of crop requirements, the risk of excessive N and P contamination (pollution) is sharply reduced.

Agrologists must therefore draw up agro-environmental reclamation plans that will limit N and P inputs based on the following factors:

- analyses of FRs and soil, and associated trends;
- generally accepted agronomic practices;
- the standards in the RRAO that apply to the AEFP; visit:
  http://www.menv.gouv.qc.ca/publications/lois-reglem-en.htm;
- the OAQ's guidelines on management of fertilizing materials – Land application after October 1; for more information, visit: http://www.oaq.qc.ca/.

To determine N and P requirements and contribution, agrologists can refer to the *Guide de référence en fertilisation* published by CRAAQ (2003); visit: http://www.craaq.qc.ca/index.cfm?p=10&l=fr. This guide contains sections on estimating N and P availability in FRs. For municipal biosolids, supplementary information on the availability of these elements is provided in Appendix 5. With regard to biosolids and paper mill residuals, syntheses of a number of Québec research studies have been collated by the Centre de recherche en horticulture at Université Laval (1998), the Conseil des productions végétales du Québec (CPVQ, 2000) http://www.craaq.qc.ca/index.cfm?p=30&l=fr, the Association québécoise des spécialistes en sciences du sol (AQSSS), in conference proceedings, http://www.sbf.ulaval.ca/aqsss.html and the Québec Forest Industry Council (Désilets, 2002) http://www.cifq.qc.ca/html/english/index.php?PHPSESSID=9b0d1ac0921b9f3e2366560312ed816b.

It should nevertheless be kept in mind that the N level in FRs can vary over time, as is the case for continuously generated paper mill biosolids. Furthermore, there is a large margin of error associated with estimates of the agronomic efficiency of nitrogen in FRs. This is due primarily to ammonia volatilization, which can range from 6%–68% (WEF, 2000). Accordingly, it is recommended that a mineral fertilizer be used to meet at least 25% of the crop's nitrogen requirements so as to reduce the risk of under- or over-fertilizing (Hébert et al., 2003). In many cases, the combined use of biosolids and nitrogen fertilizer will allow for superior yields.

Nitrogen management is also more problematic with large inputs of residuals that have a high C:N ratio, such as primary deinking paper mill biosolids. The agronomic risk is reduced when these materials are applied in limited quantities, or when they are applied before growing crops that have low nitrogen requirements, such as leguminous plant (CRAAQ, 2003; Machrafi et al., 2003). Where appropriate, FRs with a high C:N ratio can be mixed with FRs that have a lower C:N ratio to minimize the risk of immobilizing soil nitrogen. Such a mixture should, however, be a homogeneous one that is prepared at the plant or by a specialized promoter, in order to limit the spatial variability of the nitrogen that is actually applied to the soil during the spreading operation. This aspect must also be taken into consideration when applying mixed paper mill biosolids that were field stored underneath ("capping") a layer of primary paper mill biosolids (see Table 9.2).

10.2 Other agronomic parameters

Other routine agronomic parameters, such as potassium, manganese, sodium, boron and pH, must be analyzed for a number of FRs (see Section 6.1). Nonetheless, the Ministry has not set maximum limits for these substances. It is up to agrologists to determine the specific criteria to be used when these parameters do not conform to the guideline values (Table 10.1).

10.3 Components of AERPs

Besides dealing with N and P management and other agronomic parameters, AERPs must include supplementary measures designed to protect the environment. The general requirements for AERPs are listed in Table 10.1. The tables that follow describe the specific requirements related to separation distances (Table 10.2), other spreading constraints (Table 10.3), measures for protecting workers (Table 10.4) and the requisite information and awareness program (Table 10.5).

It should be noted that the separation distance guidelines for odours from FRs are regulated under the *Environment Quality Act*, which is not the case for farm fertilizers. This is because odours from FRs do not result from agricultural activities. Note, however, that municipalities are responsible for setting the dates on which FR application is prohibited (see Section 3.7 and Appendix 1).

Section 498 of the *Highway Safety Code* prohibits the release of materials of any type on public roads. Carriers of FRs and farmers should therefore use appropriate transport and spreading equipment to ensure compliance with the legislation.

TABLE 10.1 MINIMUM CONTENT OF AERPS – GENERAL REQUIREMENTS – AGRICULTURAL RECLAMATION

- Identification of the origin of the FR, description of the process by which it was generated, agronomic characterization, determination of its FR status and C-P-O classification, with supporting documents (sections 6 to 8).
- Location plan mentioned in Table 5.1.
- Agro-environmental fertilization plan, or attestation of the agrologist if the receiving farm is required to have an AEFP (Section 5.4.4).
- Minimum soil analyses, appended to the CA application or included in the AEFP (Table 6.5).
- Incorporation of the FR storage criteria (Section 9).
- Agronomic recommendations for N and P for each parcel of land, specifying the application rates, spreading dates and choice of spreaders. Compliance with the standards of the RRAO is mandatory.
- As applicable, specific agronomic recommendations if the pH of the residuals is >10 or < 3.5, or if the sodium (Na) level > 1%, or the manganese level (Mn) > 3 000 mg/kg, or the boron (B) concentration > 200 mg/kg (all of these levels being based on dry weight).
- Incorporation of the separation distances (Table 10.2) and spreading constraints (Table 10.3).
- Commitment by the agrologist to inform farmers and workers concerned about the health and safety measures to be taken in relation to Category P2/P3 residuals (Table 10.4).
- Incorporation of minimal measures related to information and awareness (Table 10.5).
- Commitment by the agrologist to make at least two monitoring visits (personally or represented by another agrologist or a technician under his supervision). One of these visits must be made during the spreading equipment calibration phase.
- Undertaking to provide the regional office of the Ministry with a reclamation report after the reclamation operation has taken place, and no later than December 31 of the current year. This report must outline any changes pertaining to the CA application, namely: classification, quantities delivered, application rates and the lot numbers of the receiving parcels, etc. These reports can be grouped together, if, for example, several CAs are administered by the same agent or applicant in a given administrative region.

TABLE 10.2 SEPARATION DISTANCES FOR FR SPREADING TO PROTECT WATER AND AIR

Environment to Be Protected	Location	Basic Requirements	Additional Requirements for Categories P2/P3 (or O2/O3)
Ground water	Groundwater catchment work intended to supply drinking water for human consumption	30 m[(1)] 100 m if the FR is contaminated with human fecal matter, except for products certified by the BNQ[(1)].	
	Collective groundwater catchment work – Bacteriological protection area	The bacteriological protection area deemed vulnerable for some collective works defined in the RRGC, except where the FR is certified by the BNQ. Until June 15, 2006, an area of 100 m[(1)] applies.	
	Collective groundwater catchment work – Virological protection area	The virological protection area deemed vulnerable for some collective catchment works defined in the RRGC applies if the FR is contaminated with human fecal matter, with the exception of FRs certified by the BNQ. Until June 15, 2006, the virological protection area of a collective catchment work that is deemed vulnerable and that has a mean flow rate greater than 75 m^3 per day corresponds to the zone defined by a 300 m radius around the work[(1)].	
	Peat bog and organic soil (> 30% organic matter)		**P2/P3:** prohibited
Surface water	Agricultural ditch (flow area < 2 m²)	1 m[(2, 3, 4)]	
	Ditch in a non-agricultural environment	1 m	**P2/P3**: 10 m
	Watercourse, lake, swamp > 10 000 m² or pond	3 m[(2, 3, 4)]	
	Soils in flood-prone areas		**P2/P3**: prohibited
Air (bioaerosols)	Property line		**P2/P3**: 10 m[(5)]
	Road		**P2/P3**: 10 m[(5)]
	Municipal urbanization perimeter[(6)]		**P2/P3**: 500 m[(5)]
	Protected immovable[(6)]		**P2/P3**: 200 m[(5)]
	Dwelling[(6)]		**P2/P3**: 100 m[(5)]
Air (odours)	Dwelling[(6)]		**O2**: 75 m (**O3**: 500 m), except where it is incorporated into the soil immediately[(7, 8)].

(1) These are mandatory standards set out in the RRGC. The standards may differ for a catchment work that supplies drinking water for more than 20 persons or that has a flow rate > 75 m³/day and include separation distances of 200 or 300 m. For the exact wording of the standards, visit: http://www.menv.gouv.qc.ca/publications/lois-reglem-en.htm.

(2) These are regulatory standards set out in the RRAO, which are mandatory for cultivated land in an agricultural zone. For the exact wording of the standards, visit: http://www.menv.gouv.qc.ca/publications/lois-reglem-en.htm. See also the glossary in this *Guidelines*.

(3) These riparian strips may be amended solely through a municipal by-law.

(4) The riparian strip is measured from the high water line. If there is a slope, this setback must include an area at least 1 m wide at the top of the slope.

(5) The distance can be reduced by half if the residual is solid and has a dryness of at least 15% or if land application is done using spray booms with drop pipes or the equivalent.

(6) See Glossary.

(7) The distance can be reduced, provided that a letter of consent is obtained from the owner or tenant of the dwelling.

(8) Incorporation into the soil in less than 5 minutes using a suitable tillage implement. See note 4 in Table 8.3.

TABLE 10.3 OTHER FR SPREADING CONSTRAINTS FOR PROTECTING WATER, AIR, SOIL, CROP SAFETY AND PUBLIC SAFETY

Environment/Persons to Be Protected	Location/Activity	Basic Requirements	Additional Requirements (categories C2, P2/P3, O2/O3, as applicable)
Ground water	**Collective** groundwater catchment work	Prevent runoff in the protection areas for groundwater catchment works, for FRs not certified by the BNQ (standard in the RRGC).	
Surface water	Incorporation into the soil	< 48 hours if the spreading is done on bare soil (exceptions: perennial crops; FR with very low N and P levels (C:N ratio > 30 and P_2O_5 < 0.25%, dry weight); FRs used for mulching (Section 12.3)).	**P2**: < 6 hours, if option c of category P2 in Table 8.3.
	Maximum hydraulic load (liquid residuals)	< 100 m^3/ha/day.	
	Spreading period (liquid residuals)	Only from June 15 to August 15 if the main beneficial value of the residual is its water content for irrigating plants (Table 7.1).	
	Spreading equipment (liquid residuals)	Specialized equipment that minimizes soil compaction if a post-harvest spreading operation is involved.	
	Frozen or snow-covered soil	Land application prohibited (standard in the RRAO).	
	Ground slope	< 9% (< 5% if the residual is liquid).	
Air (bioaerosols)	Spreading equipment (liquid residuals)		**P2/P3**: use of spray booms with drop pipes or the equivalent (not required in the forest environment).
Soil	Trace element load		**C2**: < 22 t (d.w.) of residuals /ha/5 years (1)
Crop safety	Prohibited crops		**P2/P3**: food crops intended for human consumption, maple stands exploited for maple products, tobacco, pasture operations.
	Delay before harvesting crops intended for human consumption(2)		**P2/P3**: > 36 months after land application (14 months in the case of P2 and if the harvested portion of plants is the above-ground part, e.g. sweet corn grown after a hay crop that received an application of a P2 fertilizing residual).
	Delay before harvesting crops intended for animal consumption (grains, hay, etc.)		**P2**: > 30 days (P3: > 42 days). Spreading on pasture land prohibited.
Public	Delay before harvesting sod		**P2/P3**: > 12 months
	Public access to spreading sites		**P2/P3**: >12 months

(1) Calculate using the following equation: mass of C2 to be spread + mass of C2 already spread (preceding 60 months). Calculation not required if the FR to be spread contains ≥ 25% CCE (dry weight); or ≥ 1% P_2O_5 (d.w.); or if the application rate < 4.4 t/ha/year (d.w.).

(2) This refers to P2/P3 FRs used for non-food crops, such as forage crops, on land that is likely to be used for a human food crop in future growing seasons.

10.4 Protection of workers

A survey of farmers revealed that only a minority of the respondents were familiar with the personal protective measures that apply to the handling of category P2 and P3 fertilizing residuals (Groeneveld and Hébert, 2003). It is therefore important for agrologists to inform farmers and workers who handle category P2 and P3 FRs about the necessary measures to prevent microbial risks (Table 10.4). In addition, the FR generator must inform all persons involved in the delivery of FRs.

As a rule, the employer and workers are required to comply with the applicable standards of the *Act respecting occupational health and safety* (AROHS).

TABLE 10.4 PRECAUTIONS RELATED TO PATHOGENS FOR WORKERS HANDLING CATEGORY P2/P3 FRS [(1)]

Vaccination	➢ Regular immunization program for the general public
Protective gear	➢ Overalls or disposable jumpsuit ➢ Boots or shoe covers ➢ Protective visor (when warranted by the nature of the work)[(2)] ➢ Waterless antiseptic handrubs or disposable wipes (e.g. Wet-Ones®) ➢ A first-aid kit that meets the requirements of the *Regulation respecting first aid services* must be available at spreading sites.
Hygiene measures	➢ Wear clean work gear. ➢ Avoid rubbing eyes or mouth or touching face with hands. ➢ Wash hands frequently during the day (in keeping with CLSC guidelines), and before eating, drinking or smoking. ➢ Keep fingernails short. ➢ Never keep food, beverages or tobacco in the pockets of work clothes. ➢ Stand upwind (back to the wind) when applying FRs, except when using spray booms with drop pipes or any other equipment that reduces wind-induced drift of bioaerosols. ➢ After receiving a cut or skin lesion, disinfect the wound and apply protection to prevent contact between it and residuals. ➢ Wash clothes and spreading equipment that have come in contact with P2/P3 FRs (boots, spreader, front-end loader, tractor wheels, running board and floor, etc.). ➢ Never bring dirty work clothes home. Place them in a plastic bag and inform the washing attendant. ➢ Take a shower and wash hair at the workplace at the end of the day.

(1) Adapted from Groupe HBA Experts-conseils (1996), with the collaboration of Jacques Lavoie (IRSST). Workers who handle soil and plants that have been treated with residuals are subject to the same hygiene measures. These measures may also be applied at manure spreading work sites.

(2) A respirator mask is no longer mandatory. Respirators are only effective where a comprehensive respiratory protection program has been implemented in accordance with CSA Standard Z94.4-93.

10.5 Information and awareness program

Reclamation activities have been suspended in the past, following citizen complaints about the application or storage of certain types of FRs on farmland. Most of the complaints concerned odours or fears about the potential risks associated with these activities. To help foster social acceptance for FR spreading and promote good relations

with neighbours, every CA applicant must plan and implement a suitable information and awareness plan. This plan should target municipalities and all persons and stakeholders that are likely to be affected or to lodge a complaint. Individual plans will vary in their content depending on the C-P-O classification of the FR and other project characteristics. The minimum requirements are set out in Table 10.5.

Touart (1998) prepared a summary of the various aspects to be addressed in an information and awareness program. Helpful information can also be found on the website of the New England Biosolids Association (NEBRA): http://www.nebiosolids.org. Lupton (1999) has compiled a literature review of issues related to how stakeholder groups perceive the reclamation of municipal biosolids.

TABLE 10.5 INFORMATION AND AWARENESS PROGRAM – MINIMUM REQUIREMENTS

Objective	Basic Requirements	Additional Requirements (P2/P3, O2/O3)
Inform passersby and the general public	Post a sign at every entry to a passable road leading to the site to be treated indicating[1]: ➢ Project title ➢ Descriptive name of the FR ➢ Promoter's name ➢ Promoter's phone number ➢ Phone number of the regional office and MENV website address http://www.menv.gouv.qc.ca/ministere/rejoindr/repertoire-en.htm.	**P2/P3** – Spreading on **public lands**, or in **private forests**: ➢ The sign must have a pictogram with a design similar to that provided for in section 72 of the *Pesticides Management Code* (Q-2, r.2.3); ➢ The pictogram must bear the notation: "harvesting prohibited until…" (a date 12 months after the date of land application); ➢ The sign and the pictogram must remain in place throughout this period; ➢ Application on an area greater than 100 ha: issue a public notice similar to that provided for in section 58 of the *Pesticides Management Code:* http://www.menv.gouv.qc.ca/pesticides/permis-en/code-gestion-en/index.htm.
Inform municipalities	[2]	**O2/O3** – Send a fax or email at least 2 (working) days before deliveries.
Inform neighbours		**O2/O3** - Phone (or send a letter/fax/email) at least 7 days before deliveries and application operations. **O2** – Radius of 75 m; **O3** – Radius of 500 m (around the application or storage areas).
Inform MENV	Inform the regional office within 2 working days of receiving a complaint.	

(1) Posting is not mandatory, however, if the quantity of Cx-P1-O1 FR < 150 m³ per establishment.

(2) Information has already been given in the certificate attesting that the activity does not contravene any municipal by-laws obtained in connection with a CA application (Table 5.1).

11 APPLICATION ON FOREST LAND (SILVICULTURAL USE)

The general requirements for agro-environmental reclamation plans for silviculture are the same as those for agricultural reclamation (Section 10). However, certain differences must be taken into consideration:

- the professional who prepares the AERP must be a forest engineer, or an agrologist working under the supervision of a forest engineer,
    - the agronomic or silvicultural nature of certain activities, for example, Christmas tree production, nurseries and plantations, should be validated through the appropriate professional order;
- if public land is involved, written agreement must be obtained from the Ministère des Ressources naturelles;
- the application rate must be commensurate with the seedlings' nitrogen requirements, according to the type of stand and the forest management approach involved, and must never exceed 200 kg of available N/ha/year:
    - available nitrogen is calculated by taking into account the mineral nitrogen in the FR, the efficiency coefficient for the organic fraction for the first year, the residual effect of previous applications, and other specific factors;
    - to promote uptake of the nitrogen applied, the silvicultural prescription must also address phosphorus and potassium management.

Nitrogen inputs may be unnecessary for forest stands that have reached maturity, such as maple stands, and they may even pose risks from a silvicultural and environmental standpoint (Couillard et al., 1995). It would be superfluous to fertilize some natural stands of noble hardwoods in which a selection cutting regime is applied and which have a high nutrient recycling rate. According to Michon and Granger (unpublished data), a positive response to fertilization has not yet been demonstrated in cases like this. For seedlings and young plantations that are more fragile, the nitrogen application rate must be low in order to prevent adverse silvicultural effects and to avoid stimulating competing vegetation. In nurseries, nitrogen application rates must be limited in order to avoid nitrate contamination of groundwater, especially if the soil is sandy (Dubé and Delisle, 1995).

Various activities and studies have been conducted in Québec which describe practical aspects and the silvicultural and environmental effects of the reclamation of municipal biosolids in different types of plantations and forest stands (MENV, MFo and MSSS, 1991; Beauchemin et al., 1993; Payment, 1993; Couillard et al., 1995; Dubé and Delisle, 1995; Groupe HBA; 1996; Michon et al., 1996; Cogliastro et al., 1997; Granger et al., 1999). Furthermore, the technical aspects of the silvicultural reclamation of paper mill residuals are documented in a guide published by the Québec Forest Industry Council (QFIC, 1997).

12 OTHER TYPES OF APPLICATIONS

12.1 Bulk distribution of FRs for household use

Facilities that compost municipal and paper mill residuals sometimes hold open house events at which they distribute free samples of their composts and biosolids to the public. This type of distribution should normally be covered by a CA (exemptions are mentioned in Section 4, notably for products sold in small containers). This may be an enterprise CA or a specific CA.

The applicant must demonstrate that the product meets the C1-P1 or C2-P1 criteria (Section 8) by carrying out sampling in accordance with Section 6. The product thus distributed to the public will not be subject to specific spreading constraints. However, it must be accompanied by a document providing directions for use and appropriate warnings about application rates and odours.

The method of distributing farm compost is explained in Section 14.

12.2 Roadside enhancements and erosion control

This activity consists in employing biosolids and composts to promote vegetation cover and prevent erosion on slopes. This is beneficial for the quality of the environment (particularly the water in ditches). Many studies have shown that compost is effective for reducing erosion and facilitating the establishment of vegetation on degraded soils. The Texas Department of Transportation strongly recommends the use of compost for this purpose. Other FRs rich in organic matter can likewise be used.

For roadside applications, class C1-P1-O1 or C2-P1-O1 fertilizing residuals must be used, owing to the proximity of surface water and the manipulations performed by workers assigned to such sites.

The other CA requirements are limited to the regulatory standards listed in Table 5.1 and the characterizations mentioned in Section 6. Specific use requirements must be met in accordance with the standards of the Ministère des Transports du Québec, namely standard 9101 – *Matériaux pour l'aménagement paysager* (December 2002), and the *Cahier des charges et devis généraux* (2003) on landscaping.

12.3 Mulching, hydroseeding and landscaping

The use of organic FRs as mulches for market garden crops, apple orchards, vineyards or tree plantings can help to reduce the need for herbicides and conserve soil moisture, which is advantageous from an environmental and agronomic standpoint. The mulches derived from FRs consist of fibrous and coarse residuals, such as primary biosolids from paper mills and bark.

Since mulch must be applied in large amounts and repeatedly for agricultural uses, it is essential to comply with the category C1-P1 requirements. This will prevent the excessive buildup of chemical contaminants in the soil, as well as the risk of microbiological contamination of food products intended for human consumption. As a rule, the use of FRs in mulching must satisfy the requirements of the AERP for agricultural (Section 10) or silvicultural (Section 11) applications.

The same considerations apply for hydroseeding, except that category C2 fertilizing residuals may be used, because smaller quantities are employed. For hydroseeding in public places, however, category O1 fertilizing residuals must be used.

For landscaping purposes, C1-P1-O1 or C2-P1-O1 fertilizing residuals are generally used to avoid inconveniencing the public and engendering risks related to pathogens.

13 FR-BASED SOIL MIXES

13.1 General

A soil mix is a synthetic soil that is made from various materials and serves as a growing medium for plants. It generally resembles natural earth and has little odour.

Many different inputs can be used in the manufacture of commercial soil mixes, including:

- a base mineral soil (often sand);
- organic amendments:
  - peat moss
  - compost
  - composted manure
  - primary paper mill biosolids.
- mineral amendments:
  - perlite/vermiculite
  - agricultural lime
  - quicklime
  - ash
  - gypsum, etc.
- mineral fertilizers.

Depending on the intended use and target market, a variety of horticultural qualities can be obtained. The BNQ has outlined the characteristics required for given uses. For more information, visit:

http://www-es.criq.qc.ca/pls/owa_es/bnqw_norme.detail_norme?p_lang=en&p_id_norm=12546&p_code_menu=NORME.

Since the organic matter in soil mix is stabilized, it does not give off an offensive odour. A mixture of putrescible and foul smelling matter is more likely to be associated with a composting activity (see Section 14).

13.2 Manufacture and use of soil mixes

A CA may be required for the manufacture of soil mixes to prevent the spread of contaminants (ground and surface water) or to mitigate the effect of nuisances (odours, noise, dust) associated with the manufacturing site (see the CA exemptions listed in Section 4). The operations involved in manufacturing soil mixes must therefore be

described in the CA application, together with appropriate mitigation measures for water-air-soil impacts. The section on composting in the *Guide sur les actes statutaires et les critères d'aménagement et d'exploitation de divers lieux de valorisation de matières fermentescibles ou infermentescibles* (MENV, 1999, preliminary version) can be used as a reference.

The CA application must also contain sufficient guarantees that the soil mix to be produced and distributed is not likely to alter the quality of the environment within the meaning of section 22 of the EQA and does not exceed the maximum limits set out in Schedule 1 of the *Land Protection and Rehabilitation Regulation*.

CA applications for the manufacture of soil mix must therefore include the following:

- description of the quality control measures for the soil mix, including the analytical parameters and planned sampling frequency, as well as record keeping on the inputs;
- written undertaking by the manufacturer (board of director's resolution) to carry out quality control and meet the environmental quality criteria for horticultural soil mixes shown in Table 13.1, based on the sampling frequency set out in Table 6.2;
- if production exceeds 5000 t/year per type of soil mix, the manufacturer must undertake to arrange annual monitoring by a CEAEQ-accredited sampling firm, beginning in January 2006 (Section 6.6.2).

If these conditions are not met, the soil mix may not be distributed unless specific authorization is obtained setting out the applicable restrictions on use. The basis for the criteria in Table 13.1 is outlined in Appendix 1.

TABLE 13.1 ENVIRONMENTAL QUALITY CRITERIA FOR HORTICULTURAL SOIL MIXES

Chemical Contaminants[1]	**Maximum Limit - Total Concentration Analysis** [1] (mg/kg)	**Alternative Criterion** [1] **– Mehlich-3 Extractant** (mg/kg)
Arsenic	12	-
Cadmium	2.0	0.3
Chromium	99	0.7
Cobalt	29	1.1
Copper	100	-
Mercury	0.4	-
Molybdenum	5	-
Nickel	52	2.0
Lead	70	5.0
Selenium	1.4	-
Zinc	200	4.0
Dioxins & furans[2]	4 ng TEQ/kg (d.w.)	-
Microbiological Parameters	**Maximum Limit**	
E. coli	Median $\leq$ 1000 MPN/g (d.w.), **and** maximum value $\leq$ 2500 MPN/g (d.w.).	
Salmonella	Not detected at the detection limit < 3 MPN/4 g (d.w.).	
Oxygen uptake[3]	Mean $\leq$ 400 mg O_2/kg organic matter (d.w.)/hour.	

(1) Each inorganic trace element must comply with at least one of the two yardsticks (total concentration or Mehlich-3 extractant). The measure selected may differ from one parameter to the next. In cases where there is no alternative criterion, the total concentration applies. Comparisons for chemical contaminants must be based on the mean concentration.

(2) Applies if an input is supposed to contain more than 17 ng TEQ/kg (d.w.).

(3) Applies if one of the following inputs is used: human fecal matter (including municipal biosolids not certified by the BNQ), matter contaminated with human fecal matter, abattoir residuals (including biosolids and manures), meats that are unfit for consumption, paper mill biosolids or livestock residuals, or a compost made with any of the previously mentioned inputs that is not certified compliant by the BNQ.

14 COMPOSTING

14.1 Composting site

Composting of residual materials can be centralized either at sites with permanent facilities such as composting plants, in fields or on the ground at other locations that can accommodate heaps of materials.

14.1.1 Centralized sites and permanent facilities

Individuals who want to build and manage centralized (permanent) composting sites are required to submit a CA application, except in the case of the exemptions described in Section 4.2. The methods for building and operating permanent sites for composting municipal and industrial residuals are set out in the *Guide sur les actes statutaires et les critères d'aménagement et d'exploitation de divers lieux de valorisation de matières fermentescibles ou infermentescibles* (MENV, 1999, preliminary version). Complementary information can be found in the *Guide de la collecte et du compostage des résidus verts* (MENV, 1993). For composting of paper mill residuals, the composting standards of the *Regulation respecting pulp and paper mills* apply if these residuals make up the majority of the composted matter.

14.1.2 Heaps on ground (temporary)

Composting on the ground or on field margins is an acceptable practice for limited volumes (maximum 1 500 m³/establishment/year) and for a limited period (maximum 12 months per site). Since the environmental risks are comparable to those associated with temporary field storage, the criteria to be respected (Table 14.1) are very similar.

TABLE 14.1 CRITERIA FOR COMPOSTING ON GROUND – TEMPORARY SITES

- ≤ 1500 m³/establishment/year.
- Minimal dryness at the start of composting ≥ 25%.
- Compliance with the separation distances shown in Table 9.1.
- To ensure that the mixture is homogeneous, it must be turned at least once after windrowing using special equipment, unless the windrowing was done with a manure spreader.
- Geotextile or other covering that is permeable to air but waterproof; for exceptions see Table 9.2.
- Compliance with the other precautions listed in Table 9.2 (right column).
- 40°C, at least at some point during composting (measure with a thermometer).
- ≤ 12 months at the same location (rotate sites).
- Description of the composting regime prepared by an engineer or an agrologist. This professional must also make an inspection visit every year to attest to the compliance of the composting regime.

14.2 On-farm composting of manures and "full treatment"

If a CA is required for on-farm composting of manures, the same criteria apply as for composting of other residuals (Section 14.1). For information on building permanent structures for on-farm composting, readers can consult the *Guide technique d'entreposage des fumiers*. Odour management is not governed by the EQA, since odours result from agricultural activities. Appendix 6 describes the general administrative constraints that apply to on-farm composting of manures and use of the resulting compost.

Manure composting can be undertaken to perform a "full treatment" as required under the RRAO. This composting must be carried out in a permanent composting facility, whether at the farm or in a plant. Appendix 7 gives the specific requirements in this regard.

The quality requirements for farm composts that are intended for non-agricultural uses are the same as for other types of compost, primarily owing to risks of a sanitary nature (pathogens).

Information on the advantages and drawbacks of on-farm manure composting can be found in the documents published by Biorex (1989; 1994) and the CRAAQ (2003). Technical information on composting manure with green residuals is available in a recent report by the Centre de recherche industrielle du Québec (CRIQ, 2004). The report can be accessed at the following website: http://www.recyc-quebec.gouv.qc.ca/client/fr/rubriques/Nouvelles.asp?id=177.

14.3 Composting of dead animals

This practice is prohibited by the *Regulation respecting food,* administered by MAPAQ, except in the context of specific pilot projects.

If MAPAQ were to modify its regulations to permit industrial composting of dead animals, this activity would have to be carried out in composting plants that possess a CA issued specifically for this purpose. If on-farm composting of dead animals was permitted by MAPAQ, on-farm spreading of farm compost would not be subject to a CA under the regulations currently in force (see Section 4.2 and Appendix 6). See also Section 8.3.3 on the risks related to bovine spongiform encephalopathy (BSE).

14.4 Quality control and use of compost

Compost quality control must be ensured by the compost generator. For small production volumes (i.e. less than 5 000 tonnes/establishment/year, dry weight), a CA for use will not be required if the compost that is produced meets the C1P1O1 category requirements and the maximum limit criteria for sharp foreign objects in accordance with the CAN/BNQ 0413-200 standard on composts. However, if the production

volume is greater than 1 500 tonnes/establishment/year (dry weight), a CEAEQ-accredited firm is required to conduct sampling (Section 6.6.2). This sampling is in addition to the routine quality control that the promoter is required to perform. This exemption from a CA for land application complements the other exemptions, in particular the exemption applying to BNQ-certified composts (Section 4).

If a CA is required for the use of compost, a CA application must be filed as in the case of other FRs.

14.5 CPTAQ authorization

Authorization from the CPTAQ is required for any non-agricultural activities carried on in an agricultural zone. The CPTAQ has stated the following position (Bertrand, 1995):

> "When a person buys or receives as compensation fermentescible materials that can be reclaimed on agricultural land, whether this material is stored on the person's farm, processed into a product that can be used for agricultural purposes or incorporated into the farm soil as an amendment, this activity constitutes an agricultural activity within the meaning of the first paragraph of section 1 of the Act."

Furthermore, it appears that if the farm-produced compost is used on another farm, this is likewise deemed an agricultural activity by the CPTAQ, given its recently stated position concerning on-farm FR storage (Section 9.5).

In practice, CPTAQ authorization may be required if the activity meets the following conditions simultaneously:

- the composted materials do not result from agricultural activities; and
- the compost that is produced will not be used for agricultural purposes.

15 OTHER USES OF FRs

15.1 Livestock bedding

Studies conducted in Québec and elsewhere have shown that paper mill biosolids can be used as bedding for animals (Beauchamp et al., 2003; Cozak et al. 2003, Jean-François Ménard, personal communication). This is advantageous since FRs can serve both as a source of comfort for animals and as a soil amendment. Studies on primary deinking biosolids have not shown any adverse impacts on the health or productivity of swine and chickens (Beauchamp et al., 2002; Machrafi et al., 2003). Requests to use FRs as bedding material over the coming years may increase, because of the rising price of conventional forestry residuals.

If the use of bedding is governed by a CA, the requirements in Table 15.1 apply. However, the manure that is produced is deemed a "manure" that can be used for agricultural purposes without a CA (see Section 4.2.5).

TABLE 15.1 CRITERIA FOR THE USE OF FRS AS LIVESTOCK BEDDING WHEN A CA APPLICATION IS REQUIRED

Objectives	Criteria
Absorb liquids.	> 40% dry matter
Absorb liquids and provide comfort for animals.	> 50% organic matter (dry weight)
Immobilize ammonia and reduce odours.	C:N ratio > 30
Protect animals, livestock farmers and soil.	Class C1-P1-O1 or C2-P1-O1
Provide comfort and prevent specific husbandry problems such as mastitis (dairy herds) or respiratory problems caused by bioaerosols.	Letter from a veterinarian undertaking to notify the regional office if specific problems arise.

15.2 Sediment barriers

Composts and other residuals with similar physical properties, such as primary paper mill biosolids, can be used in construction zones and areas with degraded soil to control erosion. In such cases, the compost or other material is formed into mini-windrows or longitudinal bundles and placed in water flow areas, in places where silt fences would normally be installed. Water entraining sediment and silt is filtered by this material and the sediments are captured by the matrix. Sometimes these residual-based barriers are more effective than conventional silt fences for water quality protection around work sites.

After the compost or the FR has been used as a silt fence, the materials can be land applied to promote revegetation of adjacent disturbed sites. The same constraints apply as for roadside enhancements (Section 12.2). Residuals can serve a dual purpose in this context.

Abbreviations and acronyms

AEFP	Agro-environmental fertilization plan
AERP	Agro-environmental reclamation plan
AROHS	*Act respecting occupational health and safety*
BAPE	Bureau d'audiences publiques sur l'environnement du Québec
BNQ	Bureau de normalisation du Québec
CA	certificate of authorization
CCE	calcium carbonate equivalents
CCME	Canadian Council of Ministers of the Environment
CEAEQ	Centre d'expertise en analyse environnementale du Québec
CFIA	Canadian Food Inspection Agency
CHU	corn heat unit
C:N	carbon-nitrogen ratio
CPTAQ	Commission de protection du territoire agricole
CRAAQ	Centre de référence en agriculture et agroalimentaire du Québec
CRIQ	Centre de recherche industrielle du Québec
DMR	Direction du milieu rural
d.w.	dry weight
EQA	*Environment Quality Act*
FR	fertilizing residual
IRSST	Institut Robert-Sauvé en santé et sécurité au travail
ISO	International Organization for Standardization
MAPAQ	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec
MENV	Ministère de l'Environnement du Québec
MPN	most probable number
MRI	multiple reclamation index
MSSS	Ministère de la Santé et des Services sociaux
N	nitrogen
NATO	North Atlantic Treaty Organization
NEBRA	New England Biosolids and Residuals Association
NV	neutralizing value, calcium carbonate equivalents
OAQ	Ordre des agronomes du Québec
P	phosphorus (or pathogen category, as applicable)
PAH	polycyclic aromatic hydrocarbons
PCP	pentachlorophenol
RCM	regional county municipality
RRAEQA	*Regulation respecting the application of the EQA*
RRAO	*Regulation respecting agricultural operations*
RRGC	*Regulation respecting groundwater catchment*
TEQ	toxic equivalents of dioxins and furans
UPA	Union des producteurs agricoles
USEPA	United States Environmental Protection Agency

Glossary

agent
Legal or natural person who is mandated by the applicant to prepare or present a CA application. An agreement between the two parties (mandate) must define the roles and responsibilities of each party. French: ***mandataire.***

agricultural activity
With respect to the application of the *Environment Quality Act*, jurisprudence has interpreted the expression "agricultural activities" by drawing on the *Petit Robert* dictionary (1990), which defines the expression *agriculture* as follows: [TRANS.] cultivation of the soil and, more broadly, the aggregate of operations that involve transforming the natural environment for the production of plants and animals that are useful for humans. This definition differs from the one adopted by the CPTAQ with regard to the protection of agricultural land. French: ***activité agricole.***

agro-environmental fertilization plan (AEFP)
"…a plan that determines, for each parcel in an agricultural operation and each annual growing season (maximum of 5 years), the crop grown and the spreading limits for fertilizers" (*Regulation respecting agricultural operations*). French: ***plan agroenvironnemental de fertilisation***.

bioaerosols
Airborne particles, made up of microorganisms (bacteria, viruses, moulds) or their by-products, such as metabolites, toxins or fragments of microorganisms, that can disperse in the air and affect human health (Forcier, 2002). French: ***bioaérosols.***

biosolid
"Organic product obtained from the physico-chemical and/or biological treatment of wastewater" (BNQ, 2002). Syn.: sewage sludge. Biosolids result from primary wastewater treatment (primary biosolids), or from secondary wastewater treatment (secondary biosolids), and these two types of biosolids are often combined (mixed biosolids). These biosolids can be derived from the treatment of either municipal wastewater or industrial wastewater. They are used as organic soil amendments or as a source of fertilizing elements (fertilizer). French: ***biosolide***.

CA applicant
Legal or natural person who signs an application for a certificate of authorization. After the CA is issued, the applicant becomes the CA holder. French: ***demandeur de CA.***

CA holder
Legal or natural person to whom a certificate of authorization has been issued. This person is legally liable for complying with the conditions governing the certificate of authorization. French: ***titulaire de CA***.

calcareous amendment
Soil liming amendment containing at least 77% calcium carbonate (wet weight). Do not confuse with calcium carbonate equivalents derived from hydroxides or oxides rather than from carbonates. This is a subcategory of liming materials. French: ***amendements calcaires***.

compliant with BNQ (Bureau de normalisation du Québec) standards
Satisfies the requirements of a BNQ standard. A product described as "compliant" is not necessarily "certified." A compliant product must nevertheless bear a label or delivery slip containing the mandatory warnings, in accordance with the standard. A product that is "certified" by the BNQ is obviously considered "compliant." French: ***conforme aux norms du Bureau de normalisation du Québec***.

compost
"Solid mature product resulting from composting which is a managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase" (BNQ, 1997a). Compost resembles a humus-rich soil mix; it is odourless and generally has an oxygen uptake rate of less than 400 mg O_2/kg of organic matter/hour. French: ***compost***.

composting
A managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase (marked elevation of temperature) (BNQ, 1997a). French: ***compostage***.

contaminant
"… a solid, liquid or gaseous matter, a microorganism, a sound, a vibration, rays, heat, an odour, a radiation or a combination of any of them likely to alter the quality of the environment in any way" (*Environment Quality Act*). See **pollutant**. French: ***contaminant.***

drainage furrow
Shallow water channel, lined with grass, which is used to drain part of one or more parcels of agricultural land. Syn: drainage swale, outlet rill. French: ***rigole***.

dryness
Dry matter content. French: ***siccité***.

dwelling
"A dwelling having an area of at least 21 m^2 that does not belong to the owner or the operator of the livestock facilities concerned or to a shareholder or manager owning or operating the facilities." Source: *Guidelines respecting odours caused by manure from agricultural activities* (Québec, 2003). For the purposes of interpreting the *Guidelines*, the expression "receiving parcels" is substituted for "livestock facilities." French: ***maison d'habitation***.

farm compost
Compost produced on a farm using farm products. This compost no longer has the characteristic smell of manure and it has an oxygen uptake rate of less than 1 500 mg 0_2/kg of organic matter/hour. It is typically less mature and has a lower hygiene quality than all-purpose commercial composts, except when it has undergone "full treatment." French: ***compost « de ferme »***.

farm products
Within the meaning of the RRAEQA, residuals deriving from agricultural activities such as manures and plant residues. Materials traditionally employed on livestock farms as bedding are included. These must consist of plant-derived products that have not undergone chemical treatment, for example, sawmill sawdust and bark, or peat moss. Materials such as paper mill biosolids are not considered farm products. However, farm animals that died on the farm are considered farm products. French: ***produit de ferme***.

fertilizer
"…any substance or mixture of substances, containing nitrogen, phosphorus, potassium or other plant food, manufactured, sold or represented for use as a plant nutrient" (*Fertilizers Act*); consult the following site: http://laws.justice.gc.ca/en/F-10/57808.html. French: ***engrais***.

fertilizing materials
The ISO definition for this concept, which it terms "fertilizers and soil conditioners," is as follows: "All materials that are used to maintain or improve plant nutrition and the physical and chemical properties and biological activity of soils, either separately or together." (ISO, 1984). French: ***matières fertilisantes***.

fertilizing residuals (FRs)
Residual materials intended for use in maintaining or improving plant nutrition and the physical and chemical properties and biological activity of soils, either separately or together. This definition combines the expression "residual material," as defined in section 1 of the *Environment Quality Act* (EQA), and the concept of "fertilizing materials," which corresponds to the ISO expression "fertilizers and conditioners," as defined in this glossary (ISO, 1984). By convention, the definition of fertilizing residuals excludes residuals from agricultural activities. French: ***matières résiduelles fertilisantes***.

forest management
"Forest management includes timber felling and harvesting, the installation and maintenance of infrastructures, the carrying out of silvicultural treatments including reforestation and the use of fire, the repression of insect epidemics, cryptogamic diseases and competing vegetation, and all other activities affecting the productivity of a forest area" (*Forest Act* (R.S.Q., c. F-4.1, section 3). French: ***aménagement forestier (activité d').***

full treatment
"(…) a treatment by which livestock waste is transformed into a solid product of a different nature, such as fertilizing granulates or mature composts, and through which the bacteria it contains are destroyed (…)" (*Regulation respecting agricultural operations*).
Full treatment of livestock waste gives rise to marketable products that can be used off-farm. Spreading of these products on agricultural lands is restricted to "limited activity zones," also called "surplus municipalities." French: ***traitement complet***.

liming materials
"A product of industrial processes composed primarily of calcium or magnesium, or a mixture of these two minerals, in one or more forms but generally in the form of oxides, hydroxides or carbonates, which is used mainly to maintain or improve the quality of soil as a growing medium, primarily by raising the pH" (BNQ 1997b). Liming materials include ashes, cement kiln dust, lime mud from paper mills and all other mineral residuals or alkaline products used mainly for raising soil pH or amending the soil with calcium or magnesium. French: ***amendements calcaires ou magnésiens (ACM)***.

livestock waste
"…animal urine and fecal matter. It also means bedding used as absorbents, contaminated water and precipitation water that came into contact with livestock waste" (*Regulation respecting agricultural operations*). French: ***déjections animales***.

micronutrient
"A plant nutrient (for example boron, copper, molybdenum, manganese, iron and zinc) required in lesser quantities than major (for example nitrogen, phosphorus and potassium) and secondary (for example calcium and magnesium) plant nutrients, having essential physiological functions in plant metabolism." (BNQ, 1997a). French: ***oligoélément***.

mineral fertilizer
Fertilizer that contains less than 15% organic matter. An example would be commercial mixes produced by fertilizer manufacturers that contain small quantities of granulated municipal biosolids. Federal legislation does not permit the use of the notation "organic base" for a fertilizer containing less than 15% organic matter, wet weight. Wood ashes are considered liming amendments by the BNQ, rather than mineral fertilizers, although ashes also have fertilizing properties. French: ***engrais minéraux.***

municipal biosolid
"Biosolid obtained from municipal wastewater pretreated to remove gravel and coarse solid waste" (BNQ, 2002). French: ***biosolide municipal.***

municipal urbanization perimeter
"The boundary envisaged for the growth of a municipality's urban areas, as defined in its development plan, with the exception of any portion of the perimeter in an agricultural zone." Source: *Guidelines respecting odours caused by manure from agricultural activities* (Québec, 2003). French: ***périmètre d'urbanisation d'une municipalité***.

pollutant
"…a contaminant or a mixture of several contaminants present in the environment in a concentration or quantity greater than the permissible level determined by regulation of the Government, or whose presence in the environment is prohibited by regulation of the Government" *(Environment Quality Act*). French: ***polluant***.

protected immovable
According to the definitions in the *Guidelines respecting odours caused by manure from agricultural activities*, this expression may denote: “a) a business; b) a recreational, sports or cultural centre; c) a municipal park; d) a public beach or marina; e) land belonging to an educational institution or an institution within the meaning of the *Act respecting health services and social services* (R.S.Q., c. S-4.2); f) a campground; g) buildings of an outdoor recreational area or a nature interpretation centre; h) a ski lodge or golf clubhouse; i) a religious temple; j) a summer theatre; k) a tourist accommodation establishment within the meaning of the *Regulation respecting tourist accommodation establishments*, except bed and breakfast establishments, tourist homes or basic furnished lodgings; l) buildings used for wine tasting purposes in vineyards or restaurants of 20 seats or more that hold a year-round operating permit, and facilities for country or any other similar form of dining where the eating facilities do not belong to the owner or operator of the livestock facilities concerned.” French: ***immeuble protégé***.

residual material
“…any residue resulting from a production, treatment or utilization process and any substance, material or product or, more generally, any object that is discarded or that the holder intends to discard” (*Environment Quality Act*). French: ***matière résiduelle***.

soil mix
A synthetic soil made from a variety of materials that is used as a growing medium for plants. It generally resembles natural earth and has little odour. French: ***terreau.***

Appendices

APPENDIX 1 SUPPLEMENTARY INFORMATION AND BASIS FOR CRITERIA – TABLE BY TABLE

Table 4.1: Regulatory exemptions from a CA

The interpretations and definitions in Table 4.1 differ from those in the 1996 edition of the document entitled *Guide d'interprétation du Règlement relatif à la LQE* (MENV, 1996) http://intramenv/00E/m/milieux_hydriques/guide_interpretationLQE/GUIDE-reglement-1.pdf.

Table 4.3: Low environmental risk activities – Land application

Domestic composts, plant residues, etc.

In light of a characterization campaign undertaken by the Ministry and a literature review, it appears that composts of this type contain few pathogens and few trace elements (metals), or that they are unlikely to contain high levels of these.

Domestic compost, even if it contains few pathogens (Brassard et al., 1999), is not completely risk free, because the plant matter it contains can emit bioaerosols, particularly fungal spores, which can affect certain individuals just as house plants can. The risk is nonetheless considered low, or fairly low, in relation to the risk associated with other activities for which the MENV does not require a CA.

Leaves, tree pruning debris, bark and wood residuals

For these types of FRs, the amount that can be land applied is limited for the sole purpose of deriving beneficial use from spreading and preventing any disguised type of disposal. In other words, spreading must be carried out on cultivated parcels of land. In a context of mulching for perennial crops, larger quantities may be applied to ensure the mulch has the desired effect. This type of application is unlikely to be repeated every year, for practical reasons. Mulching also helps to reduce herbicide use, thereby eliminating all risk to the environment, provided that the residuals do not come in contact with contaminants (preservatives [PCP], fecal matter, etc.). Land application of recycled grass clippings is not encompassed in these exemptions owing to the risk of producing offensive odours and the risk of nitrate leaching.

Table 4.4: Low environmental risk activities – Soil mixes and storage

Soil mixes

Less than 150 m^3/year – Operations producing less than 150 m^3/year of soil mix do not generate much noise, dust, odours, etc. Soil mix produced in small quantities is generally

employed on site by amateur horticulturists and greenhouse growers, or by professionals who produce their own growing media. The criterion related to annual production volume can be verified indirectly based on the quantities of soil mix or of inputs that are present at the soil mix manufacturing site at a given point in time.

Human fecal matter, etc. – Horticultural soil mix is used in home gardens and spread on lawns around dwellings. Inputs containing pathogens that are transmissible to humans must never enter into the manufacture of soil mix, in order to prevent the risk of food poisoning in children following the ingestion of soil mix. This includes some soil mixes from establishments that produce less than 150 m^3 of soil mix per year.

Temporary storage (at the spreading site)

Composts certified by the BNQ – The mandatory directions for use provided on the label do not specify storage conditions. However, these composts contain very few contaminants that are leachable in water, except nitrates in certain cases. Although the risk of nitrate leaching is limited, because certified compost contains at least 35% dry matter, which gives it considerable water retention capacity. In addition, since this is a marketed product, it should theoretically be used up fairly quickly in most cases, thus lessening the chance of exposure to rainwater. When not used, this type of compost is often stored in large heaps whose surface-to-volume ratio also minimizes exposure to rainwater for up to six months.

Liming materials certified by the BNQ – The directions for use, which include storage practices, must be followed in order for the materials to be exempt from a CA.

Table 6.1: Chemical parameters to be analyzed according to the type of residual

In the case of municipal biosolids, paper mill biosolids resulting from a process employing chlorine and composts made up of municipal residuals that have not been separated at source, the decision can be made to forego an analysis. However, conservative dioxin and furan levels must be submitted (18-50 ng TEQ/kg), for example, those from characterization campaigns (Québec, Ministère de l'Environnement, 1996; Charbonneau et al., 2001; Groeneveld and Hébert, 2004).

Table 6.2: Minimum number of samples required according to the quantity of residuals produced and the parameter to be analyzed

The minimum number of samples to be provided according to categories of residual tonnage produced is based on USEPA guidelines (1994), except in the case of microorganisms and dioxins.

Table 6.5: Soil analysis – Minimum required by the Ministry

The maximum limit criteria for Al + 0.5 Fe in soil were withdrawn following the recommendations made by Webber (2003) upon completing a literature review on this topic. In some cases, however, analysis of the FR is required in order to calculate the amount of plant-available phosphorus. Analyses of Fe in soil are required only in specific cases, whereas the analysis of Al remains mandatory under the RRAO for the purpose of determining phosphorus saturation.

Table 8.2: C categories – Maximum limits

Parameters covered by maximum limits

The 11 standard trace elements (As, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Se, Zn) covered in the Canadian Council of Ministers of the Environment guidelines for compost quality (CCME, 1996) were retained. Furthermore, these parameters overlap with those standardized by the USEPA (1993) for the reclamation of municipal biosolids, the standards established by the Canadian Food Inspection Agency (CFIA, 1997) and the BNQ standards on FRs (BNQ 1997a, 1997b, 2000). These inorganic contaminants have been supplemented by dioxins and furans, which are standardized in some European countries. Maximum limits have been set for all of these parameters.

The C1 and C2 criteria retained for the parameters are among the most stringent in the world (Désilets, 2003, Van Coïllie and Laquerre, 2003). In Canada, they have been harmonized in recent years with the criteria applied by the CFIA, the CCME and the BNQ through ongoing collaborative efforts.

Category C1

The C1 criteria come from the A category used for composts by the BNQ (1997a) and by the CCME (1996). “Category A” denotes composts of high environmental quality for which land application rates need not be restricted with respect to trace elements. Most of the criteria retained correspond to the background metal concentrations in soils, that is, the 98th percentile of agricultural soils in three provinces including Québec (BNQ, 1997a). This approach is based on a risk management concept called “no net degradation,” which holds that a level of contamination equal to the level of contamination naturally present in soils is acceptable.

Sole reliance on the “no net degradation” approach has proven to be deficient from a broader perspective, because nearly all manure-based composts, and those resulting from recycled domestic waste, would have to be rejected. For some trace elements, such as As, Cu, Cr, Hg and Mo, the CCME and the BNQ have chosen to apply a different risk management concept, namely the “best available technology” approach. Under this approach, the level of contamination present in compost that has been produced using the

best manufacturing technologies is deemed acceptable. Additional explanations on the criteria for standard trace elements are provided in the *Support Document for Compost Quality Criteria* (Bureau de normalisation du Québec, Environment Canada and Agriculture and Agri-Food Canada, 1996).

The *Guidelines* has also incorporated the recent modifications recommended in 2004 by the working group reviewing the BNQ standard for composts with respect to Cu and Zn. As a result, the criterion of 100 mg Cu/kg has been increased to 400 mg Cu/kg. According to Hébert and Groeneveld (2003), this change will not have a negative impact on composts. Other FRs that may be reclassified from category C2 to C1 as a result of this change consist of some primary deinking paper mill biosolids and some municipal biosolids treated with lime. The proposed change to the criterion for Zn is minor (700 vs 500 mg Zn/kg)

For dioxins and furans, the all-purpose C1 criterion of 17 ng TEQ/kg (d.w.) for top-quality green residual compost comes from a German standard (Fricke et al., 1996, cited by Webber, 1996). According to recent analyses in Québec (Groeneveld and Hébert, 2003), the majority of commercial composts meet this criterion, as do the majority of paper mill biosolids (Hébert et al., 2002). However, most municipal biosolids produced in Canada and the United States exceed this criterion (Bright et al., 2003).

Category C2

The C2 criteria are based mainly on the B category criteria applied by the BNQ and the CCME for compost quality, which come essentially from the CFIA criteria as set out in Trade Memorandum T-4-93 (CFIA, 1997) (visit the online address provided below). The CFIA based its maximum acceptable concentration criteria for composts mainly on maximum cumulative metal additions to soils (kg/ha). This loading value was then converted to concentrations for various products using the agronomic application rate and the nitrogen level.
http://www.inspection.gc.ca/english/plaveg/fereng/tmemo/t-4-93e.shtml

Here is a brief description of how the CFIA established the maximum permissible loadings based on Ontario data:

- the CFIA used the mean levels of trace elements in agricultural soils in Ontario, in mg/kg;
- depending on the relative toxicity of the elements, it considered that these mean soil levels could be multiplied by 2, 4 or 8 (Ontario, Ministry of Agriculture and Food, Ministry of the Environment, Ministry of Health, 1986);
- the difference in concentration between “mean” and “acceptable” soil levels was converted to an “acceptable loading,” in kg/ha;
- the CFIA then doubled the Cd loading in order to permit land application of certain commercial fertilizing materials (mineral fertilizers);
- the CFIA determined that this maximum acceptable cumulative loading (“maximum acceptable cumulative metal additions to soils”) corresponded to a period of 45 years.

Although useful in the past, this approach seems outmoded now, especially considering the criteria that the USEPA (1993; 1994; 1995) has developed on the basis of in-depth risk analyses. That is why changes were made to the C2 criteria in the *Guidelines*. For example, the As and Pb concentrations were reduced to bring them into line with the USEPA's *exceptional quality* category. In addition, the maximum limit for Cd was reduced to 10, in keeping with the "best available technologies" approach and the European Union's draft standard (2000). However, for ashes and other liming materials, the maximum limit criterion comprises an option for harmonizing it with the BNQ standard on liming materials (1997), according to the neutralizing value.

During public consultations in January 2004, the BNQ committee reviewing the "compost" standard recommended that there should no longer be a maximum limit for Cu for category B (equivalent to C2), as in the CCME guidelines (1996). The MENV nevertheless retained a maximum limit of 1 000 or 1 500 mg/kg, depending on the phosphorus level in the FR. The value of 1 500 corresponds to the USEPA's *exceptional quality* criterion. This modification permits more extensive reclamation of municipal biosolids while ensuring environmental protection. The composition of hog slurries generally respects this criterion.

The maximum limit criterion of 50 ng TEQ/kg (agricultural use) for dioxins and furans dating back to 1997 (MENV, 1997) was retained in keeping with the "best available technologies" concept and Canadian initiatives for reducing dioxins and furans in the environment. However, the USEPA's most recent risk analyses of municipal biosolids show that a dioxin and furan limit does not necessarily protect the environment or human health (2003): http://www.epa.gov/ost/biosolids/. Accordingly, the subcriterion of 27 ng was removed to simplify the approach. The subcriterion of 100 ng TEQ/kg, retained for non-agricultural uses, is in line with the European Union's draft standard (2000).

Given a scenario where FR application is done at maximum intensity and maximum contamination levels (theoretical) for spreading on agricultural land are attained, Van Coïllie and Laquerre (2003) showed that the buildup of dioxins and furans over a period of 100 years would not result in an exceedance of the CCME guideline (2001) for the quality of agricultural soils. For more information on the position adopted by the MENV with respect to maximum dioxin and cadmium limits for FRs, readers should consult Hébert (2003). See also the comments in tables 10.3 and 13.1 concerning the buildup of other chemical contaminants.

Parameters not retained in establishing maximum limits

Aluminum (Al) and iron (Fe)

The aluminum and iron criterion **(Al + 0.5 Fe)** introduced in 1995 (MENV, 1995) was eliminated in keeping with the recommendation formulated in a literature review on the topic (Webber, 2003). However, the analysis remains mandatory if salts have been added (alum, ferric chloride, etc.). The analysis is aimed at determining P availability in fertilizing residuals. It should be noted that few paper mills use Al or Fe salts.

Furthermore, although a number of residuals may contain high total concentrations of Al and Fe, the latter are often constituents of clayey or sandy particles. In such a case, the elements Al and Fe are not very reactive from a chemical standpoint.

Boron (B), manganese (Mn), sodium (Na) and pH

The CCME (1996), Ontario (Ontario, Ministry of Environment and Energy and Ministry of Agriculture, Food and Rural Affairs, 1996) and the United States (USEPA, 1993) have not set standards for these parameters with respect to the reclamation of composts and municipal biosolids. Since phytotoxicity is the potential risk, analysis of FRs is required in some cases, but no maximum limit criterion has been established (guideline values are provided). It is up to the agrologist or forest engineer to determine the limits that should apply, if any. It should be noted that Na and B are very soluble and hence unlikely to accumulate in soils in regions with high rainfall, like in Québec.

Barium (Ba)

Although the levels of this element may be significant (up to 4000 mg Ba/kg) in wood ashes, no criterion was retained for the following reasons:

- phytotoxicity constitutes the only environmental risk, in theory;
- there are no reports in the literature of phytotoxicity incidents resulting from massive application of ashes (Kabata-Pendias, 2001);
- the rise in soil pH resulting from the application of ashes reduces the plant availability of Ba (Kabata-Pendias, 2001);
- the presence of Ca in ashes reduces the toxicity of Ba (Kabata-Pendias, 2001);
- Ba occurs naturally in ashes and comes from wood;
- ashes are land applied in small quantities to prevent an excessive rise in pH;
- to our knowledge, no guideline has been established for Ba levels in residuals anywhere in the world, except in the State of Maine (1994).

Polychlorinated biphenyls (PCBs)

These contaminants are rarely detected in municipal biosolids (St-Yves and Beaulieu, 1988), paper mill biosolids (H.C. Lavallée inc., 1996) or composts (Groeneveld and Hébert, 2003). The main reason is that the use of PCBs has been banned in industrial production for a number of years.

The most toxic congeners, namely planar PCBs, are sometimes integrated with the broad group of dioxins and furans and represented in toxic equivalents. However, their contribution to the total toxic equivalents of dioxins in municipal biosolids is limited, just as it is in composts (Groeneveld and Hébert, 2003).

Polyaromatic hydrocarbons (PAHs)

As a rule, PAHs are not detected in FRs, although small quantities may at times be found in paper mill residuals (H.C. Lavallée inc., 1996) and composts (Groeneveld and Hébert, 2003). Furthermore, the risk of uptake by plants is low (Sauerbeck and Leschbner, 1992). The half-life values for PAHs in agricultural soils are generally $<$ 180 days in the soil (Nagpal, N, 1993). Consequently, there is little likelihood of long-term accumulation in soils following repeated land application.

Extractible halogenated (chlorinated) organic compounds (EOX)

Adequate determination of these contaminants was not possible during the characterization campaign targeting paper mill residuals in 1994 (H.C. Lavallée inc., 1996). However, the specific chlorinated molecules that were analyzed (PCBs, chlorophenols, dioxins, furans and others) are present at low levels.

Petroleum hydrocarbons

This parameter was not retained for the following reasons:

- to our knowledge, no maximum limit criterion for petroleum hydrocarbons has been developed in North America or Europe for FRs such as municipal biosolids and composts;
- the analytical method for C10-C50 petroleum hydrocarbons, which was developed for contaminated soils, has not been validated for organic-rich matrices like biosolids;
- the most toxic components of petroleum hydrocarbons, PAHs, are present in small quantities (see above);
- alkanes and monocyclic aromatic hydrocarbons are readily biodegradable or volatile;
- theoretically, in order to exceed criterion A of the *Soil Protection and Rehabilitation of Contaminated Sites Policy* (MENV, 1999b), which stands at 300 mg C_{10}-C_{50}/kg soil, a very high rate (22 t (d.w.)/ha) of a residual containing at least 3% hydrocarbons would have to be land applied, which appears unlikely.

Note also that only one of the 25 FRs subjected to barley germination/growth bioassays by the CEAEQ (Chassé et al., 2003) exhibited a slight degree of phytotoxicity. None of the paper mill residuals, which are likely to become contaminated by oil leaks from mechanical equipment, exhibited toxicity to barley.

Other organic contaminants

A working group with the World Health Organization (cited by WEAO, 2001) concluded that ingestion of known organic contaminants by humans following the application of municipal biosolids seldom occurs and that this is not a significant risk. A literature review on synthetic contaminants (Couillard, Chouinard and Mercier, 1995) mentions that biosolids application poses a low level of risk for ecosystems and the public. Another

literature review, this one conducted for the Water Environment Association of Ontario (WEAO, 2001), showed that the presence of alkylphenols and other chemically related molecules (nonylphenols) in municipal biosolids does not present a risk, mainly owing to their rapid biodegradation in amended soils. The only organic contaminants that need to undergo future investigation are pharmaceutical products (WEAO, 2001). After examining relevant documentation, Buyuksonmez et al. (1999) showed that composts and their inputs generally contain very small quantities of pesticides. The exception is Clopyralid in green residual composts in the United States, but this product is not registered for use on lawns in Canada.

Table 8.3: P criteria

Municipal biosolids and highly contaminated matter

Residuals are divided into different groups, depending on whether they are potentially contaminated with human fecal matter or with manure. In such cases, the residuals are considered to present the same level of risk as municipal biosolids and the same requirements apply. Thus, the same approach is applied for any residual likely to be contaminated with human fecal matter, even in small amounts. Some paper mills combine their sanitary sewage and industrial wastewater streams. From a technical standpoint, the resulting biosolid is considered "municipal sludge," in terms of hygiene requirements, although it consists mostly of wood fibres. As a precaution, this approach has also been adopted for residuals contaminated with matter that presents a risk, such as manures, abattoir residuals and egg residuals.

For "municipal biosolids," the USEPA's class A and B criteria (1993) were retained and combined with the pathogen and vector attraction reduction criteria (VAR). This made it possible to develop the main options for categories P1 and P2. For category P1, the safety level was increased with respect to the U.S. criteria by requiring compliance with the criteria for both *E. coli* (true fecal coliforms) and salmonella. The use of either fecal coliforms or salmonella as permitted in the U.S. regulations was justified based on the artifacts associated with fecal coliform analysis (USEPA, 1999; Robert Bastian, personal communication). In Québec, however, the recent introduction of a specific method for *E. coli* (the true fecal coliforms) has minimized these artifacts. In the case of paper mill biosolids, salmonella were found to be present, even though the presence of *E. coli* met criterion P1 (Hébert et al, 2003). This situation therefore justifies retaining the two mandatory analyses for category P1.

Criterion P2, option C, is used here as an alternative to the USEPA criteria, which require recognized treatment and vector attraction reduction processes.

Category P3, which applies only to municipal biosolids, is a hybrid approach combining the old requirements (MENV and MAPAQ, 1991) and the U.S. approach.

The USEPA standards propose other options for pathogens which make it possible to achieve a hygiene level comparable to category P1 or P2. The MENV can be consulted in specific cases. However, the USEPA has not established specific standards that address the issue of vector attraction during storage.

Composts

For composts, criterion P1 is taken from the BNQ standard (1997a). Criterion P2 is an adaptation of the USEPA approach (1993) for sludges that undergo aerobic biological treatment. However, the composting processes (PFRP and PSRP) have not been retained due to the limitations inherent in monitoring temperatures, time periods and turnings.

Paper mill biosolids not contaminated with fecal matter

Some paper mill biosolids result from the combined treatment of industrial wastewater and sanitary sewage (human fecal matter). However, many paper mills manage these effluents separately and, as a rule, the resulting biosolids are not contaminated with pathogens. However, following a characterization campaign conducted in 1997 among some 20 paper mills (MENV, unpublished data), it was noted that three biosolids contained salmonella and that a number of other biosolids had a very high fecal coliform count (confirmed *E. coli*). Although the presence of salmonella was not explained, hypothetically it can be attributed to regrowth in mill wastewater. Note that the regrowth of other types of pathogens, like viruses or parasites, is impossible because they require living hosts in order to multiply.

Such results disprove the assumption that this type of residual could automatically be classified in category P1, without analysis. This is why the criteria that have been defined (MENV, 1999d) are more restrictive than those applicable to other types of residuals not contaminated with fecal matter.

Table 8.5: Liming criteria for abattoir biosolids

In order to prevent nuisances associated with the reclamation of limed abattoir biosolids, the Ministry has made it mandatory for abattoir liming operations to be carried out according to specific criteria (MENV, 2002a).

The criteria retained are based on the following elements:

- Foul smelling gases are produced mainly by the fermentation of biosolids in anaerobic conditions (absence of aeration);
- liming stops anaerobic fermentation and protein conversion into ammonia;
- liming reduces the odours emitted during storage three- to five-fold, compared with those produced by an unlimed residual (Kodsi and Cournoyer, 1992);
- rapid liming (at the plant) is particularly effective, since it limits the duration of anaerobic fermentation;

- the pH of a limed residual may diminish during storage, notably due to acidification by carbon dioxide in the air;
- a pH of less than 10 may reactivate fermentation and the production of foul smelling gases (USEPA and USDA, 2000);
- the drop in pH may be faster for liquid sludge, owing to such factors as more intense solution exchanges, sedimentation of lime at the bottom of the storage tank and the lower volume concentration of the liming product (lower buffering capacity);
- an excessive dose of lime at the plant slows the drop in pH during storage;
- this excessive dose of lime can be estimated from the calcium content of the residual;
- liming agents containing no calcium are not normally used, either because of their cost or because they may contribute to degradation of the concrete in storage structures;
- liming also makes the residual more hygienic with respect to pathogens, when a high pH is attained.

However, liming at the plant may have adverse effects on plant processes and equipment, as well as on odour emission in the abattoir (release of ammonia). It may also pose health and safety risks for workers (caustic products).

Table 9.1: Temporary field storage – Separation distances

The separation distances required to protect surface water are taken from the standards in the RRAO that apply specifically to field storage of manures, since the RRAO does not deal with the storage of FRs (only livestock waste). Some allowances have nonetheless been made for residuals which, unlike manures, do not contain pathogens (category P1). The separation distance for subsurface drains was eliminated, since it is difficult to monitor. However, a criterion was added for drainage furrow, further to the recommendations made by Envir-Eau (2003) and taking into account the results reported by Baribeau and Liard (1999) indicating that traces of leachates can be observed up to 4 m away from FR heaps.

The mandatory standards of the RRGC are designed to protect groundwater. The rock outcrop criterion was added as a result of the recommendations made by Envir-Eau (2001). However, the prohibition related to sandy soils was eliminated in order to bring the criteria into line with the RRGC, which applies to all soil types.

The separation distances for odours are more restrictive than those for farm manures. Those designed to protect the air (bioaerosols) are based on the IRSST's finding that, in the case of paper mills, bioaerosols released by biosolids cannot be detected from a distance of 100 m (Jacques Lavoie, personal communication).

Table 9.2: Temporary storage – Preventive measures

General

These measures are aimed at limiting the production of leachate water containing nitrogen and phosphorous, and preventing these substances from entering surface and ground water. The production of leachate water is due mainly to the following factors:

- precipitation events, related to the time period and duration of storage, and the presence or absence of a covering;
- evaporation, also related to the time period and duration of storage, but also to composting phenomena which vary according to dryness and C:N ratio;
- water absorption capacity, which is related to dryness;
- soluble N and P, related to the total N and P concentrations and to the C:N ratio of the FR, as well as to the duration of storage (Baribeau and Liard, 1999; Schreiber, 2000; Envir-Eau, 2001; Liard, 2001) and to the temperature of the heap, which affect mineralization (production of soluble forms of N and P);
- ground frost, which increases the release of leachates during thawing (Proserco, 1997); they can amount to half the volume stored in the case of biosolids with less than 20% dryness (Liard, 2001);
- climatic zone, which affects frost penetration.

The runoff of leachates towards surface water is affected by the slope and by the depth of the water resulting from rainfall or snow melt events. Nitrogen leaching at depth is affected by a number of factors, but it can be limited in part by crop uptake.

In general, the parameters that have been retained are easily measured or observed (dryness, volumes, dates, presence of structures, CHU zones). The stringency of the constraints depends on the risk of leaching and on transport phenomena related to the leachates produced.

Coverings

The time period during which heaps of more than 350 m³ need not be covered has been increased from 2 to 21 days, since the leachate waters of paper mill biosolids contain less N and P at the beginning of storage (Baribeau and Liard, 1999; Schreiber, 2000; Envir-Eau, 2001; Liard, 2001). The rules have also been relaxed for residuals with a high C:N ratio, which are less likely to produce a leachate with a high N concentration (often correlated with lower P levels).

Using sheeting for the winter storage of paper mill biosolids with a dryness of less than 20% made it possible to limit nitrogen losses to less than 2% (Proserco, 1997), which is 5 to 10 times lower than that observed for the storage of dairy cattle manure on the ground behind a stable (Biorex, 1994). That is why winter storage of this type of residual is permitted if sheeting is used. Field studies have revealed no adverse impacts on surface water and no use losses (parameters P and $N\text{-}NH_4$) for paper mill biosolids with a dryness

30% stored without a covering (Huard and Fradette, 1999). However, Liard (2001) showed that when paper mill biosolids with a dryness of less than 20% were stored uncovered in the winter, surface water became contaminated with ammonia, although the contamination level was below the aquatic toxicity guideline.

However, other studies have shown that the use of sheeting for very dry residuals does not necessarily reduce nitrogen leaching significantly. When no sheeting is present, the composting process promotes water evaporation. Tardif (2001) even observed an increase in leaching when a biosolid with a dryness greater than 30% was kept covered, probably because of water condensation on the inner surface of the sheeting in winter. Furthermore, very dry biosolids generally contain less nitrogen.

These findings, combined with modeling studies (Envir-Eau, 2001), indicate that field storage in accordance with the criteria in Table 9.2 should not lead to any loss of groundwater uses (nitrates). Water quality and safety nevertheless require compliance with the other preventive measures (separation distances from catchment works, etc.). The cost of covering paper mill biosolids with polyethylene sheeting has been estimated at about $3/tonne (Baribeau and Liard, 1999).

“Capping” of mixed paper mill biosolids with a 30-cm layer of very dry primary deinking residuals should make it possible to significantly reduce leaching and odours (Goudreau and Bouchard, 2000). Schreiber (2000) reported the same effect with a 15-cm capping layer combined with an “absorbent layer” of 25 cm of deinking residuals under the heap. However, the effectiveness of this practice depends on the capping technique employed. Shreiber (2000), Goudreau and Bouchard (2000) have shown that capping should be carried out using a snowblower instead of a front-end loader. While biosolids can be capped instead of covered with sheeting, the two types of residuals may become segregated at the time of the spreading operation, which theoretically could cause the crop-available nitrogen to vary.

Sheeting is not useful for ashes with a dryness $> 50\%$, as shown by Envir-Eau (2003). This research demonstrated that separation distances protect surface water from P contamination and from a disruption in pH balance. Baziramakenga (2003) reported, moreover, that the P in ashes is not very water soluble. In addition, ashes contain little or no nitrogen.

Dryness

The minimum criterion of 15% dryness for ground storage is taken from the standard in the RRAO related to field storage of solid manures. Liquid FRs may not be stored. Residuals such as whey may have a dryness greater than 15% without having the consistency of a solid.

The $>$ 15% and $\leq$ 20% d.m. dryness class corresponds to residuals that often have a pasty consistency and therefore are more subject to collapsing and leaching. That is why the

maximum quantity for heaps on the ground has been set at 250 m^3 per establishment. This category notably includes dehydrated municipal biosolids.

Volume limits for FRs with a dryness greater than 20% d.m. were eliminated. In fact, the volume limit corresponds to fertilization needs based on AERP requirements.

The > 20% and ≤ 25% d.m. dryness class corresponds to residuals that are more solid, but often not suitable for composting.

The > 25% and ≤ 30% d.m. dryness class corresponds to manure with a high straw content and residuals that are generally suited to composting under controlled conditions. For paper mill biosolids with a dryness greater than 25%, the loss of "gravity" leachate water by consolidation during the heaping operation should also be very limited according to laboratory tests carried out at a pressure of 15 kPa (Envir-Eau, 2001). However, in a field study, Huard and Fradette (1999) observed appreciable leaching following stacking of a paper mill biosolid with a dryness (theoretical) of 27%. In addition, leaching associated with storage of plant residues, such as hay balage, should decrease considerably at dryness values of 25% and higher (Labbé, personal communication).

The > 30% d.m. dryness class corresponds to very solid residuals suitable for composting. The 30% dryness criterion was established based on documentation on manure composting (Centre de recherche industrielle du Québec inc., 1995; Biorex, 1994) and on lime treatment of biosolids (Granger, Kodsi and Cournoyer, 1993), which indicate that at this degree of dryness, there is little spontaneous production of leachate following stacking. This value also corresponds to the water content of a deinking sludge "at equilibrium," which will produce leachates when exposed to precipitation (Trépanier and Gallichand, 1994). However, it appears that vegetable residues with a dryness of more than 30% can nevertheless produce leachates at the start of composting (Paré, personal communication) due to the lysis of cell walls.

Other criteria

Criteria related to the removal of heaps from the ground and site revegetation have been adapted from the standards for livestock waste in the RRAO and from the Swiss criteria for farm composting (Compost Diffusion, 1995). They have been defined with a view to limiting leaching towards surface or ground water. However, there is little documentation on the effectiveness of this approach. For example, in the case of winter storage of paper mill biosolids with a dryness of less than 20% and a C:N ratio of less than 15 (characteristics similar to solid manure), Baribeau and Liard (1998) measured a soil ammonia level of 1 200 mg N-NH4/g. This is equivalent to a nitrogen dose exceeding the recommended amount for a barley crop thirty times over. Site revegetation after storage does not make it possible to remove all of this nitrogen. However, for a paper mill biosolid with a C:N ratio of 22 and shorter term storage, Forget et al. (1998) obtained a soil enrichment value that was 10 times lower, because the leachate water contained less N and P.

Heaps can be protected from runoff using various techniques, such as the creation of berms.

Storage on frozen ground helps to improve the load capacity of the soil and to reduce compaction. In winter, the site is cleared of snow a few days before delivery to allow the ground to freeze.

When the storage criteria for FRs are met, water uses can be conserved and the amount of plastic sheeting waste that is generated can be reduced. Furthermore, these criteria are still more restrictive than those currently applicable to manure storage in fields.

For R&D projects, the article by Trépanier and Gallichand (1994), and the conference proceedings of the Québec Forest Industries Association (QFIA, 1999), serve as references for establishing an environmental monitoring protocol.

Table 10.2: Separation distances – Spreading

The separation distances for the protection of water are those set out in the RRAO and the RRGC which apply to FRs under the regulations in force. In the case of ditches on non-agricultural parcels of land, which are not covered by standards in the RRAO, a distance of 10 m applies; this standard is taken from the USEPA document (1993) on the protection of watercourses adjacent to receiving sites for municipal biosolids. In addition, the spreading of category P2/P3 fertilizing residuals on organic soils and in flood-prone areas is prohibited, because these aspects are not explicitly standardized in the RRAO.

The criteria for protecting the air from bioaerosols come mainly from the document *Valorisation sylvicole des boues de stations d'épuration des eaux usées municipales, Guide de bonnes pratique*s (MENV, MFo and MSSS (1991)). The separation distance of 100 m prescribed for a dwelling is the same as that for storage (see the comment in Appendix 1 concerning Table 9.1). The separation distances and other criteria used in Québec for FRs provide adequate protection for the general public and present a lower risk than that associated with manure management (Forcier, 2002).

The separation distances set out in the *Interim Criteria* (MENV, 2002b) for protecting the air from offensive odours were retained. The Ministry's decision to maintain separation distances for odours is based on the expression "odours resulting from agricultural activities" in section 19 of the EQA. This expression must be interpreted according to its everyday meaning. As such, it denotes odours resulting from or closely associated with an agricultural activity, in particular livestock raising activities. However, livestock operations produce livestock waste that the producer must dispose of, notably through land application, an activity which entails odours. Although FR reclamation may be beneficial for agriculture, it is not the result of agricultural activities and therefore any "resulting" odours are not considered to be from agricultural activities. It is therefore a "complementary" activity.

Under subsection 4 and paragraph 3 of section 113 of the *Act respecting land use planning and development*, the municipality has the power to establish separation distances in an agricultural zone solely for the following purposes:

- to reduce the inconvenience associated with odours resulting from agricultural activities;
- to ensure the preservation of a water supply source.

Paragraph 3 provides that, when the municipality establishes separation distances, it must specify the open space that must be left between the locations where "livestock wastes" are spread and buildings other than those used for agricultural purposes. Under these provisions, a municipality does not have the power to establish separation distances with the aim of reducing odours associated with FR spreading, because these odours do not result from the livestock raising activity and do not relate to "livestock wastes."

Thus, separation distances for FR odours in an agricultural zone are governed solely by the *Environment Quality Act*, which is administered by the Ministère de l'Environnement. However, a municipality may establish separation distances with respect to FR spreading outside an agricultural zone established under the *Act respecting the preservation of agricultural land and agricultural activities*, since, in this case, paragraph 3 of section 113 of the *Act respecting land use planning and development* is not applicable.

Table 10.3: Spreading – Other constraints

Nitrogen and phosphorus

No criterion was retained for the depth of the water table, because there are no such criteria for the application of manures and fertilizers. Given that this variable fluctuates considerably over time, it is difficult to measure. However, risk prevention can be achieved by imposing other constraints (agronomic dose of N, separation distances, etc.). The soil depth criterion was eliminated as well, for similar reasons.

Chemical contaminants

The maximum loading of 22 tonnes d.w./ha/5 years for all C2 residuals comes from the BNQ standard on composts (1997a). This loading value is harmonized with the permissible level established by the CFIA (1997). In practice, the value of 22 t (d.w.)/ha is equivalent to nearly 1% of the weight of an agricultural soil in the plough layer (Conseil des productions végétales du Québec inc., 1996). The preventive approach of restricting loading to 22 t (d.w.)/ha/5 years for category C2 simplifies the management and monitoring of spreading activities, since soil analyses are not required, as in other provinces and the United States. In Ontario, for example, soil analyses for metals must be conducted at the start of the first reclamation activity. After that, the operator must record data to track theoretical or actual enrichment over the long term for each of the elements considered separately. This approach is not suitable, for the following reasons:

- total metal analysis of an agricultural soil is not a good indicator of risk or of uptake by plants (European Commission, 2002; Ontario, Ministry of Environment and Energy and

Ministry of Agriculture, Food and Rural Affairs, 1996). The readily extractible fraction of the metals (Mehlich 3) represents only 6.3%, on average, of the total present in agricultural soils (Giroux et al., 1992). For soils that have become heavily contaminated with metals through industrial activities, this correlation is theoretically better.

- total metal analysis of soil is subject to many errors, affecting the representativeness of the results, especially when the number of soil samples per unit area is very limited and when sampling is done by the farmer himself;
- assessment of metal enrichment of soil is based on a value that is both questionable and inconclusive from an environmental standpoint;
- agricultural enterprises are not really equipped for long-term record-keeping (more than 5 years);
- the Ministry does not have the human resources necessary for carrying out systematic long-term monitoring, except in a sporadic and targeted fashion.

However, the loading limit of 22 t (d.w.)/ha/5 years for category C2 residuals simplifies the calculations and monitoring tasks, since it is not predicated on future land applications, and soil analyses are not required. For example, if 3 t (d.w.)/ha of C2 ashes were land applied on a parcel in May 2001 and 2 t (d.w.)/ha in October 2002, then 11 t (d.w.)/ha of municipal biosolids in 2003, the maximum amount of C2 paper mill residuals that can be applied in August 2004 is 6 t (d.w.)/ha (22-(3+2+11)). If this application is made, no more C2 residuals can be land applied before June 2006. Nonetheless, additional quantities of C1 residuals may be spread during this period, since the agronomic recommendation would be the only limit applicable.

In practice, loading limits are rarely ever attained, because of the prescribed limits for fertilizing elements, including nitrogen and phosphorus (WEAO, 2001). Moreover, the Ministry has computed that an application of biosolids containing 1% P_2O_5 would be limited to about 300 t (d.w.)/ha over a period of 100 years, or 15 t (d.w.)/ha/5 years on average for a grain corn crop. This is owing to the fact that the greater the initial application of P, the greater the soil enrichment with P and the greater the reduction required in subsequent agronomic application rates. The *Guide agroenvironnemental de fertilisation* (MENV, 1999c) estimates that every 3.5 Kg P/ha added over and above the amounts removed by the crop translates into an increase of 1 kg P/ha (Mehlich 3) in the soil.

For more information, visit: http://www.menv.gouv.qc.ca/milieu_agri/agricole-en/guide-index.htm.

With regard to liming materials, an excessive input in a given year not only incurs unnecessary purchase costs, it also makes it necessary to defer the next application of liming material to prevent soil pH imbalance. Based on this assumption, the MENV calculated 70 t/ha to be the maximum application over a 100-year period.

Thus, if a maximum application is made of biosolids containing $>$ 1% P_2O_5 and liming materials containing $>$ 25% CCE, the loading limit of 22 t (d.w.)/ha/5 years of C2

residuals will be met on average over a 100-year period, without the need for specific monitoring. The C2 budget for the previous 5 years need not be calculated in such situations, thereby simplifying the work required of the agrologist. This is similar to the USEPA approach, whereby no monitoring of loadings is required for municipal biosolids (rich in P) that meet the requirements of the "*exceptional quality"* category (USEPA, 1993). Nonetheless, the C2 criteria are more restrictive than the U.S. criteria. See also Hébert (1998) regarding the potential buildup of metals in agricultural soils.

When necessary, the Ministry may perform targeted sampling of soils that have received C2 fertilizing residuals as part of a scientific assessment of the actual buildup of metals. This georeferenced sampling can be done based on data capture for FR receiving parcels using the computer programs SAGIR and POA, which are available in the regional offices.

Even if we take the hypothetical example of repeated applications over a 100-year period of extreme amounts of FRs containing the maximum permissible levels of contaminants (C2 criteria), the receiving soils will still meet the criteria specified in Schedule 1 of the *Land Protection and Rehabilitation Regulation*. Modelling work done by Fouchécourt and Beausoleil (2001) yielded the same conclusion. The only exception would be copper, an element for which the calculations would indicate at most a 50% exceedance of the standard (150 vs 100 mg Cu/kg soil). However, this modelling was based on mixed paper mill residuals, which likely contained 22 times more copper than the normal (mean) concentration of 34 mg Cu/kg reported by Charbonneau et al. (2001). Furthermore, according to Van Coïllie and Laquerre (2003), the scenarios of agricultural FR reclamation modelled by Fouchécourt and Beausoleil (2001) would be difficult to implement in practice. This is particularly true for reclamation in the natural environment (repeated inputs are less likely).

The criterion related to the pH of the receiving soil was not retained, because pH is a short-term measure and the potential risk of metals buildup in soils can only be assessed over the long term.

The restrictions related to Al and Fe were removed further to the recommendations made by Webber (2003).

With regard to dioxins and furans, readers should refer to the relevant comments in Table 8.2. Data on cultivated soils in Québec indicate that many agricultural soils contain a level below 0.5 ng TEQ/kg (Charbonneau, Hébert and Jaouich, 2001).

Pathogens

As a precaution, the criteria were tightened by prohibiting the application of category P2 and P3 FRs to fertilize land being used to grow food crops for human consumption. However, the P3 constraints were relaxed to a considerable extent and harmonized with those of category P2, because the hygiene quality is similar in terms of the reduction in *E. coli*.

Odours

The Ministry no longer sets prohibition periods for FRs aimed at preventing odours. A number of municipalities amended their by-laws on December 19, 2002, following the adoption of Bill 137 (*An act to amend various legislative provisions concerning municipal affairs*). Sections 34 and 41 of this act amend the *Cities and Towns Act* through the inclusion of section 463.2:

> "The council may, by by-law, prohibit the spreading of livestock waste, sludge or residues from pulp and paper mills for up to eight days, after 31 May and before 1 October, the dates of which shall be specified by the council so that the prohibition does not apply for more than two consecutive days."
>
> "In order for the prohibition to apply in the course of a year, the by-law establishing the prohibition must be adopted and published not later than the last day of February and March, respectively, of that year."
>
> "The clerk may, in writing and on request, authorize a person to carry out spreading prohibited by the by-law. Where there has been rain on five consecutive days, the clerk must grant the authorization."

The Municipal Code was likewise amended by including the preceding text in section 550.2.

These legislative amendments give municipalities the power to set spreading prohibition dates. This appears to have the effect of preventing or rendering null and void any municipal by-law that would overstep the powers conferred on the municipality.

Table 13.1: All-purpose soil mixes

Criterion A of the *Soil Protection and Rehabilitation of Contaminated Sites Policy* (MENV, 1999b) could not be retained. Based on the data compiled by Giroux et al. (1992), it appears that more than half of the soil series for Québec agricultural soils exceed criterion A for at least one of the parameters. However, the soils analyzed in this study did not undergo intensive fertilization; hence, the contaminant levels they contain represent the background level from natural sources.

Accordingly, the maximum permissible levels (total concentrations) of chemical contaminants in soil mixes were established in accordance with the following principles:

- the 98th percentile of agricultural soils was retained for **Cd**, **Co**, **Cr**, and **Ni** based on the data of Giroux et al. (1992), or the Ontario data for **Se** (Ontario Ministry of Environment and Energy, 1996), by assuming that the background level is not problematic in most cases. The data of Giroux et al. (1992) are based on the analysis of 76 soil series from hay fields in Québec that are deemed uncontaminated;

- however, at least 12% of the different types of agricultural soils in Québec naturally exceed the 98th percentile for at least one of the 11 parameters. These agricultural soils are not deemed to present toxicity or to have received significant inputs of metallic contaminants;
- for **Mo**, **Pb** and **Zn**, the CCME (1997; 2002) guidelines for agricultural soils were retained; these guidelines derive from a risk assessment process and consist of values greater than the 98th percentile for agricultural soils;
- the CCME guideline of 63 mg **Cu**/kg was not retained, because it was set for very acid soils (pH 4-4.3), which is rarely the case for agricultural soils or gardens (Hébert and Groeneveld, 2003). Instead, we retained criterion B of the *Soil Protection and Rehabilitation of Contaminated Sites Policy* (MENV, 1999b) and Schedule l of the *Land Protection and Rehabilitation Regulation*;
- the CCME guideline of 1.4 mg **Cd**/kg was not retained either, because it has come under criticism (Van Coïllie and Laquerre, 2003) and it is exceeded in 14% of cases by agricultural soils that are deemed uncontaminated, without apparent risk;
- for **Hg**, the CCME criterion exceeded criterion B of the *Soil Protection and Rehabilitation of Contaminated Sites Policy* (MENV, 1999b), and Schedule 1 of the *Land Protection and Rehabilitation Regulation*. To promote source reduction of Hg, the criterion of 0.4 mg Hg/kg was retained, which corresponds to the background concentration in some Québec soils according to the Ministry's Service des lieux contaminés (Hugues Ouellette, personal communication);
- conversely, for **As**, the CCME guideline for human health risks was retained.
- in the case of dioxins and furans, the CCME's guideline for background concentration was adopted (2001).

In all cases, the total concentration criteria for elements in soil mixes comply with Schedule 1 of the *Land Protection and Rehabilitation Regulation* (see Table A1.1). An estimated 93% of the soil series for agricultural soils meet these criteria, but 7% of soils exceed them naturally.

TABLE A1.1 TABLE OF MAXIMUM LIMIT CRITERIA FOR CHEMICAL CONTAMINANTS IN SOIL MIXES

Chemical Parameters (mg/kg)	98th Percentile for Agricultural Soils[1]	CCME Guidelines [2]	*Land Protection and Rehabilitation Regulation* – Schedule 1
Arsenic	14	**12**[3]	30
Cadmium	**2.0**	1.4	5
Chromium	**99**	64	250
Cobalt	**29**	-	50
Copper	39	63	**100**
Mercury[4]	0.08	6.6	2
Molybdenum	2.5	**5**	10
Nickel	**52**	50	100
Lead	61	**70**	500
Selenium	**1.4**	-	3
Zinc	113	**200**	500
Dioxins & furans – ng TEQ/kg		**4**	15

(1) Calculated based on the data of Giroux et al. (1992), except for As and Se, which are based on data from the Ontario Ministry of Environment and Energy (1996).

(2) Taken from: CCME (1997), or CCME (2001) for dioxins and furans, or CCME (2002) for Mo and Ni.

(3) The values that are in bold characters and underlined are the criteria retained.

(4) The criterion of 0.4 mg Hg/kg was retained, which corresponds to the background concentration in some Québec soils according to the Ministry's Service des lieux contaminés (Hugues Ouellette, personal communication).

However, according to a study conducted for the European Commission (2002), and according to Sauvé et al. (1998), the concentration of bioavailable metals in the soil would be a better indicator of risk than the total concentration used on its own. Researchers with the IRDA (Giroux et al., 1992) had previously suggested that the soil criterion be based on the Mehlich-3 extractant. An alternative criterion to the total concentration was therefore established for some metals on the basis of bioavailability. The 98th percentile for agricultural soils was estimated based on the data of Giroux et al. (1992). Thus, a soil or a soil mix that exceeds the total metal concentration for a given parameter would not be considered a risk or abnormal, compared with agricultural soils, provided that the Mehlich-3 concentration of this element is normal (i.e. meets the 98th percentile criterion). No bioavailability criterion was adopted for Hg, given that it is not available to plants. No criteria were retained for As, Mo and Se due to the absence of representative data for Québec soils. No bioavailability criterion was adopted for copper, to avoid permitting the production of a soil mix that contains more than 100 mg Cu/kg and that exceeds the criterion set out in Schedule 1 of the *Land Protection and Rehabilitation Regulation*.

With regard to the maximum limits for pathogens in soil mixes, the P1 criteria for compost were adopted.

Table 14.1: Composting in heaps on the ground

The limit of 1 500 m^3 per year is approximately equivalent to the volume of manure that a large dairy farm (about 100 dairy cows) must store in heaps. This volume limit of 1 500 m^3 more or less corresponds to the Swiss mass-based criterion of 1 000 t, beyond which a more in-depth environmental assessment is required for on-farm composting of non-agricultural source residuals (Compost Diffusion, 1995). See the comments on storage in tables 9.1 and 9.2.

APPENDIX 2 EXPLANATION OF THE ANALYTICAL METHODS USED FOR INDICATOR ORGANISMS AND PATHOGENS

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Fall 2003

Introduction

Like the regulations administered by the Ministère de l'Environnement (MENV), the analyses referred to in the *Guidelines* must be performed in laboratories accredited by the Centre d'expertise en analyse environnementale du Québec (CEAEQ).

Some confusion exists regarding the analytical methods to be used for P criteria (pathogens) and the different definitions of the bacteria groups that can be detected with these methods. The information provided below will help readers understand the analytical methods for P criteria and the associated results. Moreover, it should be kept in mind that Québec criteria for pathogens are taken from the USEPA (1992) standards for the use of municipal sewage sludge. The text below draws numerous parallels with the USEPA approach.

Escherichia coli and fecal coliforms

In the document *Control of Pathogens and Vector Attraction in Sewage Sludge*, the USEPA (1992) recommends testing for fecal coliforms to assess the compliance of municipal sewage sludge with Class A or B. The levels applying to these classes are 1 000 MPN/g dry solids and 2 000 000 MPN/g dry solids. (Table A2.1). The P1 and P2 levels in the *Guidelines* are the same, respectively, as those used by the USEPA, but they apply to *Escherichia coli*, and not to "fecal coliforms." It is important to distinguish between fecal coliforms and *E. coli* in the analysis and interpretation of results in relation to the criteria.

TABLE A2.1 COMPARISON OF MENV CRITERIA WITH THOSE OF THE USEPA FOR *E. COLI* OR FECAL COLIFORMS

P Criteria of the MENV *E. coli*	Class According to the USEPA Fecal Coliforms	Level (MPN/g dry solids)
P1	A	< 1 000
P2	B	< 2 000 000

Methods used for the detection and enumeration of fecal coliforms

For the detection and enumeration of fecal coliforms in municipal sewage sludge, the USEPA (1992) recommends that practitioners employ methods 9221E and 9222D contained in the manual *Standard Methods for the Examination of Water and Wastewater* (APHA, AWWA and WEF, 1992). Method 9221E is a multiple-tube fermentation technique that uses the lactose

fermenting ability of fecal coliforms to detect them in a lactose broth incubated at a temperature of 44.5°C (Table A2.2). The lactose fermenting activity of the bacteria can be detected through the production of gas in the tubes of broth. According to the USEPA, this method can be used to test for classes A and B. Method 9222D is a membrane filtration technique that is likewise based on the ability of fecal coliforms to ferment lactose at an incubation temperature of 44.5°C. Blue colonies obtained with this method come from bacteria that ferment lactose. In practice, therefore, the group of fecal coliforms is defined by their ability to ferment lactose at 44.5°C.

TABLE A2.2 COMPARISON OF ANALYTICAL METHODS

Method	Source	Technique	Targeted Microorganisms	Properties Used to Determine the Presence of the Targeted Microorganisms
9221E	*Standard Methods*	Multiple tubes	Fecal coliforms	Fermentation of lactose at 44.5°C
9222D	*Standard Methods*	Membrane filtration	Fecal coliforms	Fermentation of lactose at 44.5°C
MA.700 – Fec-tm 1.0	CEAEQ	*Multiple tubes*	*Escherichia coli*	Use of MUG at 44.5°C

The USEPA authorizes the use of two microbiological analysis techniques: the multiple tube technique and the membrane filter technique (Table A2.2). Each has its advantages and drawbacks. The drawback of the multiple tube method is that it is more labour intensive than the membrane filter method. On the other hand, the multiple tube technique is better suited to the analysis of solid samples compared to membrane filtration. In fact, the latter cannot be used to test for bacterial concentrations as "low" as 1 000 CFU/g dry solids (Class A of the USEPA) because the membrane becomes clogged during the analysis of solid samples that are barely diluted. The multiple-tube fermentation technique does not have this limitation. For these reasons, the USEPA permits the use of either technique, namely 9221E (multiple tubes) or 9222D (membrane filter) in testing for Class B (2 000 000 MPN/g dry solids), but only Method 9221E can be used in analyses for Class A.

Methods 9221E and 9222D have been used for decades in the analysis of municipal wastewater and municipal sewage sludge. These types of samples are generally found to contain a lot of fecal coliforms, with the majority of them belonging to the species *E. coli*. Since this bacterium comes from human and animal intestines, methods 9221E and 9222D therefore permit the detection of fecal pollution.

In other types of residuals or wastewater, the proportion of *E. coli* in relation to fecal coliforms may differ from that found in municipal wastewater streams. Some matrices may in fact contain a large proportion of bacteria that are not *E. coli* but that nonetheless yield a positive response in tests done with methods designed to detect fecal coliforms.

This is the case for the bacterium *Klebsiella pneumoniae*, which conforms to the definition of fecal coliforms because it ferments lactose at an incubation temperature of 44.5°C and therefore can be detected using methods 9221E and 9222D. This bacterium is often present in

wastewater and biosolids from the pulp and paper industry, as well as in composts and other organic residuals. However, it also occurs naturally in the environment. Since this bacterium is present in the natural environment, it is not considered a true indicator of fecal contamination. Its presence can therefore cause an overestimation of fecal pollution. *K. pneumoniae* can therefore be considered an interference for methods 9221E and 9222D of the *Standard Methods for the Examination of Water and Wastewater* during the analysis of certain types of residuals and wastewater.

Furthermore, some authors recommend that the name "thermotolerant coliforms" be employed instead of "fecal coliforms" to avert this interference problem and the confusion over the definition. "Thermotolerant coliforms" denotes the group of bacteria that ferment lactose at 44.5°C. This more accurate name helps to reduce the confusion surrounding the term "fecal coliforms" since these are not necessarily fecal in origin.

Methods used to detect and enumerate *Escherichia coli*

Since the early 1990s, new analytical methods have been developed to better target the bacterial species *E. coli*. Under these methods, a sample is mixed with a culture medium containing an enzyme substrate, which is then incubated for 24 h at 35°C. There are a number of enzyme substrates that permit detection of *E. coli*. One example is MUG (4-methyl-umbelliferyl-ß-D-glucuronide). When *E. coli* is present in the sample, the MUG is metabolized by the enzyme ß-glucuronidase, which is fairly specific to the bacterial species *E. coli*. Under the conditions prescribed for this method, only this enzyme is capable of metabolizing MUG. The use of MUG by the bacterium causes the emission of blue fluorescence in the culture medium, which can be seen under UV light. The other enzyme substrates that are specific to *E. coli* likewise use ß-glucuronidase to reveal the presence of this bacterium. However, a different colour may appear in response to the enzyme substrate.

These recent methods have greater specificity than methods based on lactose fermentation at 44.5°C. The majority of *E. coli* strains possess the enzyme ß-glucuronidase, but this enzyme occurs in very few strains of other species. *K. pneumoniae* does not possess ß-glucuronidase and does not cause interference with the use of enzyme substrate methods. It should be noted that these methods have been developed primarily for analyzing drinking water and that they are rarely used today in analyzing other types of samples.

The analysis of *E. coli* as recommended by the CEAEQ

For several years now, it has been known that *K. pneumoniae* causes interference in conventional methods for analyzing fecal coliforms. The Centre d'expertise en analyse environnementale du Québec (CEAEQ) has innovated by adapting an analytical method that uses an enzyme substrate to detect *E. coli* for the analysis of fertilizing residuals. This method uses a culture medium containing MUG and applies the multiple tubes procedure (Table A2.2).

Poor understanding of the differences between fecal coliforms and *E. coli* has persisted owing to the inappropriate name for this method (Enumerating fecal coliforms – multiple tube method

MA.700 - Fec-tm 1.0). In actual fact, the method specifically targets *E. coli* in keeping with the principles explained above. At the time the method was written, the terms "fecal coliforms" and *Escherichia coli* were being used almost interchangeably in the environmental analysis field in Québec.

A new version of this method is currently being prepared. The main changes are terminology related, with the term *Escherichia coli* set to replace "fecal coliforms." The revised version, which will also include new validation data, will be entitled *Dénombrement de Escherichia coli - Méthode par tubes multiples* (MA.700 - Ec-tm 1.0) (Enumerating *Escherichia Coli* – multiple tube method).

Salmonella

The USEPA (1992) recommends the analysis of salmonella to classify municipal sludge in Class A in relation to a standard of <3 MPN/4 g dry solids. The units associated with this standard are historically based. Traditionally, salmonella analyses in municipal sewage sludge involved analyzing a 100 ml sample which typically contained 4 g of dry solids. The standard of <3 MPN/4 g dry solids constitutes the method detection limit. The Québec criterion is based on the U.S. criterion. To be classified P1 in Québec, a FR must not contain salmonella exceeding the minimum detection limit of 3 MPN/4 g dry solids.

For salmonella analyses, the USEPA recommends using the method developed by Kenner and Clark (1974), which is appended to the document *Control of Pathogens and Vector Attraction in Sewage Sludge* (USEPA, 1992). The method of Kenner and Clark makes it possible to enumerate salmonella species with the multiple tube technique. To start, the sample is diluted and apportioned among tubes containing a selective enrichment broth for salmonella. Following incubation, an aliquot of broth is transferred to a selective and differential culture medium designed to identify salmonella: the XLD medium. Typical colonies belonging to the genus *Salmonella* are confirmed through fermentation tests on Kliger Iron Agar or Triple Sugar Iron Agar media and through a urease test.

When the first version of the *Interim Criteria for the Reclamation of Fertilizing Residuals* appeared, the CEAEQ improved on the approach of Kenner and Clark for salmonella analysis by modifying certain stages. The method *Dénombrement des salmonelles - Méthode par tubes multiples* (MA.700 - Sal-tm 1.0) was thus published in April 1999. In the CEAEQ method, a diluted sample is apportioned among several tubes of DSE broth and then incubated at $40 \pm 0.2°C$ for 24 hours. After this incubation period, an aliquot of enrichment broth is transferred to the XLT4 culture medium, which is in turn incubated at $37 \pm 0.5°C$ for 24 hours. These colonies' membership in the genus *Salmonella* is confirmed by an oxidase test and by the use of biochemical test kits.

The CEAEQ chose the XLT4 medium, described by Miller and Tate in 1990, because it is recognized as being more effective than the XLD medium employed by Kenner and Clark (1974). Biochemical test kits are also more effective for confirming the presence of salmonella

because, with this approach, the results of several biochemical tests serve to confirm that the colonies belong to the genus *Salmonella*. Kenner and Clark (1972) proposed only two tests.

Finally, it should be pointed out that, to our knowledge, there is no standardized method that is widely employed to analyze salmonella in environmental samples. The document *Standard Methods for the Examination of Water and Wastewater* contains a section (9260D) on the quantitative analysis of salmonella which is similar to the approach of Kenner and Clark (1972), but it uses different culture media. However, with this method there are six possible combinations of enrichment media and detection media. The CEAEQ method has the merit of specifying the culture media to be employed and offering a certain degree of standardization.

References

American Public Health Association, American Water Works Association and Water Pollution Control Federation. 1992. *Standard Methods for the Examination of Water and Wastewater*, 18th Edition.

USEPA. 1992. *Control of Pathogens and Vector Attraction in Sewage Sludge,* EPA/652/R-92/013. Office of Research and Development, Washington.

APPENDIX 3 FORMULA FOR CALCULATING SLUDGE AGE (CATEGORY P3)

Use the same formula as that shown on the monitoring forms for municipal wastewater treatment plants proposed under the Programme d'assainissement des eaux du Québec (PAEQ), namely:

$$\text{Sludge age} = \frac{X \bullet V_a}{Q_p X_p + Q_e X_e}$$

Where:

X: VSS (monthly or weekly mean[1], mg/L)
Va: Volume under aeration and in the decanters (m³)
Qp: Mean volume of purged sludge (m³/d)
Xp: VSS of purged sludge (monthly or weekly mean[1], mg/L)
Qe: Mean effluent flow rate (m³/d)
Xe: VSS of the effluent (monthly or weekly mean[1], mg/L).

[1] According to the set frequency for the plant's category, i.e.:

- monthly frequency for category 2,
- weekly frequency for categories 3 and 4.

Mean sludge age is the average of the monthly or weekly sludge age calculated over the full 12-month period preceding the CA application.

APPENDIX 4 INDEPENDENT QUALITY CONTROL OF FRS OR QUALITY CONTROL BY A CEAEQ-ACCREDITED SAMPLING FIRM – CONFIRMATION CRITERIA FOR CATEGORIES C AND P

TABLE A4.1 CONFIRMATION REGARDING PROMOTER-DECLARED CATEGORY C (CHEMICAL CONTAMINANTS)

Category Declared in CA Application	Category According to Sampling Conducted Pursuant to Section 6.6	Position/Action
C1	C1	**Position** - Category C in CA application confirmed
C2	C1	
C2	C2	
C1	C2	**Action** – Conduct another sampling no later than 30 days after receiving the analytical report. Take 3 separate composite samples (the same day) and test for the parameters called into question. **Position** - Category C is confirmed if the mean of the 4 analyses (the first and the 3 subsequent ones) comply with criterion C (C1 or C2, as applicable). Failing this, the category of the residual must change (C2 or it is classified "out of category," as applicable).
C2	Out of category	

TABLE A4.2 CONFIRMATION REGARDING PROMOTER-DECLARED CATEGORY P (PATHOGENS)

Category Declared in the CA Application[1]	Results of Sampling Performed in Accordance with Section 6.6	Position/Action
P1	➢ < 1000 *E.coli*/g, d.w., ➢ **and** absence of salmonella (with a detection limit < 3 MPN/4 g, d.w.), ➢ **and** in the case of compost, oxygen uptake rate ≤ 400 mg/kg organic matter/hour, ➢ **and** if a granulated biosolid, > 90% d.m.	**Position** - Category P1 confirmed
	Salmonella not detected, but: ➢ *E. coli* > 1000 and < 2500 MPN/g, ➢ **or** compost with an oxygen uptake rate > 400 mg/kg organic matter/hour, ➢ **or** granulated biosolid with < 90% d.m.	**Action** – Perform sampling no later than 30 days after receipt of the analytical report. Take at least 3 spot samples (the same day) and test for the parameter(s) called into question. **Position** - Category P1 is confirmed if the median of the analyses (the first and subsequent ones) < 1000 E.coli/g (d.w.) and if the maximum value is < 2500 MPN/g. The mean values of the oxygen uptake rate and of dry matter, if required, must also meet the criterion; otherwise, the residual is considered to be P2.
P1	➢ detection of salmonella **or** > 2500 *E. coli* /g.	**Position**: category P2, see Section 8.3.2 of the *Guidelines* (special cases)

(1) Since there are many options in category P2, the regional office must confirm whether or not the category P2 applies, on a case-by-case basis.

APPENDIX 5 AVAILABILITY OF N AND P IN MUNICIPAL BIOSOLIDS

Nitrogen

The availability or the apparent efficacy of nitrogen during the first year can be calculated using the following equation:

$$Available\ N = inorganic\ N + (ECOR\ x\ organic\ N)$$

The ECOR (efficiency coefficients for the organic fraction) is determined with reference to Table A5.1.

TABLE A5.1 EFFICIENCY COEFFICIENTS FOR THE ORGANIC FRACTION OF NITROGEN IN MUNICIPAL BIOSOLIDS

Crop	Type of Biosolid	ECOR		
Corn (before sowing)	All types of biosolids	30%		
Grains (before sowing)	All types of biosolids	20%		
		Cut I	**Cut II**	**Cut III**
Hay fields, 3-cut system	Liquid aerobic biosolids	30%	15%	5%
Hay fields, 3-cut system	Dehydrated aerobic biosolids	20%	5%	5%
Hay fields, 3-cut system	Dehydrated anaerobic biosolids	10%	5%	5%

Source: UDA inc. (1990)

In the case of corn and grain crops, the values in the table represent the proportion of organic nitrogen contained in sludges that should be available to the crop when land application is carried out prior to sowing. For hay fields, the values represent the proportion of organic nitrogen that should be available to each forage cut in a three-cut management system when spreading is done at the start of the growing season.

According to the Water Environment Federation (2000), available nitrogen in municipal biosolids ranges from 6%–68% of total nitrogen, with an average value of 37%. For more information, visit: http://www.wef.org/applications/periodicals/viewabstract.cfm?ID=965&Authors=Gilmour%2C%20John%2C%20Wilson%2C%20Steve%2C%20Cogger%2C%20Craig.

Phosphorus

Phosphorus availability (1st year) can be calculated using the following equation:

$$\%\ available\ P = 70 - (Al_{total} + 0.5\ Fe_{total}\ (in\ mg/kg) - 20\ 000)/2000.$$

Webber (2003) confirmed the usefulness of this empirical equation.

APPENDIX 6 ON-FARM MANURE COMPOSTING – MENV REQUIREMENTS

Background

This document, which is intended for agricultural producers, summarizes the regulatory standards and environmental requirements related to on-farm composting of manures and other farm products. The acts, regulations and technical documents produced by the MENV prevail, however, with respect to interpreting the regulations. Note that these acts and regulations may be amended from time to time.

The technical, agronomic and economic aspects of composting are not detailed in this document. Readers are invited to consult the *Guide de référence en fertilisation* published by the CRAAQ (2003), which includes a section on the fertilizing value of composts and the advantages and disadvantages of on-farm composting.

Definitions

Compost: "Solid mature product resulting from composting which is a managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase" (BNQ, 1997a). Compost resembles a humus-rich soil mix; it is odourless and generally has an oxygen uptake rate of less than 400 mg O_2/kg of organic matter/hour.

Farm compost: Compost produced on a farm using farm products. This compost no longer has the characteristic smell of manure and it has an oxygen uptake rate of less than 1 500 mg 0_2/kg of organic matter/hour. It is typically less mature and has a lower hygiene quality than all-purpose commercial composts, except when it has undergone "full treatment."

Composting: A managed process of bio-oxidation of a solid heterogeneous organic substrate including a thermophilic phase (marked elevation of temperature) (BNQ, 1997a).

Full treatment: "(…) a treatment by which livestock waste is transformed into a solid product of a different nature, such as fertilizing granulates or mature composts, and through which the bacteria it contains are destroyed (…)" (*Regulation respecting agricultural operations*).
Full treatment of livestock waste gives rise to marketable products that can be used off-farm. Spreading of these products on agricultural lands is restricted to "limited activity zones," also called "surplus municipalities."

Certificates of authorization (CA)

A CA may be required to carry out composting or to use the resulting compost product.

Composting activities

The following composting activities do not require a CA:

- on-farm composting of less than 500 m^3 of manure or farm products. These materials can come from other agricultural enterprises. The 500 m^3 volume includes material that is undergoing composting, and that which is already composted and present on a farm at a given point in time. Accelerated composting may therefore permit the composting of more than 500 m^3/year, while ensuring that the volume is less than 500 m^3 at any given time.
- on-farm composting of less than 150 m^3 of a mixture of manure and dead leaves.
- composting of less than 150 m^3/year of non-agricultural plant residuals, separated at source, that do not result from an industrial process and that are not contaminated (notably with fecal matter or pesticides).

Although a CA is not required in such cases, the agricultural enterprise must make sure that it does not contaminate the environment, in particular, through the production of leachate water (manure effluent). The Ministry can seek assurance in this regard and check that the activity is indeed a composting activity and not simply storage. This presupposes that the manure has a moisture content of less than 75%, that it is aerated or turned using appropriate equipment and that it undergoes an increase in temperature. If it is not a composting activity, or if environmental contamination occurs, violation notices may be issued under the *Environment Quality Act* (EQA).

A CA is mandatory for other composting activities, including the following:

- on-farm composting of more than 500 m^3 of manure;
- on-farm composting of manure to achieve the objectives of "full treatment" in accordance with the *Regulation respecting agricultural operations* (RRAO);
- manure composting in a location other than a farm;
- composting of large quantities of grass and leaves from municipal recycling;
- composting of municipal or industrial sludges;
- other (check with the Ministry's regional offices).

A CA application must therefore be submitted to the MENV before any of these composting activities are initiated; otherwise a violation notice may be issued under the EQA.

Two categories of on-farm composting activities are covered by CAs:

- on-farm composting, in the field, in temporary locations: in such cases, the requirements of the *Guidelines for the Beneficial Use of Fertilizing Residuals* (MENV, 2004) must be met. The volume limit is 1500 m^3/year and the heaps must be covered, during certain time periods, with sheeting that is air permeable but waterproof.
- on-farm composting at a permanent leak-proof site: in this case, the *Guide technique d'entreposage des fumiers* (CRAAQ, 2002) must be consulted to determine the characteristics of a leak-proof structure.

Additional requirements apply for "full treatment" at the farm. This composting activity must be carried out in permanent facilities designed for this purpose.

Note that manure storage at the start of composting activities is governed by the RRAO. A leak-proof structure is therefore required in many cases.

In all cases, composting activities must comply with municipal by-laws pertaining to odours. An attestation of compliance with municipal by-laws must be appended to CA applications for composting.

Use of the resulting compost

Farm compost may be used without a CA in the following cases:

- spreading of farm composts on agricultural land;
- sale of composts in small bags, in accordance with the *Fertilizers Act*;

Use of "farm composts" on the farm must be in conformity with the standards set out in the RRAO and the RRGC and must be taken into account in preparing AEFPs. In the case of farm composts that have undergone "full treatment" as defined in the RRAO, land application is prohibited in agricultural operations located in limited activity zones.

In other cases of compost use, a CA is required, notably for:

- application of "farm composts" on non-agricultural land in situations not covered by the previously mentioned exemptions. An example of this is bulk compost distribution to citizens or landscape planners, in raw form or as a mix (soil mixes);
- composts produced on farm, which do not conform to the definition of "farm composts."

If the farmer delivers his compost to a soil mix manufacturer, the latter is required to have a CA.

If composts are used in the ways described above without obtaining a CA, the MENV can issue a violation notice.

With respect to a CA application for compost use, the *Guidelines for the Beneficial Use of Fertilizing Residuals* (MENV, 2004) sets out quality requirements (metals, pathogens, etc.) and use restrictions (crop, application rates, setbacks from wells, etc.). An agrologist must prepare an AERP and attest that all the criteria and regulatory standards have been met, notably the applicable RRAO standards (AEFP, spreading agreements, etc.).

Land application of "farm composts" must also comply with municipal by-laws governing the spreading of farm manures (odours).

If a compost is marketed, it must comply with the requirements specified in the federal *Fertilizers Act* dealing with labelling and contaminant concentrations, among other things. The Canadian Food Inspection Agency (514 283-8888) oversees the application of this Act.

APPENDIX 7 FULL TREATMENT OF MANURES BY COMPOSTING

Background

This document describes the regulatory and administrative requirements related to "full treatment" of manures through composting, pursuant to sections 46 to 48 of the *Regulation respecting agricultural operations* (RRAO). The agricultural operation whose raising site is regulated under sections 46 to 48 of the RRAO can opt to carry out "full treatment" at its site or have it done by a third party. Depending on the situation, these requirements apply to the livestock raising facility, to the third party that manufactures the compost, or to the receivers or users of the "full treatment" product.

Section 45 of the RRAO defines "full treatment" as follows:

> "(…) a treatment by which livestock waste is transformed into a solid product of a different nature, such as fertilizing granulates or mature composts, and through which the bacteria it contains are destroyed (…)."

For other definitions, see the glossary in this *Guidelines for the Beneficial Use of Fertilizing Residuals* (MENV, 2004).

Authorization and agreements

The livestock raising facility that carries out "full treatment" is required to submit a CA application. If full treatment is handled by a third party, the CA application must contain an agreement with a (composting) company pre-authorized by the MENV to receive manures. The composting company must have demonstrated to the MENV through analytical results that it has the capacity to produce category P1 compost (see the corresponding section of this *Guidelines*). The volume of livestock waste produced by the raising facility that is to undergo "full treatment" must be clearly indicated in the CA application, along with the volume of livestock waste not covered by this treatment.

In addition, the company carrying out the full treatment through composting must undertake in writing to convert the manures and/or farm residuals that it receives into a mature marketable compost with an appropriate hygiene quality (pathogens). It must also undertake to ensure that the compost produced will not be used on an agricultural operation located in a limited activity zone. The validity of the raising facility's CA depends on the existence of this agreement and the third party's compliance with it. Specific requirements are outlined in the sections below.

Mature hygienic compost

The compost must be either "certified" by the Bureau de normalisation du Québec (BNQ) or meet the P1 category criteria for composts set out in the *Guidelines for the Beneficial Use of Fertilizing Residuals*. As a rule, "farm composts" manufactured in the field do not attain this

degree of maturity, and specialized composting facilities and equipment are necessary. Quality analyses must be available and must be provided to the MENV on request.

Compost that can be marketed and used elsewhere than in agricultural operations located in limited activity zones

- If the compost is **BNQ-certified** it is deemed marketable. Its use for **land application** does not require a CA provided that the directions for use prescribed by the BNQ (labelling) are followed. The manufacturer must undertake that it will not distribute the compost to an agricultural operation located in a limited activity zone.
- If compost (not certified by the BNQ) is **converted to soil mix by the compost manufacturer,** the composting CA, or a specific CA, must indicate that the stakeholders undertake to comply with the requirements of Section 13 of the *Guidelines for the Beneficial Use of Fertilizing Residuals*. In this case, the product is deemed marketable and it can be distributed and used without a CA.
- If the compost is not BNQ-certified and it is **shipped to a third party to be made into soil mix**, the following warning must appear on the product: ATTENTION: Authorization may be required from the Ministère de l'Environnement du Québec to manufacture soil mix from this compost.
- If the compost is **sold in bags (< 50 L)**, it is deemed marketable and it can be used without a CA. The manufacturer must undertake in writing to comply with the P1 category criteria in the *Guidelines for the Beneficial Use of Fertilizing Residuals* and must provide analytical results to the MENV on request. The seller is required to comply with the federal *Fertilizers Act*. The MENV must inform the Canadian Food Inspection Agency (CFIA) accordingly, which will oversee quality control and ensure compliance with the federal legislation.
- **Compost resulting from "full treatment" that is produced on a farm** and made solely of farm products is deemed "farm compost." Its use for agricultural purposes is exempt from a CA under the *Regulation respecting the application of the EQA.* However, this compost must be land applied in accordance with the standards in the RRAO and it must not be spread on agricultural land in a limited activity zone.
- **In other cases,** the use of compost resulting from "full treatment of manures" requires a CA and falls into category P1. Alternatively, the operator can apply for a CA to distribute (rather than use) a C1P1O1 class compost produced at a rate of less than 5 000 t/year (see Section 14.4 of the *Guidelines for the Beneficial Use of Fertilizing Residuals*).

Other considerations

Traceability. To ensure that livestock waste destined to undergo full treatment is traceable, the compost manufacturer (the agricultural operation or a third party) must keep records indicating the quantities and origin of the inputs. The compost manufacturer may be required to prove that the compost has been shipped to locations outside limited activity zones, or that it has not been spread on agricultural lands located in a limited activity zone.

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