GUIDELINES FOR THE UTILIZATION OF BIOSOLIDS AND OTHER WASTES ON AGRICULTURAL LAND

MARCH 1996

Ontario

Ministry of Environment and Energy

Ministry of Agriculture, Food and Rural Affairs

GUIDELINES FOR THE UTILIZATION OF BIOSOLIDS AND OTHER WASTES ON AGRICULTURAL LAND

March 1996

Ministry of
Environment
and Energy

Ministry of
Agriculture, Food
and Rural Affairs

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Guidelines for the Utilization of Biosolids and Other Wastes on Agricultural Land

SECTION 1. INTRODUCTION

The purpose of this document is to facilitate the use of biosolids and other waste materials on agricultural land, while protecting environmental quality, consumer and animal health, food quality and the productivity of the land. These Guidelines are intended to supplement Ontario Regulation 347 under the Environmental Protection Act.

The document outlines criteria which must be met before biosolids or other waste materials can be considered for use on agricultural land. In essence, these materials must be of benefit to crop production or soil health and not degrade the natural environment, before approval for use will be given by the Ministry of Environment and Energy (MOEE). The materials should supply essential plant nutrients and/or organic matter, or other constituents that will maintain crop production or soil health.

For clarification, the term sewage biosolids refers to stabilized municipal "sewage sludge" as included in Processed Organic Waste, in Ontario Regulation 347. Hauled sewage (septage) is not included in this category. The term "other wastes" includes materials not defined as sewage biosolids, septage or agricultural waste in Ontario Regulation 347. The term "waste materials" is used frequently in this document and refers to both sewage biosolids and other wastes.

SECTION 2. PROCEDURES

Producers of potentially usable waste materials must obtain approval to spread or apply the material on agricultural land. Once the waste material is judged suitable for land application, a specific site must be approved and receive a Certificate of Approval from the Ministry of Environment and Energy for an "Organic Soil Conditioning Site", before the waste material can be spread. The Certificate of Approval allows agricultural land application of waste materials for crop production or ground cover growth. No waste materials within the scope of this document will be allowed to be applied to agricultural land unless a Certificate of Approval has been issued.

Section 2.1 Submissions

A detailed proposal must be submitted to the local MOEE District office for review. Advice on the required details and information can be obtained from both MOEE and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) local offices. Application forms are available from the local MOEE office.

The local MOEE office is responsible for issuing Certificates of Approval for the organic soil conditioning sites. Refer to Appendix 1 for MOEE's sampling and analytical procedures for sewage and other biosolids.

Because wastes other than sewage biosolids can be of many types and qualities, the local MOEE may seek the opinion of the Biosolids Utilization Committee (BUC). Proposals are reviewed and recommendations are provided to the MOEE on the acceptability of the waste for agricultural use, appropriate application rates, spreading procedures and soil characteristics. Because waste types and qualities vary, additional analysis may be required for review by BUC (Refer to Appendix 2). Figure 1 outlines the flow of information to and from BUC.

Section 2.2 Analytical Requirements

The applicant must submit all analyses necessary to identify the components which benefit crop production and pose minimal risk to:

- plant growth;
- crop quality;
- public and animal health; and
- quality of the environment.

A number of these components are discussed more fully later in this document. [In the future these Guidelines may be expanded to cover analytical requirements for specific types of wastes.]

Section 2.3 Assessing Suitability

The applicant should establish the potential benefit of waste spreading to agriculture. Advice is available from experienced agronomists in OMAFRA's Agriculture Division or other suitably qualified specialists.

Part of the submission to the MOEE for approval should include an agronomist's comments. This is important if the material has not been used for agricultural production in the past. The agronomist's comments or report should cover:

- the need for greenhouse and field testing, and for demonstration projects;
- the benefits and concerns with the material;
- the rationale used to develop the recommended application rate(s).

Section 2.4 Certification and Approval of Spreading Operations

Before approval is given, the MOEE must be satisfied that application of the waste will not conflict with any environmental legislation and will be of benefit to agriculture.

If wastes are unfamiliar, laboratory testing and possibly greenhouse and field testing may be required to provide information on the benefits provided by the material. Any such proposal should contain not only the proposal outline but also the methodology of reporting the findings. When experimentation and field testing are required, approval can be given by a MOEE Director's letter, under the Environmental Protection Act, authorizing the "experimental" application of wastes. The hauler will require an Organic Waste Management System Certificate to transport the waste material to the experimental site.

In summary: before routine land application can begin, approval is required for the application site and the hauling of the waste. The site must receive a Certificate of Approval for an "Organic Soil Conditioning Site" and meet the conditions required by the Environmental Protection Act, and Ontario Regulation 347. The hauler must receive an Organic Waste Management System Certificate for the specific waste materials before they can be moved to the land application site.

Section 2.5 Monitoring and Quality Control

The applicant may be required, at the request of the MOEE, to provide for a suitable field monitoring program and routine analysis for specified parameters of concern. The applicant must ensure that each batch produced and/or each load hauled is of uniform, consistent and acceptable quality.

SECTION 3. WASTE MATERIAL STABILIZATION

Before applying any waste to agricultural land, it must be treated in such a manner as to minimize the odour potential and reduce the number of pathogenic organisms and other potentially harmful constituents to an acceptable level. (see Section 4).

Section 3.1 Sewage Biosolids

All sewage biosolids must be "stabilized" before being spread on agricultural land. MOEE approved municipal anaerobic and aerobic digestion processes provide appropriate stabilization. Other stabilization methods will be reviewed on an individual basis. The review will determine the acceptability of the treatment method for use on waste materials intended for land application.

Section 3.2 Other Wastes

All wastes other than sewage biosolids applied to agricultural land must have an acceptably low potential to generate odours and must contain acceptably low concentrations of organisms pathogenic to humans or animals.

As with sewage biosolids, anaerobic and aerobic digestion may be used to stabilize waste and possibly control odours and pathogenic organisms. In general, wastes may be considered as appropriately stabilized, if:

- Odours after spreading are no more objectionable than those produced from normal farming practices; and

- The pathogenic content of the wastes is no greater than that of digested sewage biosolids.

Many industrial wastes do not have objectionable odours and may not contain pathogens. For such wastes, depending on the processes involved, stabilization may not be required and separation distances from water courses, wells and residences may be less than those discussed in Sections 6.11 to 6.15. The MOEE District Office can provide guidance in this matter.

SECTION 4. CRITERIA RELATING TO WASTE ELEMENTS

Waste materials contain elements which can be either desirable or undesirable for agriculture. Analysis of the waste may be required before and after it has been approved, or on an ongoing basis. The frequency of analysis must be approved by the MOEE.

Samples submitted for analysis are to be representative of the batch proposed for land application. Table 1 outlines some of the analysis requirements the applicant must be prepared to provide about the processes, products used in processing and the contaminants likely to be present in the waste. The applicant will be required to permit MOEE staff to obtain samples for analysis, if required.

Farmers receiving waste materials are to receive a copy of the analytical results. Waste application to land needs to be well managed in order to protect soil and agricultural production. The elements of primary concern are considered in the following sections.

Section 4.1 Potentially Desirable Constituents

Before waste materials are applied, the farmer should be advised of nutrient concentrations, so that waste material and fertilizer application rates may be adjusted. The nutrient application rates should be based on the fertilizer recommendation for the crop (see OMAFRA Publications 296, 360 and 363).

Section 4.11 Nitrogen

Nitrogen may be present in the ammonium, nitrate and organic forms. Ammonium plus nitrate nitrogen is a rough measure of the nitrogen immediately available to the crop.

The amount of ammonium plus nitrate nitrogen which may be supplied to the soil by waste materials is limited to protect the quality of ground water, soil and crop.

The quantity of nitrogen applied in any one growing season, should be based on ammonium plus nitrate nitrogen content and fertilizer recommendations.

In no case may the plant-available application rate for sewage biosolids, exceed 135 kg of nitrogen/ha over a five year period for crops, or a four year period for sod. For other wastes, the nitrogen application rate will be based on soil test results, crop requirements and contaminant loadings.

The ammonium plus nitrate nitrogen concentrations of anaerobically digested sewage biosolids and other waste materials must be analyzed regularly. The frequency of the analyses should permit the estimation of the nitrogen concentration within 25% of the actual concentration. It should be noted that traditionally, aerobically digested sewage sludges have only low levels of ammonium plus nitrate nitrogen.

The suitability of crops to receive sewage biosolids, is discussed in Tables 6 and 7. In addition, Table 7 provides criteria for application rates and time of application.

Section 4.12 Phosphorus

The acid soluble phosphorus content of sewage biosolids or other wastes must be determined. Approximately 40% of the applied phosphorus is available to plants as fertilizer phosphorus.

Section 4.13 Potassium

Sewage biosolids contain low levels of potassium. For other wastes, potassium application rates will be evaluated on a case-by-case basis. The recommended application rate should be based on soil test results, crop requirements and contaminant loadings.

Section 4.14 Other Nutrients

In addition to the macro-nutrients, micro-nutrients may be available in waste materials. Soil test results and crop requirements should be considered before waste materials with high concentrations of micro-nutrients are approved for spreading on agricultural land.

Section 4.15 Organic Matter

Sewage biosolids are a source of organic matter. Other wastes rich in organic matter, but low in levels of plant nutrients, may be suitable for some soils. These wastes will be considered for land application on a case-by-case basis.

Section 4.2 Potentially Undesirable Elements

To ensure proper and continued spreading of sewage biosolids and other wastes on agricultural land, standards have been developed which limit the application of many potentially undesirable elements.

Section 4.21 Metals of Principal Concern to Agriculture

The metals of concern are:

arsenic	copper	lead
cadmium	mercury	selenium
cobalt	molybdenum	zinc
chromium	nickel	

Waste materials may be acceptable for land application when their metal concentrations are consistent with Table 1. The metal concentrations of the soil on the site must be the same or lower than that listed in Table 2, column 3. Background information on metals is provided in Appendix 2.

These Guidelines restrict the amount of heavy metals that can be applied to soil, to limit metal accumulation. Only anaerobically digested biosolids with ratios of ammonium plus nitrate nitrogen to metal equal to or greater than those in Table 1, column 2 may be applied on agricultural land. Aerobic biosolids and other wastes must have metal concentrations no greater than those in column 4 in mg/kg of solids before being used on agricultural land on an on-going basis.

Applying waste materials in accordance with these Guidelines could elevate the metal concentrations of a typical Ontario soil to the maximum recommended limits within 25 to 55 years. However, if the metal concentrations in waste materials are reduced, waste applications may be allowed to continue for a longer period of time. For example, if the nitrogen to metal ratios for anaerobic sewage biosolids are greater than those in Table 1, column 3, or if the metals to solids ratios for aerobic sewage biosolids are no greater than those in Table 1, column 5, the application to the same area of land might continue for at least 250 years.

Section 4.22 Sodium

Sewage biosolids contain little sodium, while other wastes, such as those from the food processing industry, frequently contain significant levels. High concentrations of sodium can cause irreversible damage to soil structure. Therefore, wastes applied to agricultural land must conform with the sodium criteria in Table 3. However, these rates can be raised to a maximum of 400 kg/ha for sands and sandy loams, and 1000 kg/ha for loams, clay loams, clays and organic soils, when the following conditions are met:

- Soils must be well drained, or tile drained and;

- Applications of high-sodium waste will be permitted only if soil sodium and soil electrical conductivity are monitored annually. Exchangeable sodium in the soil must not be allowed to exceed 5% of the soil's cation exchange capacity. Soil conductivity, measured on a saturation extract, should not exceed 2.0 millisiemens per centimetre or, if measured in a 2:1 water to soil suspension, should not exceed 0.45 millisiemens per centimetre.

Section 4.23 pH

The pH of a waste material applied to an established crop should be in the range of 6.0 to 8.5. Materials with pH levels outside of this range may be applied to agricultural land only before planting or after harvest when crops are not present.

Section 4.24 Boron

Most crops are boron intolerant, therefore a limit of 1 kg boron/ha/yr has been established. The hot water soluble boron concentration in the soil, for these crops, should be equal to or less than 1.0 mg/L.

For boron tolerant crops, the application limit is 2 kg boron/ha/yr. For these crops, hot water soluble boron concentration in the soil should be equal or less than 1.5 mg/L. The farmer should consider these levels when planning the cropping sequence of those sites receiving waste materials.

Section 4.25 Other Elements

Analytical information about other elements may be needed, to help the applicant and the MOEE assess the suitability of waste materials for land application. The applicant will be required to provide appropriate analytical documentation upon request.

Section 4.26 Industrial Organic Contaminants

There are significant gaps in knowledge with respect to the fate of organic contaminants in biosolids applied to land. However, with over twenty-five years of experience in land spreading, there is no evidence to suggest that there are any organic contaminants in sewage biosolids that would pose a risk to humans.

At present, little is known about the effects of industrial organic contaminants contained in other wastes when applied to agricultural lands. The concentrations of each industrial organic contaminant will be assessed on a case-by-case basis.

As experience is gained and relevant research results reviewed, standards will be established for:

- allowable concentrations of industrial organic contaminants in other waste materials approved for land application;
- maximum application rates of these contaminants to soil;
- maximum concentration of these contaminants in soil.

Waste materials containing high concentrations of industrial organic chemicals will not receive approval for land application.

SECTION 5. CRITERIA & SPREADING RATES

Spreading rates are regulated to ensure that the application of wastes are beneficial to the agricultural land where they are applied, and do not cause any short or long term harmful effects.

Section 5.1 Sewage Biosolids

Biosolids may not be applied to soils with metal concentrations that are equal to or greater than those listed in Table 2, column 3.

Section 5.11 Anaerobically Digested Sewage Biosolids

The nitrogen to metal ratios, as shown in Table 1, column 2, relate ammonium plus nitrate

nitrogen concentrations to metal concentrations in sewage biosolids. The average ammonium plus nitrate nitrogen concentrations in the biosolids are divided by the average metal concentrations during the same period. Anaerobic sewage biosolids, with ratios equal to or greater than those in Table 1, column 2, may be used on land; those with lower ratios may not be used on land.

Application rates are based on the concentrations of plant-available nitrogen i.e. ammonium plus nitrate nitrogen. The nitrogen application rate should not exceed that specified in Section 4.2.

Section 5.12 Aerobically Digested and Other Stabilized Aerobic Sewage Biosolids

For land application, the metal concentrations in aerobic sewage biosolids should not exceed those specified in Table 1, column 4, in mg/kg of solids. The average metal concentrations in the biosolids during the preceding twelve months are divided by the average total solids concentrations during the same period. Aerobic sewage biosolids, with concentrations equal to or less than those in Table 1, column 4 may be used on land; those with higher concentrations may not be used on land.

Aerobic sewage biosolids may be applied at rates up to 8 tonnes of solids per hectare per five years. The nitrogen application rate should not exceed that specified in Section 4.2.

Section 5.13 Dewatered and Dried Sewage Biosolids

All dried and dewatered sewage biosolids used on agricultural land must conform with Table 1, column 4. Anaerobically digested sewage biosolids used on agricultural land must also conform with the criteria in Table 1, column 2, prior to dewatering or drying.

Dewatered and dried sewage biosolids may be applied at rates up to 8 tonnes of solids per hectare per five years. However, the nitrogen application rate should not exceed that specified in Sections 4.11.

The farmer should be advised of the ammonium plus nitrate nitrogen and phosphorus concentrations in dried or dewatered sewage biosolids, so that appropriate adjustments to biosolids and fertilizer applications can be made.

Section 5.14 Marginally Acceptable Sewage Biosolids

A marginally acceptable sewage biosolid is one which fails to meet the criteria for metals (Table 1, column 2 or 4), but which is within 10% of those criteria. Such biosolids can be applied to the land on a temporary basis, however application rates must be reduced. If, after repeated sampling, those biosolids do not meet the acceptable metals criteria, action must be taken to reduce the metal contents. Alternatively they must be disposed of by means other than land application.

Section 5.2 Wastes Other Than Sewage Biosolids

Spreading rates for other wastes will be based on soil test results, nutrient content, crop requirements, and contaminant loadings.

The farmer must be advised of the ammonium plus nitrate nitrogen, phosphorous, and potassium concentrations. With this information, appropriate adjustments can be made to the fertilizer rates.

SECTION 6. CRITERIA RELATING TO SPREADING SITES

Under the Environmental Protection Act, all waste material spreading sites must be approved by the Ministry of the Environment and Energy. Prior to this, the site location, land and soil characteristics, and proposed site management methods must be assessed. This assessment will minimize the risk of contamination to surface watercourses, groundwater, wells and residences.

Table 4 and 5 outline minimum requirements for the spreading of sewage biosolids. Distances between the fields and buildings, water courses and wells, soil criteria and waiting periods between spreading and human contact for other wastes will be evaluated, on a case-by-case basis, depending on the type of material, the level of pathogenic organisms and industrial organic chemicals, and the characteristics of the site.

Section 6.1 Separation Distances

The separation distances required for waste material spreading operations are provided in Table 4 and 5. If lessor distances are approved, these will be specified in the Conditions attached to Certificates of Approval for the site.

Section 6.11 Separation From Surface Watercourses

For the purposes of these Guidelines, a surface watercourse is defined as a natural or established watercourse or an open municipal drain along which water flows on a continuous or intermittent basis. In addition, ponds, lakes, springs and wetlands and points of direct access (such as catch-basins for drainage tiles or municipal drains) should be treated as watercourses for purposes of determining separation distance.

The minimum distance between the spreading site and a surface watercourse is listed in Table 5. These distances were developed taking into account land slope and soil permeability. When sewage biosolids are applied by methods other than irrigation, the MOEE may approve a reduction in separation distances. For example, separation distances may be reduced when:

a. waste materials are injected directly into the soil;

b. materials are spread by surface irrigation and are incorporated when dry and within 24 hours;

c. materials are spread on soils which are described in soil survey reports as "well drained";

d. materials are spread when there are crop residues which will prevent or inhibit precipitation from washing biosolid residues into watercourses;

e. application, soil tillage, and/or cropping patterns follow land contours;

f. there are other local or site factors which inhibit or prevent the transfer of waste material residues into watercourses.

Waste materials should never be applied within 10 metres of any watercourse or body of water.

Ministry of Environment and Energy staff can advise on separation distances from bodies of water or drainage channels other than surface watercourses as defined above.

Section 6.12 Separation From Groundwater

The groundwater table should be greater than 0.9 metres from the soil surface at the time of biosolids or other waste application.

Section 6.13 Separation From Bedrock

Sewage and other biosolids may be applied to soils greater than 1.5 metres deep. Shallow soils (1.5 m or less over bedrock) will be evaluated on a case-by-case basis.

Section 6.14 Separation From Residences

When sewage biosolids are applied to land close to residences, concerns may arise because of the potential for odours, air-borne drift of particles and surface run-off. The level of concern will depend upon the application method and land slope. The minimum distances between the spreading site and a residence in a residential area is normally 450 metres. For an individual residence not in a residential area the minimum separation distance is 90 metres. However, when liquid wastes are injected into the soil, or when it is spread by surface irrigation and is incorporated within twenty-four hours, distances may be reduced. In addition, the distance may be reduced by the farmer when he or she is the owner and occupier of the individual residence. The applicant must provide technical justification for any reduction in the separation distance before the local MOEE will render a decision to allow the reduction.

The absolute minimum distances for waste material application in all cases are 50 metres from a residence in a residential area, and 25 metres from an individual residence.

Section 6.15 Separation From Water Wells

The minimum separation distance between the spreading sites and water wells shall be 15 metres for drilled wells more than 15 metres deep and 90 metres for all other wells, including dug wells.

Section 6.2 Soil Criteria

In order to be used for spreading of biosolids and other wastes, soils should be of the mineral type with average to low metal content, having a pH greater than 6.0 (in most cases), and having a low existing phosphorus level in the top soil layer.

Section 6.21 Organic Soils

Waste materials may be applied to "mineral" soils but not to "organic" soils. Organic soils are defined as soils which contain 17% or more of organic carbon by weight and which have a depth of 0.4 metres or more of unconsolidated organic material. Soils which do not meet these specifications are termed mineral and are permitted to receive waste materials.

Section 6.22 Metals

Waste materials may not be applied to soils where any of the metal concentrations are equal to or greater than those listed in Table 2, column 3.

Section 6.23 Phosphorus

Waste materials may not be applied to soils containing more than 60 milligrams of Olsen sodium bicarbonate extractable phosphorus per litre in the top 15 centimetres of soil.

Section 6.24 Soil pH

Most metals are more soluble, and therefore more available to plants, in acid soils than in neutral or alkaline soils. Waste materials containing allowable levels of metals should not be applied to soils with pH values of less than 6.0. However, sewage biosolids containing lime may be applied to soils of lower pH, when they will raise the soil pH to at least 6.0.

Section 6.25 Soil Tests

Certificates of Approval will not be issued, nor will waste materials be allowed to be spread, unless satisfactory analyses for phosphorus and soil pH are available from soil samples taken within three years of the proposed application date. Heavy metal analysis of the soil should be conducted prior to biosolids or other waste application. This will establish the background levels for the heavy metals.

Section 6.3 Snow Covered and Frozen Ground

To minimize runoff, most sewage biosolids or other liquid wastes should not be spread on frozen or ice covered soil. Waste materials that are low in plant nutrient content and are proven to act like crop residues with minimal waste residues moving with runoff water, may be spread in the winter. It is acceptable to spread sewage biosolids when there is little or no frost in the soil and the surface is snow-covered, as the liquid can percolate into the soil. For fields with a sustained slope of 3% or less, spreading may be allowed on frozen soil, provided that the risks of runoff are minimal. In such cases, the separation distances from surface water courses noted in Table 5 should be doubled. Where surface run-off is expected as a result of snow-melt, waste materials should not be applied.

Section 6.4 Slopes

Spreading of sewage biosolids on slopes greater than 9% and slopes 6-9% on moderate to slow permeability soils is not permitted. See Table 5 for other limitations which relate to allowable distances between sloped surfaces and surface water systems.

Section 6.5 Reducing Runoff and Soil Compaction

Soil tillage and biosolids or other waste application should, where possible, follow the contours of the land. Liquid waste materials are best applied when residues of the previous crop are present on the soil to help control runoff. Liquid or solid wastes should not be applied if the spreading vehicles will cause undue compaction or damage to soil structure.

Section 6.6 Suitable Crops and Waiting Periods After Spreading

Because of the potential for pathogenic organisms in sewage biosolids, there are restrictions on crop production for sites receiving this material. The following crops are recommended for sites receiving sewage biosolids: field corn; hay and haylage; pasture; perennial legumes; soybeans; cereals; tree fruits and grapes. When spread on land producing vegetable crops, a twelve month waiting period before the next harvest is recommended. Use on home lawns, gardens and land used for tobacco production is not recommended.

Waiting periods are required between the application of sewage biosolids and the use of the land, to limit the exposure of people and livestock. The length of these waiting periods depends on the land use after spreading. Table 7 lists land use or crop and the period of time required before site access or harvest should be allowed.

Other wastes may not have the same potential for or level of pathogens as sewage biosolids, therefore the waiting periods may be reduced. Other wastes will be evaluated on a case-by-case basis and the waiting period will be determined accordingly.

SECTION 7. WASTE MATERIAL HANDLING AND SPREADING

Care must be taken to ensure that sewage biosolids and other wastes are handled in a safe manner before final utilization and soil incorporation.

Section 7.1 Requirements for Storage

A separate Certificate of Approval is required for storage facilities for sewage biosolids or other waste. The MOEE District Office should be consulted. Storage will be required for the times when land application is not possible. For example, storage may be required during inclement weather, unsuitable soil conditions and during the required waiting periods between land applications. Sufficient storage must be available to retain the waste materials during these periods. It is anticipated that a minimum of six months storage will normally be adequate. Before waste material can be removed from storage it must be well mixed to ensure uniform quality.

Section 7.2 Sewage Biosolids Blending

Two or more batches of sewage biosolids with unacceptable nitrogen to metal ratios or metals content may be blended to form an acceptable sewage biosolid mixture. In such circumstances, proper mixing is essential and periodic testing is required to verify uniform blending. Blending of sewage and/or other biosolids with manure is not recommended because the complete mixture (manure and biosolids) will be classified as a waste.

Section 7.3 Waste Materials Spreading

The maximum allowable application depth of liquid sewage biosolids or other liquid waste materials that may be spread at any one time is 1.3 cm. Because of the depth limit, more than one application of the waste material may be required to reach the total application rate allowed. Until the preceding application of liquid waste material has dried, no further applications are permitted. See Sections 4 and 5 for criteria on maximum application rates.

Waste materials should be spread uniformly over the field, to ensure even distribution of the material. Crop growth and yield will be more consistent when applied evenly. To ensure even distribution and to determine the actual application rate, the spreading equipment must be calibrated. The system will need to be recalibrated if the consistency of the waste material changes (ie. a change in water content), as this will affect the amount of material being applied.

SECTION 8. RESPONSIBILITIES AND RIGHTS

All parties in the sewage biosolids and other waste process, operating agencies and other generators, haulers and farmers have certain responsibilities and rights to ensure that the final utilization of these wastes is successfully carried out in an environmentally friendly manner with beneficial effects for the agricultural soil.

Section 8.1 Operating Agencies

The responsibilities of agencies operating sewage treatment plants and the waste generators are set out in the following sections.

Section 8.11 Record-keeping

Permanent records are required of:

- The location of all fields receiving biosolids or other wastes
- The amount of biosolids or other wastes applied to each field

- Biosolids or other waste analyses.

A report, similar to that shown in Figure 2, is to be provided to the hauler. The report shall include data on the waste material's average nutrient content per cubic metre. A copy of this report is to be held by the waste generator.

The generator must supply to the farmer information on the annual average quantities of metals per cubic metre (ppm, g/tonne, mg/kg) of biosolids or other waste, if requested.

Section 8.12 Waste Material Analysis

The number of biosolids or other waste samples analyzed must be sufficient to establish representative values for all pertinent parameters. Sampling frequency is subject to approval by MOEE District staff.

Section 8.13 Monitoring Application Rates

Steps should be taken to verify that the application rates conform with those specified by the Certificates of Approval as it is the responsibility of the biosolids generator to ensure the safe and adequate final disposal of the wastes generated at their facility.

Section 8.14 Contingency Planning

Sewage treatment plant operating authorities and other waste generators are required to prepare contingency plans for situations where sewage biosolids quality may temporarily fail to meet the requirements of these Guidelines. These situations may be the result of digester failure or of the need for digester cleanouts, plant maintenance or expansion. Weather and soil conditions will determine whether sewage biosolids can be spread on land. Contingency plans must provide for alternative methods for treatment, disposal and/or storage.

Section 8.15 Marginal Sewage Biosolids

Operating authorities must review the acceptability of their sewage biosolids immediately on receipt of analyses, to determine if corrective measures are needed to prevent material from becoming unacceptable.

Whenever marginal sewage biosolids are utilized on agricultural land as per Section 5.14, the agricultural producer is to be advised of the deviations in sewage biosolids quality from the standards.

Section 8.2 Waste Material Haulers and Spreaders

The hauler must spread the sewage biosolids uniformly on land at the required rate (See Sections 8.13 and 8.3). The nitrogen application rate must not exceed 135 kg of plant available/ha/5 years or that specified by any conditions in the Certificate of Approval, whichever is the lessor. In essence, the actual rate of material and rates of nutrients applied must not exceed the limits specified in either the Guidelines or as outlined in the Certificate of Approval issued by the MOEE.

With any waste material spreading, the hauler must comply with all site requirements and maintain all separation distances. Staking out distances from wells, watercourses and residences may help to maintain proper separation distances.

The hauler must ensure that the farmer receives a report, similar to that shown in Figure 2, as soon as practicable after completing biosolids or other waste application to any field. The rights of the farmer must be respected with regard to timing and rate of material applied.

Section 8.3 Farmers

The farmer, the hauler and the waste generator should work together to develop a utilization program for individual fields. The farmer has the right and the responsibility to insist on program flexibility. The application rates should be adjusted to suit the nutrient requirements of the crop, as long as it is within the rate approved by MOEE. In addition, the farmer has the authority to stop or refuse biosolids or other wastes from being spread, on the approved site, at any time.

The farmer also has the responsibility to see that appropriate waiting periods between waste material spreading and cropping or pasturing are observed. Advice should be obtained from intended market sources as to other limitations or restrictions.

Farmers will receive a copy of a report, similar to that shown in Figure 2, to help them in crop management.

SECTION 9. COMPLAINTS REGARDING SPREADING METHODS AND INTERPRETATION OF GUIDELINES

Questions on these Guidelines should be directed to:

a. MOEE District staff, when questions relate to site approvals, haulage, waste material quality or environmental issues;

b. OMAFRA local staff, when questions relate to spreading methods, the need for supplemental fertilizers, crop quality, or animal health;

c. The local Medical Officer of Health, when questions relate to public health.

TABLE 1: Criteria for Metal Content in Sewage Biosolids

1	2	3	4	5
Metals	Anaerobic Biosolids		Aerobic, Dewatered and Dried Biosolids and Other Wastes	
	Minimum Ammonium + Nitrate Nitrogen (NH_4^+-N + NO_3^--N) to Metal Ratios		Maximum Permissible Metal Concentrations (mg/kg of solids)	
	Present Requirements	Long-term Targets	Present Requirements	Long-term Targets
ARSENIC	100	480	170	35
CADMIUM	500	4200	34	4
COBALT	50	220	340	77
CHROMIUM	6	32	2800	530
COPPER	10	45	1700	380
MERCURY	1500	8400	11	1.4
MOLYBDENUM	180	1700	94	1.2
NICKEL	40	210	420	80
LEAD	15	75	1100	220
SELENIUM	500	2800	34	6
ZINC	4	20	4200	840

a. Acceptability of biosolids will be judged on the basis of the average concentrations of nitrogen, metals and solids during the preceding 12 months.

b. All dewatered and dried biosolids must meet the appropriate biosolid criteria before dewatering and drying.

c. The long term targets are based on the assumption that metal additions to soil from waste materials is undesirable and that application rates of metals should be reduced in the future.

TABLE 2: Criteria for Metal Content in Soils

1	2	3	4	5	6
Metal	Mean Metal Content in Uncontaminated Ontario Soils [a] (mg/L)	Maximum Permissible Metal Content in Soils Receiving Waste Materials [a] (mg/L)	Maximum Permissible Metal Addition to Uncontaminated Soil [b] (kg/ha)	Maximum Permissible Metal Application per 5 years [d] (kg/ha)	Minimum Number of Years to Reach Max. Recommended Metal Content in Soil [b, c]
ARSENIC	7	14	14	1.40	50
CADMIUM	0.8	1.6	1.6	0.27	30
COBALT	5	20	30	2.70	55
CHROMIUM	15	120	210	23.30	45
COPPER	25	100	150	13.60	55
MERCURY	0.1	0.5	0.8	0.09	45
MOLYBDENUM	2	4	4	0.80	25
NICKEL	16	32	32	3.56	45
LEAD	15	60	90	9.0	50
SELENIUM	0.4	1.6	2.4	0.27	45
ZINC	55	220	330	33.00	50

a. Based on dry weight at 100°C, the terms mg/L, µg/g and mg/kg are interchangeable

b. Columns 4 and 6 take into account the mean metal content of uncontaminated soils (see column 2). These numbers are examples because most soils are unlikely to have exactly the mean metal contents listed in column 2.

c. Based on anaerobic biosolid applications providing 135 kg/ha of ammonium plus nitrate nitrogen, or aerobic biosolid applications providing 8 tonnes of dry solids per hectare per 5 years, as outlined in these Guidelines. The number of years is rounded to the nearest five. See sample calculation in Figure 4

d. Column 4 divided by column 6 will give metal application for one year. To obtain the figures in column 5 the yearly metal application figures are multiplied by 5.

TABLE 3: Sodium Criteria

SUGGESTED ANNUAL SODIUM ADDITION TO ONTARIO SOILS	
Soil Texture	Annual Maximum Sodium Addition (kg/ha)
Sands, sandy loams Organic soils, loams, clay loams and clays	200 500

Note: Higher additions may be acceptable under some conditions.
Refer to Section 4.22.

TABLE 4: Separation Distances

(For additional information, refer to Section 6.10)

Feature	Distance (metres)	Notes
Water Table	0.9	Measured vertically
Bedrock	1.5	Measured vertically
Drilled Wells more than 15 m deep	15	Measured horizontally
All other wells including dug wells	90	Measured horizontally
Individual residences	90	Measured horizontally
Residential areas	450	Measured horizontally
Under some circumstances these distances may be reduced: refer to Sections 6.11 & 6.14. Refer to Table 5 for separation distances from water courses.		

TABLE 5: Minimum Separation Distances of Spreading Sites from Watercourses

Maximum Sustained Slope	Soil Permeability	Distance (metres)
0 - 3 %	Rapid to Moderately Rapid	50
	Moderate to Slow	100
3 - 6 %	Rapid to Moderately Rapid	100
	Moderate to Slow	200
6 - 9 %	Rapid to Moderately Rapid	150
	Moderate to Slow	Not Permitted
> 9 %	All Permeabilities	Not Permitted

Notes:

a. Determine soil permeability in accordance with OMAFRA's Drainage Guide for Ontario. Determine the soil type from County Soil Maps, also available from OMAFRA.

b. Spreading must be suspended when run-off is expected. The spreading of fluid waste is not normally permitted when soils are frozen. See Section 6.26.

TABLE 6: Waste Material Application for Specific Crops

CROP	COMMENTS
Field corn, hay, haylage, pasture, commercial sod	These crops are well suited to using nitrogen supplied by waste materials. Nutrients such as nitrogen should be applied within crop recommendations.
Cereals	Spring applications of waste materials containing more nitrogen than is recommended may result in the crop lodging or falling down before harvest.
Perennial legumes and soybeans	Soybeans, and hay crops containing more than one-half legumes do not require added nitrogen. However, waste materials that supply phosphorous, potassium, and/or organic matter can be of benefit to these crops. Some materials may cause some management concerns. For example viable tomato seeds found in biosolids can pose a weed problem in a soybean crop.
Tree fruits and grapes	Some waste materials may be applied in late fall. However early applications of the material may cause nitrogen to be released at the wrong time causing poor fruit quality, delayed hardening of trees or vines and winter injury.

Notes:

a. The maximum application rate per hectare for anaerobically digested biosolids is 135 kg/ha of ammonium + nitrate nitrogen per 5 years (4 years for commercial sod); for aerobic, dewatered or dried biosolids, the application rate is 8 tonnes of solids per hectare per 5 years. Other wastes application rates are reviewed on a case-by-case basis.

b. The maximum depth of a liquid material applied to land at one time is 1.3 cm (130 cubic metres per hectare).

c. Nitrogen application rates for individual crops should not be exceeded. Refer to OMAFRA publications 296, 360 and 363 for the recommended nutrient application rates.

TABLE 7: Spreading Restrictions Related to Public Health and Pathogens

Crop	Waiting Period After Application
Hay and Haylage	3 weeks before harvest
Pasture for horses, beef or dairy cattle	2 months before grazing
Pasture for swine, sheep or goats	6 months before grazing
Commercial Sod	12 months before harvest
Small fruits	15 months before harvest
Tree Fruits and grapes	3 months before harvest
Vegetables	12 months before harvest
Tobacco	Application not recommended
Home lawns and gardens	Application not recommended
Golf Courses and recreational land	Application recommended only if stabilization additional to digestion is used to reduce pathogenic content.
Some of these restrictions may be lifted for those wastes not containing pathogens. However, wastes other than sewage biosolids will be evaluated on a case-by-case basis.	

FIGURE 1: Information Flow

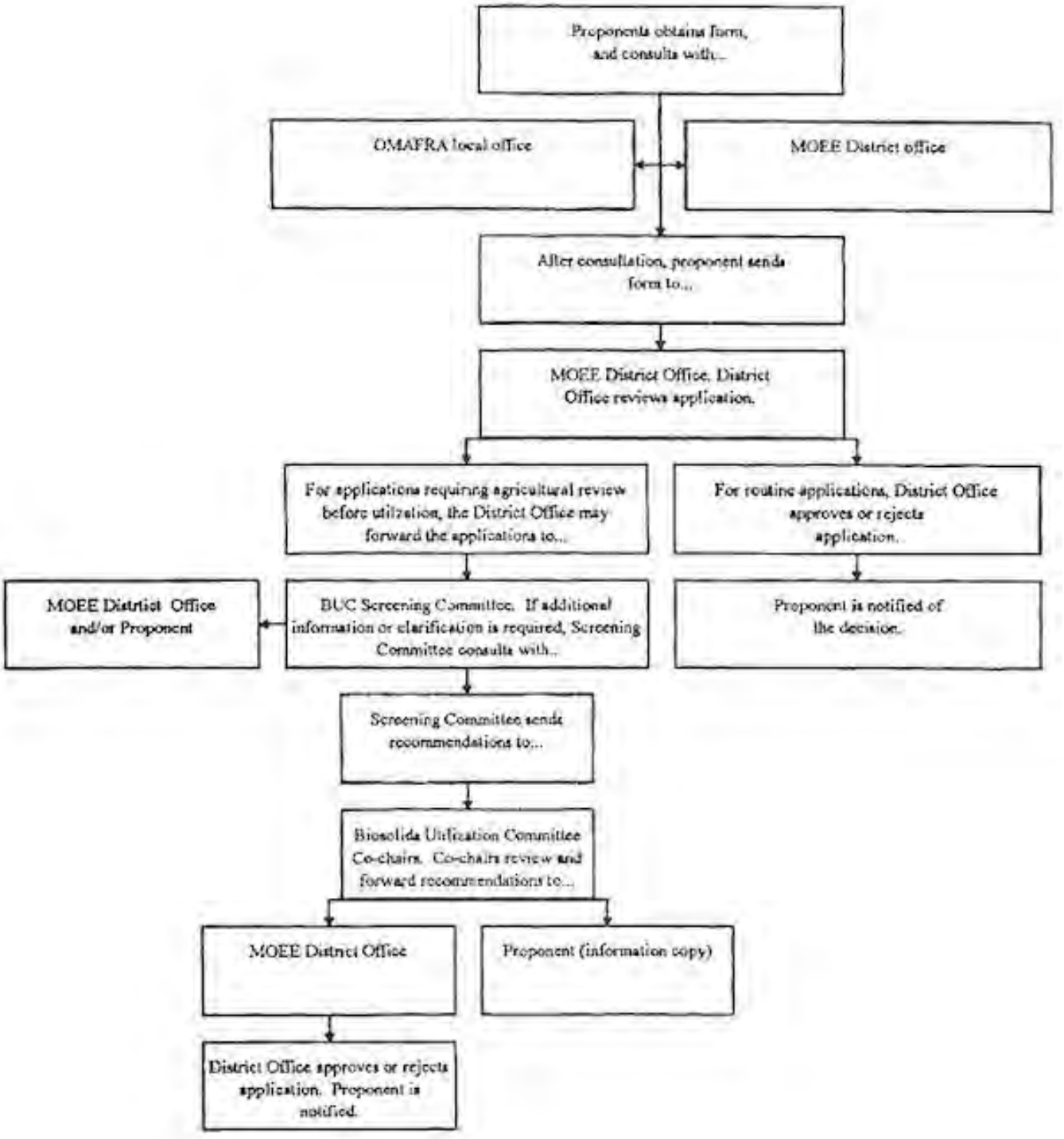

FIGURE 2: Report on Waste Materials Applied to Agricultural Land

Part A: Average Nutrient Content

(To be completed by the Generator)

Generator Name and Location _____

Waste Material Description _____

Storage Site Location (when applicable) _____

Nutrient Concentrations in: kg/m^3 for liquids; and kg/tonne for solids

Nitrogen (ammonia plus nitrate nitrogen)_____ (low levels only in aerobically digested biosolids)

Total Phosphorous _____

Signature of Employee responsible _____

Part B: Restrictions

Part C: Site and Waste Material Source and Quality Data

(To be completed by the Hauler)

Farm Operator _____ Date _____

Site _____ Field _____

Area Covered _____ (Hectares)

Total Amount Applied _____ (Cubic metres or kg)

Application Method _____

Hauler's Signature _____

Part D: Comments

Conversion Factors

1 kg = 2.2 lb 1 cubic metre = 220 gallons

1 ha = 2.5 acres 1 mg/L = 0.001 kg/m^3

FIGURE 3: Sample Calculation of Spreading Rates

MINIMUM NUMBER OF YEARS TO REACH MAXIMUM RECOMMENDED METAL CONTENT IN SOIL (Table 2 Column 6)

Maximum application rate of aerobically digested sewage biosolids

- 8 tonnes of solids per hectare per 5 years

Arsenic 170 mg/kg (aerobic biosolids, Table 1 column 4)

Amount of arsenic added to the soil in 8 tonnes of solids per ha

$$170 \text{ mg/kg} \times \frac{1 \text{ kg}}{1000000 \text{ mg}} \times 1000 \text{ kg/tonne} \times 8 \text{ tonnes/ha} = 1.36 \text{ kg/ha}$$

A hectare of mineral soil 15 cm deep (6 inches) weighs about 2000 tonnes.

$$\frac{1.36 \text{ kg arsenic added}}{2000 \text{ tonnes soil}} = 0.00068 \text{ kg arsenic / tonne soil}$$

Converting to mg/L (ppm)

$$0.00068 \text{ kg/tonne} \times \frac{1 \text{ tonne}}{1000 \text{ kg}} \times 1000000 \text{ mg/kg} = 0.68 \text{ mg/L (ppm)}$$

Minimum number of years to raise soil metal concentration to maximum level

Uncontaminated soil level 7 mg/L (ppm) (Table 2, Column 2)
Maximum level permitted 14 mg/L (ppm) (Table 2, Column 3)

Therefore the soil concentration has to be raised 7 mg/L (ppm) to reach the maximum level
Minimum number of applications allowed, to reach maximum soil concentration of 14 mg/L (ppm)

$$\frac{7 \text{ mg/L (ppm)}}{0.68 \text{ mg/L (ppm)}} = 10 \text{ applications of 8 tonnes}$$

Minimum number of years to reach maximum metal content in soil

10 applications x 5 year application period = 50 years

FIGURE 4: Calculations for Aerobic Biosolids Use on Land

1. To determine aerobic sewage biosolids acceptability, calculate "Actual Metal to Solids Concentration" and compare with the Permissible Values in Table 1.

i.e. $\frac{\text{Metal Concentration (mg/L)} \times 10^6}{\text{Solids concentration (mg/L)}} = \frac{\text{mg of metal}}{\text{kg of solids}}$

2. Calculate maximum application rate per 5 year period.

i.e. $\frac{8 \times 10^6}{\text{Solids (mg/L)}} = \frac{\text{Cubic Metres of Biosolid}}{\text{Hectare}}$

FIGURE 5: Calculations for Anaerobic Biosolids Use on Land

1. To determine anaerobic sewage biosolids acceptability, calculate "Actual Nitrogen to Metal Ratios" and compare with the Permissible Values in Table 1.

i.e. $\frac{\text{Ammonia + Nitrate Nitrogen (mg/L)}}{\text{Metal concentration (mg/L)}} = \frac{\text{mg of metal}}{\text{kg of solids}}$

2. Total volume which can be applied over a five year period.

i.e. $\frac{135{,}000}{\text{N (mg/L)}} = \frac{\text{Cubic Metres of Biosolid}}{\text{Hectare}}$

where: N = Average ammonia + nitrate Nitrogen concentration

$\frac{\text{metre}^3 \text{ Anaerobic sewage biosolids}}{\text{hectare}} \times 89 = \frac{\text{Imp. Gallons}}{\text{acre}}$

$\frac{\text{Imp. Gallons}}{220} = \text{meter}^3$

Appendix I

Sampling and Analytical Procedures
for use with *the*

Guidelines for the Utilization of Biosolids
and
Other Wastes on Agricultural Lands

Prepared by the

Biosolids Utilization Committee

Preface and Acknowledgements

The Guidelines for the Utilization of Biosolids and Other Wastes on Agricultural Lands contain numeric chemical criteria for both the soils to which a biosolid is applied and for the biosolids applied to the land. Whenever numeric criteria are used and sampling is required, it is important for the basic methods of sampling and analysis to be clarified if meaningful accurate comparisons of numbers are desired. For this reason, the Biosolids Utilization Committee developed this document on sampling and analytical methods to be used in conjunction with the guidelines.

The sampling methods described are consistent with good practices that are currently being conducted. These methods are thought to be reasonable and to provide an acceptable quality of sampling. The analytical principles and practices described are consistent with those of the Ontario Ministry of Environment and Energy (MOEE) Laboratory Services Branch and are in agreement with the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) laboratory methods. It is the hope of the committee that this document will result in an improved degree of comparability of analytical results from sampling for the purposes of the guidelines.

For the purposes of this document, the term "sewage biosolid(s)" refers to municipal "sewage sludge" as included in Processed Organic Waste, in Ontario Regulation 347. Hauled sewage (septage) is not included in this category.

For information with regard to the guidelines, please contact your local MOEE District Office.

Sampling Procedures for the Utilization of Sewage Biosolids and Other Wastes on Agricultural Lands

Sampling Procedures for the Ontario Guidelines for the Utilization of Biosolids and Other Wastes on Agricultural Soils

1.0 SOIL SAMPLING

Sampling of the soil to which sewage biosolids and other wastes are to be applied is necessary to determine the acceptability of the site for receiving the particular material. The method of soil sampling should be described and provided by the applicant to the MOEE along with the date of sampling, the name of the company undertaking the sampling and the analysis. The results of the analyses of soil samples for pH, sodium bicarbonate extractable phosphorus (Olsen test), and metals should be included along with the date of analysis. The sampling and testing for pH and phosphorus must have been undertaken within three years preceding application of a sewage biosolid or other wastes.

Summaries of acceptable analytical methods are presented in Section 5.2. It should be noted that the methods for phosphorus and boron analysis are for plant-available fractions. The analytical methods for other parameters use much stronger extracting or digesting procedures.

1.1 Collection of Soil Samples

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field should be sampled separately. At least 20 soil cores i5 cm deep should be taken from any fields up to 5 ha in size. For fields larger than 5 ha, additional cores should be taken, but at a lower frequency (for example, 2 cores for each additional ha). The more cores that are taken, the more likely the soil sample will provide a reliable measure of the fertility and metal concentrations in the field. For analysis for fertility, one sample should not represent more than i0 hectares, and if a sample indicates failure of the fertility requirements for biosolid application, biosolids should not be applied to that portion.

The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well, and the soil sample placed into an appropriate, properly labelled container for analysis. The area sampled should be traversed in a zig-zag pattern to provide a uniform distribution of sampling sites. Parts of a field that differ markedly in appearance of soil or crop should be sampled separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

1.2 Metals

In the Guidelines, the maximum allowable metal concentrations in soils receiving sewage biosolids, are based on the "mean metal content of uncontaminated Ontario soils", as stated in these Guidelines on page 20, Table 2. In many soils, metal concentrations will be higher than the mean. For some soils, one or more metal concentrations may exceed the maximum allowed in the Guidelines. It is therefore necessary that soil testing be conducted prior to the first application of sewage biosolids or other wastes to determine the suitability of the soil. Analysis of samples on a field by field basis may not be necessary if a sampling program that has been conducted in the area indicates background metal concentrations to be acceptable, and there is no likelihood of potential contamination of the field from sources of metals. Otherwise, samples collected as per section 1.1 of this document should be analyzed for the eleven metals listed in the Guidelines. For metal analysis, the limit of one sample representing at most 10 ha does not apply so long as adequate numbers of samples are taken to establish metal concentrations with sufficient confidence to determine the soils acceptability for receiving sewage biosolids or other wastes.

Using the information derived from the testing, together with information about metal concentrations in sewage biosolids and/or other wastes applied, the metal concentration in the soils after each sewage biosolids or other waste application can be calculated. When calculations indicate that further additions of sewage biosolids or other wastes could result in exceedences of soil criteria, additional soil analyses should be conducted before further sewage biosolids applications are permitted.

2.0 SEWAGE BIOSOLIDS SAMPLING

Sampling and analysis together provide a means of determining whether sewage biosolids (municipal sewage sludge) and other wastes are acceptable for land application at "Organic Soil Conditioning Sites". Acceptable sewage biosolids and other wastes have the capacity to promote crop production or to enhance ground cover growth. In general, analyses will identify the concentrations of chemicals which either:

- have an adverse effect on agriculture and the environment; or
- promote plant growth.

The analytical data, the standards established in the Ontario Guidelines, and the crop requirements published by OMAFRA can be used by agronomists or MOEE staff to determine:

- maximum application rates in any one year;
- the intervals between applications;
- the maximum number of applications.

The following sections present guidance on sampling procedures and sampling frequencies that are normally acceptable for the use of sewage biosolids and other wastes on agricultural lands. The frequency of sampling and the parameters to be analyzed for, may be amended from time to time at the discretion of the local MOEE District Manager.

2.1 Sampling Locations and Methods for Fluid Biosolids

a) When a sewage biosolid is being applied to land, samples should be obtained from a composited mixture of grab samples, taken such that the sample is representative of the material being sampled that day. The grabs and composites should be collected in clean non-metallic containers and covered, except when another grab is being added. The purpose is to provide accurate estimates of the nutrients and metals in the sewage biosolids delivered to the farmer's fields.

   To obtain samples for analysis, the composited mixture should be mixed to ensure homogeneity. Samples should be collected from it as required in 500 mL or larger sample bottles. Sample bottles must be left ⅓ to ½ empty.

   One 500 mL sample will suffice for nitrogen, phosphorus and total solids analyses. A different 500 mL sample is required for metals analyses, when these are required.

b) When a sewage biosolid is being retained either at the sewage treatment plant or being transferred to external storage, grab samples as in a) are required. Multiple sampling points should be used and the grab samples composited.

c) At larger sewage treatment plants, on-site nitrogen analyses may be needed to provide accurate information to individual farmers. Portable testing equipment can have advantages.

d) Biosolids from each storage location should be sampled at the time the material is being removed for spreading. Samples may be taken either from the spreading vehicle or from the haulage vehicle which conveys the material to the spreading vehicle.

2.2 Sampling Locations and Methods for Dried and Dewatered Biosolids

For all dried and dewatered biosolids, metal concentrations must be determined before biosolids are dried or dewatered. For anaerobically digested, the nitrogen to metals ratios must also be determined before drying or dewatering. In this way, the acceptability of the biosolids for land utilization can be determined.

No more than 8 tonnes of dry solids per hectare per 5 years may be spread. The maximum spreading rate permitted is determined using the percentage of solids in the biosolids after drying or dewatering.

2.2.1 Sampling Locations & Methods for Dried & De-watered Biosolids

A composite mixture of grab samples of approximately i kg should be collected such that it is representative of the material being sampled during a designated sampling day. Each grab sample should be immediately deposited in a strong, sealable plastic bag. The bag should be sealed against moisture loss. At the end of the working day, the bag should be emptied onto a large non-metallic surface and small sub-samples taken from all sections of the sample until a sample of approximately 2 kg has been obtained. (Alternately, ASTM standards D346-75, D420-68, D1452-65 or D2234-76 may be followed.) This sample should be placed within a second strong plastic bag. The sample is then placed in an appropriate container for shipping to the laboratory for testing.

3.0 SEWAGE BIOSOLIDS ANALYSIS FREQUENCIES

The previous minimum MOEE sampling requirements for sewage biosolids, taking into account that not all sewage biosolids can be applied to land, are listed below:

Sampling Type	Frequency	Parameters		
Biosolids (if utilized)	Quarterly	Aerobic	Anaerobic	
		Total Solids	Total Solids	
			Ammonia + Ammonium Nitrogen (NH_3 + NH_4^+) as N	
			Nitrate Nitrogen	
		Metal Scan	(both)	
		- Arsenic	- Cadmium	- Cobalt
		- Chromium	- Copper	- Lead
		- Mercury	- Molybdenum	- Nickel
		- Potassium	- Selenium	- Zinc
Biosolids (if not utilized)	Yearly	Aerobic	Anaerobic	
		Total Solids	Total Solids	
			Ammonia + Ammonium Nitrogen (NH_3 + NH_4^+) as N	
			Nitrate Nitrogen	
		Metal Scan	(both)	
		- Arsenic	- Cadmium	- Cobalt
		- Chromium	- Copper	- Lead
		- Mercury	- Molybdenum	- Nickel
		- Potassium	- Selenium	- Zinc

These minimum requirements applied only where a consistent historical record of all the parameters noted could be established. Where inconsistent results had been obtained or new applications were being considered additional sampling was considered. In order to quantify the requirements, a sub-committee was established by the Biosolids Utilization Committee, made up of representatives of haulers, plant owners and MOEE analytical specialists, to review all existing sampling protocols for sewage biosolids and recommend a program to be followed. The following program was recommended and should be used in conjunction with the minimum program:

- sampling for all parameters should normally occur at a rate of twice per month during the period when sewage biosolids are being applied to land and at least twice in the two months preceding land application; and
- if a change in the process occurs that could result in changes in the sewage biosolids quality, more frequent analysis should be conducted. Similarly, if there is historic evidence that biosolids quality is consistent, then sampling frequencies may be reduced, as described in the following sections.

For the purposes of this document, the same analysis frequencies described in this section apply to blended biosolids. The operating authority may, in addition, wish to have individual biosolids that are being blended analyzed separately; however, this document does not require it.

3.1 Ammonium Plus Nitrate Nitrogen

3.1.1 Rationale

Analysis permits farmers to be informed about the quantity of readily available ammonium plus nitrate nitrogen applied to their fields. For anaerobically digested sewage biosolids, the analyses permits assessment of sewage biosolids acceptability. When repeated analyses show that the nitrate concentrations are negligible, nitrate analyses may be discontinued. Historical data may also indicate if nitrate analyses may be discontinued.

3.1.2 Analysis Frequency

a) Fluid Biosolids

Analyses, to determine ammonium plus nitrate nitrogen concentrations are normally required two times per month during the period when sewage biosolids are being applied to land. When analyses are conducted less frequently, nitrogen concentrations (in the material actually applied) can rarely be assessed within 25% (as required by the Guidelines).

Nitrogen concentrations can vary according to the rate of biosolids withdrawal from storage and also due to process factors. Analysis frequency can sometimes be decreased when previous analyses show that nitrogen concentrations are relatively uniform over an extended period and/or when the method of digester operation permits accurate prediction of nitrogen

concentrations. In most situations reduced analysis frequency is unacceptable. This is particularly true when the biosolid withdrawal rates from a digester are erratic and/or if there is little mixing and agitation prior to the withdrawal of each load. If analytical results over the previous year indicate that nitrogen concentrations are consistent, then analysis frequency can be reduced to once per month during the period that biosolids are being applied to land.

More frequent analyses may be necessary when nitrogen concentrations are known to be subject to wide fluctuations. In such cases, the use of portable analytical equipment is recommended, so that on-the-spot results can be obtained.

b) Dewatered and Dried Biosolids

For anaerobically digested dried and dewatered sewage biosolids, analyses for ammonium nitrogen should be conducted twice per month during the period that sludge is being applied to land. For previously untested sewage biosolids, analyses over an initial period of three months should be used to determine if the dewatered or dried sewage biosolids contain ammonium plus nitrate nitrogen concentrations in excess of 100 µg/g. If so, analyses for these forms of nitrogen will be necessary. As for other biosolids, analytical frequency may be reduced to once per month during the period that sludge is being applied to land if consistency has been demostrated in the previous years testing results.

(**NOTE:** Periodic analyses for nitrogen and metals in fluid biosolids, prior to dewatering or drying, are necessary to determine its acceptability.)

3.1.3 Assessment of Nitrogen Concentrations

When calculating spreading rates, the nitrogen concentration may be assumed to be the average of the last four available results. However, when portable analytical equipment is available, the actual nitrogen value obtained should be used.

3.2 Metals

3.2.1 Rationale

Analyses are required for the eleven metals listed in the Guidelines so that biosolids acceptability can be assessed in accordance with the Guidelines. Analysis for additional metals should be conducted when there is reason to believe that they are being introduced into the sewage in excessive or abnormal quantities.

3.2.2 Analysis Frequency

Sampling should occur at a minimum rate of twice per month during the period when sludge is being applied to land, and twice within the two months prior to land application. This gives both an accurate picture of the quality of the biosolids being applied as well as allowing the operator to detect deviations from compliance relatively quickly. Where there is historic

evidence of consistency of metal concentrations, this frequency may be reduced to as low as once every three months.

Analysis Frequency for Marginal and Unacceptable Sewage Biosolids

Marginally acceptable biosolids are ones that fail to meet the acceptability criteria for metals, but are within 10% of those criteria. They can be utilized on land on a temporary basis at reduced rates. Analysis frequencies are usually unchanged. Possible exceptions are when investigations are being undertaken to determine either the fate of metals being introduced into sewage or when the efficiency of an industry's remedial actions to reduce metal discharges to municipal sewers is being assessed.

3.2.3 Assessment of Metal Concentrations

The metal concentration can be assumed to be the average of the last four results. However, if a single sample is unusually high an additional sample should be taken and analysed. If the results confirm the first analysis then the average of the two most recent results should be used until concentrations return to normal.

3.3 Total Solids Concentrations

3.3.1 Rationale

Analysis information about total solids concentrations in aerobic and dewatered sewage biosolids permits determination of:

- biosolid acceptability according to Guidelines' criteria; and
- application rates.

3.3.2 Analysis Frequency

Analyses for total solids should be conducted twice per month during the period when material is being applied to the land, and twice in the two months preceding land application. If the analysis results vary widely, more frequent analyses may be required; if there is little variation, then analyses frequency may be reduced to once per month during the period when sludge is being land applied.

3.4 Phosphorous (Acid Soluble)

Sampling may be conducted while the sewage biosolids are being transferred to trucks which will convey it directly to fields for spreading.

3.4.1 Rationale

Since the agronomic benefits resulting from soil extractable phosphorus concentrations in

excess of 60 µg/g are negligible and high available phosphorus concentrations in surface soils can adversely impact ground and surface water quality, sewage biosolids applications which raise phosphorus concentrations above 60 µg/g are not permissible. For soils with low phosphorus concentrations, crop yields can be enhanced by sewage biosolids application. Further, the Guidelines require that farmers be advised of the amount of phosphorus applied to their land.

3.4.2 Analysis Frequency

Sampling should occur at a minimum rate of twice per month during the period when sewage biosolids are being applied to land, and twice within the two months prior to land application of biosolids. When results vary widely, additional analysis may be necessary to provide more accurate assessments. When analysis from the previous twelve months indicates that phosphorus concentrations are consistent, then analysis frequency may be reduced to once per month during the period of land application.

3.4.3 Assessment of Phosphorus Concentrations

Phosphorus concentrations are assumed to be the average of the last two available analytical results.

3.5 Other Analysis Parameters

Normally, analyses for nitrogen, metals, phosphorus and, in the case of dried and dewatered biosolids and aerobically digested and other stabilized aerobic sludges, moisture content and total solids, are the only ones required. However, MOEE District staff may, from time to time, review industrial processes, the chemicals used, and the waste by-products formed at manufacturing plants which discharge wastes to municipal sewers. Liquid waste discharges to municipal sewers sometimes contain other metals, chlorides, elements or compounds with the potential to cause land productivity, health or environmental problems. When municipal biosolids derived from sewage containing such wastes are used in agriculture, MOEE Regional and District staff may assess the need for additional analyses.

4.0 SAMPLING & ANALYSIS OF WASTE OTHER THAN SEWAGE BIOSOLIDS

When wastes other than sewage biosolids are proposed for application to agricultural land, the Biosolids Utilization Committee is available to provide advice and recommendations. See Appendix 2 for details.

4.1 Sampling

The sampling program should be designed to ensure that the material sampled is representative of the material actually applied to land. Extensive testing of different

parameters may be necessary to establish the initial suitability of the material for land application. Subsequently, ongoing analysis programs are often required to ensure that the material remains acceptable for land use. In all cases, analyses must enable the farmer to be aware of the nutrient contents and therefore determine the need for applying supplemental fertilizer.

4.2 Analyses

The Guidelines and the sections of this document which deal with sewage biosolids provide general guidance on the nature and frequency of analysis programs. In general, however, these programs must be devised on a case-by case basis. Questions which are important are:

- Are wastes produced by batch or continuous processes?
- Can constituents, which are not beneficial to agriculture, be readily removed before the wastes are actually applied to the land?
- Does the waste storage facility permit proper biosolids mixing?
- Are materials taken from storage on a batch or continuous basis?

In determining which analyses are necessary, the possibility that the waste contains detrimental organic contaminants must be considered. Wastes must be analyzed for any potential contaminants that could have adverse effects upon the environment or on human health. Therefore, the nature of the materials and plant processes used must be well described and documented. This will permit the Ministry of the Environment and Energy to conduct an appropriate organic scan should it be necessary. It is noted, however, that it is the responsibility of the applicant to advise the MOEE and the Biosolids Utilization Committee of any potentially harmful constituents in the material and to assure that appropriate analytical tests are conducted to determine the concentrations of any potential contaminants. In all cases where an initial application for a Certificate of Approval to apply waste to agricultural lands is submitted, analysis should be conducted for the parameters in Table 1 of Appendix 2. If it can be conclusively shown that one or a number of the parameters in Table 1 of Appendix 2 cannot possibly be of concern in the waste material, then those specific parameters may be dropped from the required list.

For wastes containing significant quantities of organic material, the C:N ratio can be useful in determining nitrogen requirements for crops, and should be determined. This is obtained by dividing the total organic carbon concentration by the total nitrogen concentration (Kjeldahl normally is acceptable but should be adjusted for nitrate N if nitrates are a significant portion of total N) to derive the C:N ratio.

5.0 ANALYTICAL PROCEDURES

5.1 Sample Preparation for Soils

Prior to analysis, soil samples should be prepared in the following manner. Samples should be

spread out on non-metallic trays in a dust free environment and air dried for 48 hours. If traces of moisture are still visible, air drying should continue until no signs of moisture are evident. Alternately, a subsample can be removed from a well mixed sample and its moisture content determined by oven drying to allow reporting of results on a dry weight basis. The sample is then disaggregated (not ground) with a mortar and pestle and screened through a 2 mm sieve. A sub-sample of the less than 2 mm fraction is then ground until the entire sub-sample passes a 355 µm (#45 US standard testing sieved ASTME -11 specification, Tyler equivalent 42 mesh,) sieve. The less than 355 µm fraction is used for all the inorganic analyses except Sodium Adsorption Ratio, pH, Electrical Conductivity, Phosphorus, and hot water extractable Boron, which use the less than 2 mm fraction.

5.2 Introduction to Analytical Guidelines Table

The following Tables 1 & 2 present the analytical method principles that should be used for comparison of contaminant concentrations with numeric criteria. Alternate equivalent methods should meet Method Detection Limits (MDLs) as detailed in this section and must exhibit acceptable and comparable precision and accuracy.

The method codes presented in the format; E1234A

refer to methods in use by the MOEE and are included for reference purposes. They are only provided where there is a good match between the current MOEE method and the cited list of contaminants and MDL requirements. These detailed methods currently can be obtained for a minimal cost from the MOEE. The Method Guidelines and the MOEE reference method listed are intended to assist in the identification and quantification of the broadest range of contaminants listed in the tables.

All MDLs presented in the tables are estimates that are realistically attainable for low level environmental concentrations, based on documented method performance, and/or consultation with other labs, using the listed methods and good laboratory practices. As such, the MDLs listed in the following tables represent the most stringent method performance criteria for this guideline. Where higher levels are expected or known to exist, or where less stringent criteria are identified by the guideline, MDLs should be demonstrated by the contributing laboratory as about 1/10 of the numeric criteria. For soils, MDLs are calculated using the in-run duplicate method described in Estimation of Analytical Detection Limits, MOEE publication number PIBS 299, and for sewage biosolids, the spiked sample method described in that document is used. MDLs are presented here to give additional guidance for quality assurance purposes, and it is recognized that deviations will occur. Significant failures to meet MDLs should be examined, the reasons for the failures determined, and corrective measures taken.

Table 1. Analytical Guidelines and Method Detection Limits (MDLs) for Soils

PARAMETERS	MDL* µg/g	METHOD GUIDELINES
Copper	5.0	A sample (0.50 g) is digested with concentrated nitric and hydrochloride acids in digestion tubes in a hot block digester, and analyzed by ICP. Where needed AAS or DCP can be used. MOEE laboratory reference:E3073A, E3074A, E3075A
Nickel	2.5	
Zinc	25	
Cadmium	1.0	
Cobalt	2.5	
Chromium	5.0	
Lead	10	
Manganese	25	
Sodium	25	
Potassium	25	
Magnesium	250	
Vanadium	5.0	
Molybdenum	2.5	
Barium	2.5	
Beryllium	2.5	
Strontium	5.0	
Thallium	2.5	
Mercury	0.05	A sample (0.250 g) is digested with 4:1 sulphuric:nitric acid in a hot block digester, and analyzed by CV AAS. MOEE laboratory reference: E3059A
Arsenic	1.0	A sample (0.06 g) is digested overnight with nitric:sulphuric:perchloric, (6:3:1) acid mixture. Hydrochloric acid is added, and the analysis is done by flameless AAS. MOEE laboratory reference: E3245A
Selenium	1.0	
Antimony	1.0	
Silver	0.25	A sample (0.500 g) is digested with nitric and sulphuric acids in digestion tube in a hot block digester, and analyzed by AAS. Where available ICP can be used. MOEE laboratory reference: E3063A

* MDLs are for low level concentrations. For higher levels, MDLs should be about 1/10 of the appropriate numeric criteria.

Table 1: Analytical Guidelines and Method Detection Limits (MDLs) for Soils (continued)

PARAMETERS	MDL* µg/g	METHOD GUIDELINES
Boron - hot water extract	0.02	50 ml of 0.01 M $CaCl_2$ solution is added to 25 g of air-dried soil (<2 mm), then boiled for 5 minutes. Volume loss is made up and filtrate analyzed by ICP. AAS or DCP can be used.
Sulphur	50	A sample (0.250g) is combusted with copper and iron accelerators in a combustion furnace. The evolved SO_2 is titrated with potassium iodate using starch as an indicator. MOEE laboratory reference: E3096A
Fluoride	2.5	A sample (0.50g) is extracted with 0.1N perchloric acid for 4 hours at 80°C. The sample is shaken for one hour. TISAB III M Buffer is added, and the solution is shaken for 15 minutes. The analysis is done by Ion Selective Electrode. MOEE laboratory reference: E3063A
Nitrogen (total)	0.5 (mg/g)	A sample (0.08-0.40 g) is digested with conc. sulphuric acid followed by potassium persulphate. It is neutralized with sodium hydroxide, and analyzed by automated colourimetry. MOEE laboratory reference: E3116A

* MDLs are for low level concentrations. For higher levels, MDLs should be about 1/10 of the appropriate numeric criteria

Table 1: Analytical Guidelines and Method Detection Limits (MDLs) for Soils (continued)

PARAMETERS	MDL µg/g	METHOD GUIDELINES
pH Electrical Conductivity	0.25 --	A sample (10 g) is shaken with 20 ml distilled water for 30 minutes, allowed to stand for 30 minutes, and analyzed by a pH meter and a conductance meter. MOEE laboratory reference: E3137A
Sodium Adsorption Ratio	--	Ratio is calculated from concentrations (me/L) of sodium, calcium and magnesium in extract from pH procedure as follows. SAR = $[Na]/(([Ca]+[Mg])/2)^{0.5}$ If units used are mmol/L then SAR = $[Na]/([Ca]+[Mg])^{0.5}$)
Nitrate + Nitrite	5.0	A sample (10 g) is extracted with distilled water by shaking for 30 minutes. Nitrate is reduced to nitrite with hydrazine in alkaline media containing cupric ion. Nitrite is diazotized with sulphanilamide, and the product coupled with ethylenediamine dihydrochloride. The analysis is done by colourimetry. MOEE laboratory reference: E3208A
Phosphorus (Sodium bicarbonate extractable (Olsen method))	--	A sample (5 g) is extracted with 0.5M $NaHCO_3$ solution adjusted to pH 8.5 with 1M NaOH solution by shaking for 30 minutes. Analysis is done by automated colourimetry on the filtered extract.
Chloride (Water Extractable)	0.25	A sample (10 g) is extracted with distilled water by shaking for 30 minutes. It is centrifuged, filtered (0.45 mm), and analyzed by ion chromatography. MOEE laboratory reference: E3013A
Hexavalent Chromium	2.5	A sample (5 g) is digested using alkaline digestion. The solution is extracted with APDC-MIBK, and analyzed by AAS. Cr (III) and Cr (VI) spikes are required.

* MDLs are for low level concentrations. For higher levels, MDLs should he about 1/10 of the appropriate numeric criteria

Table 2: Analytical Guidelines and Method Detection Limits (MDLs) for biosolids

PARAMETERS	MDL* µg/ml	METHOD GUIDELINES
Copper	0.09	An appropriate sample (usually 5.0 ml) is dried in a test tube overnight at 110°C . It is then digested with concentrated nitric and hydrochloric acids in digestion tubes in a hot block digester, and analyzed by ICP. Where needed AAS or DCP can be used. MOEE laboratory reference: E3071B
Nickel	0.14	
Zinc	0.32	
Cadmium	0.04	
Cobalt	0.17	
Chromium	0.05	
Lead	0.16	
Manganese	0.03	
Magnesium	0.17	
Vanadium	0.04	
Molybdenum	0.09	
Barium	0.02	
Beryllium	0.03	
Strontium	0.02	
Silver	0.03	
Titanium	0.02	
Calcium	0.59	
Iron	0.81	
Mercury	0.05	A sample (3 ml) is digested with 4 ml HCl/HNO_3 and 6 ml $KMnO_4$ and analyzed by CV AAS. MOEE laboratory reference: E3058A
Arsenic	0.08	A sample is digested overnight with nitric:sulphuric:perchloric, (6:3:1) acid mixture. Hydrochloric acid is added, and the analysis is done by flameless AAS. MOEE laboratory reference: E3091A
Selenium	0.08	
Antimony	0.08	
Phosphorus	0.1	5 ml of sample are digested with sulphuric acid and analyzed by automated colourimetry MOEE laboratory reference: E3368A
Ammonia	0.25	12 ml of sample are analyzed directly by automated colourimetry MOEE laboratory reference: E3366A
Nitrate + Nitrite	0.25	same as ammonia - MOEE laboratory reference: E3366A
Nitrite	0.03	same as ammonia - MOEE laboratory reference: E3366A
Total Solids	10	50 - 100 ml of sample are weighed and dried to constant weight at 103°C (usually 20 hr) MOEE laboratory reference: E3I88B

* MDLs are for low level concentrations. For higher levels, MDLs should be about 1/10 of the appropriate numeric criteria

APPENDIX 2

INFORMATION REQUIRED BY
THE BIOSOLIDS UTILIZATION COMMITTEE
TO EVALUATE SUITABILITY OF WASTES
(OTHER THAN SEWAGE BIOSOLIDS)
FOR UTILIZATION ON AGRICULTURAL LANDS

APPENDIX 2

INFORMATION REQUIRED BY THE BIOSOLIDS UTILIZATION COMMITTEE TO EVALUATE SUITABILITY OF WASTES (OTHER THAN SEWAGE BIOSOLIDS) FOR UTILIZATION ON AGRICULTURAL LANDS

The information requirements in this document apply to all materials other than sewage biosolids which:

1) are designated as "wastes" in the *General - Waste Management Regulation* under the Environmental Protection Act (Regulation 347 of Revised Regulations of Ontario, 1990); and
2) are not exempted from Part V of the Act and that Regulation (i.e. agricultural wastes).

The requirements outlined are those currently in place as of June 1995. Revisions to the requirements are made periodically as new knowledge and understanding is gained of the application of wastes on agricultural land. Therefore, it is important that the user confirm that these requirements still apply. Such confirmation, or a copy of the most recent requirements, can be obtained from local offices of the Ministry of the Environment and Energy (MOEE), or the Ministry of Agriculture, Food and Rural Affairs (OMAFRA).

A proposal to utilize a waste other than sewage biosolids on agricultural land must first be submitted to the MOEE District Office, which is responsible for issuing the required Certificate(s) of Approval and other permits under Part V of the Environmental Protection Act. Ministry staff in that office will review the proposal, and may forward the proposal to the inter-ministry Biosolids Utilization Committee (BUC) for further evaluation. When that evaluation is completed, the BUC will forward its recommendations to the staff in the MOEE District Office.

The information outlined in Sections A and B which follow, is required by the Screening Subcommittee of the BUC, and must be included in each proposal. Review of a proposal by the Screening Subcommittee may identify a need for additional information which must be provided by the proponent. An incomplete proposal may be returned to the proponent.

The proponent should submit two copies of the proposal to the MOEE District Office for use in the evaluation.

SECTION A: TO BE COMPLETED BY ALL PROPONENTS

A.1 JUSTIFICATION

The utilization of a waste on agricultural land must benefit soil quality or crop production, and pose minimal risk to: 1) plant growth; 2) crop quality; 3) long-term land

productivity; 4) public and animal health; and 5) the quality of the environment. Justification for application of the waste on agricultural land, which satisfies these criteria, is therefore required. The proposal also must include confirmation that:

1) the waste will supply plant nutrients; or
2) the waste has value as a soil amendment.

A.2 WASTE/PROCESS DESCRIPTION

The following are required:

1) a description of the specific components of the waste (solid and liquid contents);
2) a description of the industrial or manufacturing process whereby the waste is generated; and
3) any additional information concerning interim stages of processing, chemicals used, subsequent treatment, storage, etc. (which will assist in determining any constituents of the waste that may be of concern).

The proponent should request this information from the waste generator.

A.3 WASTE ANALYSIS

The following waste analyses are required:

1) Analyses for all parameters listed in Table 1 "Analytical Parameters for Waste". Representative analyses of the waste must be conducted by an independent testing laboratory. The analytical information must include the name of the laboratory and an indication of the analytical methods used. A laboratory using analytical methods having method detection limits (MDL'S) within Ministry of the Environment and Energy (MOEE) guidelines is recommended. Wastes of agricultural or similar origin may not require analyses for all parameters listed in Table 1.
2) Additional analytical information for other metals, elements, or organic compounds that may be contained in the waste, but are not identified in Table 1. Such analyses, if not provided by the proponent, may be requested in order to assess the suitability of the waste.
3) A description of the characteristics of the waste, including any by-products generated through decomposition after application to agricultural land.
4) An indication of the quality of the waste, particularly as compared to a product currently utilized for agricultural production (e.g. a fertilizer or liming agent). Details must be provided for the identified product (i.e. manufacturers specifications and/or Material Safety Data Sheet).
5) A description of any non-biodegradable particulate matter that may be contained in the waste (e.g. plastic, glass, pop cans, styrofoam cups, etc.) The size distribution of the particulates should also be provided and the amount reported

as percent (%) solids.

A.4 AGRONOMIC COMMENTS AND RECOMMENDATIONS

All of the analytical data for the waste must be reviewed by an agronomist, and the proposal must include his/her comments or recommendations concerning:

1) the beneficial agronomic effect(s) of the waste;
2) the general suitability of the waste for application on agricultural land;
3) the soil characteristics or conditions which are needed or required to obtain the stated agronomic benefit (i.e. soil texture, soil structure, pH, nutrient levels, etc.);
4) the soil management practices which are necessary to protect soil and water quality (i.e. to avoid surface runoff, soil compaction, or leaching to ground or drainage waters);
5) the maximum application rate(s) relative to the soil characteristics and management practices identified in #3 and #4 above (i.e. maximum rates for specific soil types);
6) the time(s) when the waste should be applied;
7) the agricultural crops which should be grown before and after application;
8) the expected adjustment that will be necessary to the nutrient/fertilizer rate to compensate for nutrients in the waste;
9) the method which should be used to apply the waste (i.e. broadcast, injection, etc.); and
10) the additional measures which are necessary to maintain/protect environmental quality (i.e. avoidance of odour problems, damage to fencerows or headlands, buffer strips).

A.5 OTHER INFORMATION

The proposal should include any other information pertaining to the waste which may assist in the evaluation. Review of the proposal may identify a need for additional information.

SECTION B: TO BE COMPLETED BY ALL PROPONENTS WITH A SPECIFIC SITE

NOTE: THE EVALUATION OF A PROPOSAL WHICH INCLUDES A SPECIFIC SITE, AND THE RESULTING RECOMMENDATION(S), DO NOT CONSTITUTE APPROVAL FOR LAND APPLICATION OF THE WASTE. Approval under Part V of the Environmental Protection Act is required. The local District Office of the Ministry of the Environment and Energy should be contacted for further information on the approval process.

B.1 SITE LOCATION AND MAP

The following site information is required:

1) the site location including county, township, lot and concession; and

2) the total acreage which will be utilized for application.

The property should be identified on a topographical map.

B.2 SITE DESCRIPTION

A description of the land where the waste will be applied is required. The description should include:

1) site drainage including natural drainage patterns and, if applicable, the location, depth, and outlet of any tile drainage installations;

2) separation distances of the land to be utilized from:
   a) surface watercourses;
   b) bedrock outcrops;
   c) neighbouring properties; and
   d) water wells;

3) groundwater quality and flow direction; and

4) a detailed site map showing the above information.

B.3 HISTORY OF SITE USAGE

A brief information summary is required for the site which indicates:

1) the crops which have been grown during the last three years;

2) whether the site has been used previously for waste application (if yes, the summary should include dates of use, type of waste spread, volumes of waste spread and copies of all provisional Certificates of Approval or permits);

3) the current productivity level of the site (annual crop yield in bushels per acre); and

4) the soil amendments which have been or are being used (including quantity, quality and frequency of use for each).

B.4 SOIL ANALYSIS

The following soil analyses for the site are required:

1) Analyses for all parameters listed in Table 2 "Analytical Parameters for Soil". Representative analyses of the soil must be conducted by an independent testing laboratory. The analytical information must include the name of the laboratory and an indication of the analytical methods used. A laboratory accredited by the Ministry of Agriculture, Food and Rural Affairs is recommended.

2) Additional analytical information for metals, elements, or organic compounds that may be present in the soil (i.e. from previous waste applications). Such analyses, if not provided by the proponent, may be requested in order to assess the suitability of waste application.

B.5 AGRONOMIC COMMENTS AND RECOMMENDATIONS

All of the analytical data for the waste and site must be reviewed by an agronomist, and the proposal must include his/her comments and recommendations concerning:

1) the beneficial agronomic effect(s) and suitability of the waste relative to the soil characteristics or conditions of the site (i.e. nutrient benefit, structural benefit, pH benefit, soil microbiological benefit, etc.);

2) the recommended soil management practices for the site which are necessary to protect soil and water quality (i.e. to avoid surface runoff, soil compaction, or leaching to ground or drainage waters);

3) the recommended application rate(s) for the site (with due regard to the soil characteristics and management practices identified in #l and #2 above);

4) the soil loading rates (kg/ha) relative to parameters of concern contained in the waste (i.e. loading rates for heavy metals);

5) the recommended time(s) when the waste should be applied;

6) the recommended agricultural crops which should be grown before and after application;

7) the recommended adjustment in the nutrient/fertilizer rate which is necessary to compensate for nutrients in the waste;

8) the recommended method for application of the waste (i.e. broadcast, injection, etc.); and

9) the recommended additional measures to be carried out at the site to maintain/protect environmental quality (i.e. avoidance of odour problem, damage to fencerows or headlands, buffer strips, or contingency plans for potential spills near watercourses).

B.6 WASTE STORAGE

A description of the waste storage method (i.e. lagoon, stockpile), including storage duration and location, should be included in the proposal. Storage of waste can impact the quality of the material in addition to creating a potentially odorous situation. Therefore, evidence that storage will not significantly impact the quality of the waste or environment must also be provided. The proposed storage methods must take into account:

1) the amount of waste generated from the operation;

2) the storage capacity relative to the time periods when the waste can be applied:
   a) without damaging crops or impairing their quality;
   b) without runoff carrying the waste and/or the nutrients contained in the waste from the application site(s);
   c) without causing undue soil compaction, having regard to the application methods to be used; and

3) the control and prevention of discharges (i.e. odours) into the atmosphere, as regulated under Part 11, Section 9 of the Environmental Protection Act.

B.7 WASTE INCORPORATION METHODS

A description of the following is required:

1) the methods proposed to incorporate the waste materials; and

2) the scheduling for waste application and agricultural operations. This will include the specific months when the waste will be applied, the daily hours of operation, and the soil conditions under which incorporation will take place.

B.8 OTHER INFORMATION

The proposal should include any other information pertaining to the waste and site which may assist in the evaluation. Review of the proposal may identify a need for additional information.

Table 1: Analytical Parameters for Waste [1]

WASTE ANALYSES[2]					
1A	Chemical/Physical Properties:				
	1) Total solids content :	% as is basis			
	2) Total organic carbon :	% solids basis			
	3) Electrical conductivity :	mS/cm			
	4) pH :	measured in saturated paste for solid wastes; as is for liquid wastes			
	5) Non-biodegradable particulate matter : (rubber, metal, plastic, and other)	% solids basis of each type; and size distribution of each type			
1B	Mineral Content: (% solids basis)				
	1) Nitrogen :	Kjeldahl-N; and 2M KCl extractable Ammonium-N and Nitrate-N			
	2) Phosphorus :	Total			
	3) Calcium :	Total and 1M NH_4Ac extractable			
	4) Magnesium :	Total and 1M NH_4Ac extractable			
	5) Potassium :	Total and 1M NH_4Ac extractable			
	6) Sodium :	Total and 1M NH_4Ac extractable			
1C	Metals:(mg/kg, solids basis)				
	Required			Optionl[3] (waste/process dependent)	
	Arsenic	Copper	Nickel	Antimony	Tellurium
	Cadmium	Lead	Selenium	Beryllium	Vanadium
	Cobalt	Mercury	Zinc	Silver	Boron
	Chromium	Molybdenum			
1D	Organics:				
	1) Fats, oils, and greases[3,4] (FOG) :	Total, mg/kg; gravimetric, dichloromethane extraction for wastes which do not contain petroleum hydrocarbons; Total and separates, mg/kg; spectrophotometric, dichloromethane extraction followed by infrared determination for wastes which contain petroleum hydrocarbons			
	2) Other organic compounds[3] :	mg/kg			
1E	Miscellaneous:				
	1) Acid Leachate Test:	mg/L; as per Schedule 3 of Regulation 347 under the Environmental Protection Act			
	2) Chloride[3] :	mg/kg, solids basis; water extraction followed by Ion Selective Electrode or Ion-chromatography			
	3) Other elements[3] :	mg/kg; solids basis			

[1] Analyses for all of the parameters listed may not be necessary depending on the waste characteristics, waste generation process, or history of site usage. Justification should be provided if analysis is not carried out for certain parameters.

[2] All analytical methods used, Method Detection Limits (MDL), and QA/QC procedures must be specified in the proposal.

[3] As deemed necessary by waste characteristics, waste generation process, or history of site usage;

[4] Includes mineral oils, vegetable oils, animal fats, waxes, soaps, greases, and all related matter.

Table 2: Analytical Parameters for Soil

	SOIL ANALYSES	
2A	Agricultural Soil Test:	
	Standard soil test as per OMAFRA guidelines' for:	
	1) Phosphorus	ppm; sodium bicarbonate extractable
	2) Potassium	ppm; ammonium acetate extractable
	3) Magnesium	ppm; ammonium acetate extractable
	4) soil pH	measured in saturated paste;
	5) soil buffer pH	measured in soil-buffer suspension using S.M.P.[2] buffer solution
2B	Lime and Nitrogen Requirements for Crops:	
	Lime requirements:	tonnes/ha; as determined from standard agricultural soil test
	Nitrogen requirements:	kg/ha; based on nitrate-N as determined from standard agricultural soil test, or recommendation tables in OMAFRA Publication 296
2C	Metals (mg/kg, solids basis)	
	As deemed necessary by waste characteristics, waste generation process, or history of site usage.	

[1] As established by the Ontario Soil Management and Research Services Committee.
[2] S.M.P. = Shoemaker, McLean and Pratt (1961).

APPENDIX 3

METALS OF CONCERN IN ONTARIO SOILS:

A SYNOPSIS OF BACKGROUND INFORMATION

APPENDIX 3

METALS OF CONCERN IN ONTARIO SOILS: A SYNOPSIS OF BACKGROUND INFORMATION

Metals in Ontario Waste materials

Metal concentrations in Ontario waste materials varies widely. Metals such as Cu (copper), Mo (molybdenum), and Zn (zinc) are required by both plants and animals; in addition, Co (cobalt), Cr (chromium) and Se (selenium) are required by animals. All of these elements, along with As (arsenic), Cd (cadmium), Hg (mercury), Ni (nickel) and Pb (lead) can be toxic to plants or animals, at certain concentrations.

The level at which these metals become toxic varies from soil to soil and has not been firmly established. Metals such as copper, zinc, selenium and cobalt should be widely distributed and not concentrated on a few fields or farms. Other metals such as Ag (silver), Au (gold), Be (beryllium), Bi (bismuth), Pt (platinum), Sb (antimony), Sn (tin), Te (tellurium), and Ti (titanium) may also be toxic to plants and animals. However, research has indicated that these materials are unlikely to cause problems when biosolids are used under Ontario conditions.

When metals have entered the soil they leach very little. Field crops normally remove less than 0.4 kg per hectare per year, of any of the toxic metals from the soil. Therefore, to prevent toxic effects, soil metal concentrations must be kept at an acceptable level. This document includes criteria to guard against metals concentrations from building up to toxic levels in soils.

Acceptable Accumulations of Metals in Soil

Average metal concentrations in Ontario soils have been determined. Metal uptake by growing plants has not been closely correlated with total metal concentrations in soils. Metal uptake varies, depending upon the crop grown, soil pH, soil organic matter, and clay content, soil aeration and the concentrations of nutrients and metals. Consequently over a period of years, uptake rates will vary.

The total metal concentration in the plough layer seems, at this time, to be the most appropriate criterion for establishing limits for metal additions to soils. The maximum recommended metal concentrations (see Table 2 in the 1996 Guidelines for the Utilization of Biosolids and Other Wastes on Agricultural Land), take into account, the average metal concentrations in Ontario soils and other criteria as follows:

a. Arsenic and Nickel

The recommended maximum for these metals was set at only twice the Ontario average because of the known toxic effects of higher levels on plants.

b. Cadmium

The recommended maximum was set at only twice the Ontario average because cadmium's availability to plants is greater than that of other metals and because humans and animals have a low cadmium tolerance.

c. Cobalt, Copper, Selenium, and Zinc

Because some Ontario feed crops are deficient in these metals, recommended maximums were set at four times the Ontario averages, to allow for some soil build up. Copper and zinc are toxic to plants at high concentrations and selenium has a narrow acceptable range in animal feeds.

d. Chromium, Mercury and Lead

These metals are toxic to animals and humans and are not required by plants. Plants take up these metals less readily than other metals. Therefore, the Guidelines permit higher concentrations of these metals relative to the average content of Ontario soils, than of other metals. Although chromium is not required by plants, it has been found to be essential for animals in low concentrations and it may be deficient in human food.

e. Molybdenum

The recommended level of accumulation was set at only twice the Ontario average because molybdenum leaches more from well drained soils than do other metals. On one recorded occasion, molybdenum caused toxicity problems for Ontario livestock.

f Aluminum, Boron, Calcium, Iron, Manganese, Potassium, Sodium, and Sulphur

No recommendations have been made, because biosolid application is not expected to cause concentrations to become critical under Ontario conditions.

APPENDIX 4

REFERENCE PUBLICATIONS

APPENDIX 4

REFERENCE PUBLICATIONS

A. Relevant Legislation

Copies of legislation may be obtained from the Ministry of Government Services for a nominal charge, at 880 Bay Street, Toronto, Ontario M5S 1Z8. The Ontario Government Bookstore - first floor - telephone: (416) 326-5300 handles both direct sales and mail orders.

The Ontario Water Resources Act

This Act provides for the control and protection of quality and quantity of surface and ground waters. It is administered by the Ministry of Environment and Energy.

The Environmental Protection Act

This Act prohibits the contamination of the natural environment and provides for environment preservation and improvement. It is administered by the Ministry of Environment and Energy. Ontario Regulation 347, which establishes standards for waste disposal and utilization sites, is issued pursuant to this Act.

The Environmental Assessment Act

This Act provides for the environmental assessment of undertakings carried out by provincial and municipal agencies. It is administered by the Ministry of Environment and Energy.

The Planning Act

This Act provides for orderly planning of the development and use of lands in the province. It is administered by the Ministry of Municipal Affairs and Housing.

B. MOEE Publication

MOEE Fact Sheet: Application of Sewage Sludge to Agricultural Land (PIBS 608b)

This is obtainable from MOEE's Public Information Centre at 1-800-565-4923.

Guide to Applying for a Certificate of Approval to Spread Sewage and Other Biosolids on Agricultural Land (Organic Soil Conditioning)

This is obtainable from your local MOEE office (see Appendix 6).

C. OMAFRA Publications

Copies of these documents may be obtained from the OMAFRA offices listed in Appendix 5.

Publication 29:	Drainage Guide for Ontario
Publication 296:	Field Crop Recommendation
Publication 360:	Fruit Crop Recommendation
Fact Sheet AGDEX 540:	Land Application of Sewage Biosolids for Crop Production
Report	Analytical Results, Findings, and Recommendations of the 1995 OMAFRA Sewage Biosolids Field Survey

D. Other Publications

Class Environmental Assessment for Municipal Water and Wastewater Projects. June 1993: Contains criteria for Municipal Sewage Treatment Plants.

This document is available through the Municipal Engineers Association.

APPENDIX 5

MINISTRY OF AGRICULTURE, FOOD AND

RURAL AFFAIRS OFFICES

APPENDIX 5: MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS OFFICES

SOUTH REGION

Location	Telephone No. (Fax No. in brackets)	Address
Chatham	519 354-22150 (519/354-8842)	Box 726, 435 Grand Ave. W. Chatham N7M 5L1
Essex	519 776-7361 (519/776-8028)	46 Fox St. Essex N8M 2S2
Fenwick	905 892-4741 (905/892-1472)	726 Canboro Rd. Fenwick L0S 1C0
Komoka	519 473-6480 (519/473-6431)	100 Enterprise Dr. Unit 7, R.R.3 Komoka N0L 1R0
Petrolia	519 882-0180 (519/882-3406)	Box 730, 360 Highway #21 Petrolia N0N 1R0
St. Thomas	519 631-4700 (519/631-8784)	Box 2027, RR#5 County Road 45 St. Thomas N5P 3X1
Simcoe	519 426-7120 (519/428-1142)	Box 587 Agricultural Bldg, Blue Line Rd. Simcoe N3Y 4N5
Vineland	905 562-4147 (905/562-5933	Advisory Services Building Victoria Ave. N. Vineland Station L0R 2E0

CENTRAL & NORTH REGION

Location	Telephone No. (Fax No. in brackets)	Address
Barrie	705 725-7288 (705/725-7296)	Cedar Hill Plaza, 449 Dunlop St. W., Barrie L4N 1C3

Dryden	807 223-8502 (807/223-8502)	28A Earl Avenue Dryden P8N 1X5
Emo	807 482-2310 (807/482-2864)	Box 210, Front St. Emo P0W 1E0
Georgetown	905 873-9930 (905/873-9934)	332 Guelph St. Georgetown L7G 4B5
Gore Bay	705 282-2043 (705/282-2792)	Box 328, Meridith Eleanor Sts. Gore Bay P0P 1H0
Huntsville	not available at time of printing	
Kapuskasing	705 335-5828 (705/337-6597)	Box 160 Experimental Farm West Riverside St. Highway #11 Kapuskasing P5N 2X9
New Liskeard	705 647-6701 (705/647-6297)	Box G, New Liskeard College of Agricultural Technology Highway #11B North New Liskeard, P0J 1P0
North Bay	705 474-3050 (705/472-0882)	1500 Fisher St. Ste 201 Northgate Sq. North Bay P1B 2H3
Orangeville	519 941-3830 (519/941-5689)	R.R.4, Mono Plaza Highway #10 North Orangeville L9W 2Z1
Port Perry	905 985-2003 (905/985-9599)	60 Van Edward Dr. Port Perry L9I 1G3
Sault Ste. Marie	705 253-1161 (705/253-8777)	Heritage Corner 341 Trunk Road Sault Ste. Marie P6A 3S9
Sudbury	705 566-1630 (705/566-8166)	1899 LaSalle Blvd. Sudbury P3A 2A3

Thunder Bay	807 475-1631 (807/475-1219)	Ontario Govt. Bldg. 435 James St. S., Suite 333, Thunder Bay P7E 6E3

WEST REGION

Location	Telephone No. (Fax No. in brackets)	Address
Clinton	519 482-3428 (519/482-5031)	Box 159, 100 Don St. Clinton N0M 1L0
Duff's Corners	905 527-2995 (905/648-6817)	RR# 1, 1151 Highway 53 W., Ancaster L9G 3K9
Fergus	519 846-0941 (519/846-8178)	R.R. 1 , Wellington Place County Rd. #18 Fergus NIM 2W3
Markdale	519 986-2040 (519/986-3014)	181 Toronto St. South Markdale N0C 1H0
Stratford	519 271-0280 (519/273-5278)	581 Huron St. Stratford NSA 5T8
Walkerton	519 881-3301 (519/881-2739)	220 Trillium Court, R.R.#3 Walkerton N0G 2V0
Woodstock	519 537-6621 (519/539-5351)	P.O.Box 666, Highway #59 North Woodstock N4S 7Z5

EAST REGION

Location	Telephone No. (Fax No. in brackets)	Address

Alfred not available at time of printing

Avonmore	613 346-2143 (613/346-2689)	Box 97, Centennial Drive Avonmore K0C 1C0

PLEASE CHECK THE BLUE PAGES OF YOUR TELEPHONE BOOK UNDER THE GOVERNMENT OF ONTARIO FOR CURRENT INFORMATION.

Brighton	613 475-1630 (613/475-3835)	Box 8200, 95 Dundas St. Brighton K0K 1H0
Brockville	613 342-2124 (613/342-1886)	Box 635, 333 California Unit 15 Brockville K6V 5H8
Kemptville	613 258-8295 (613/258-8392)	Box 2004, Provincial Govt. Bldg. Concession Rd. Kemptville K0G 1J0
Kingston	613 545-4360 (613/545-9147)	Box 651, 1055 Princess St. Kingston K7L 4X1
Lindsay	705 324-6125 (705/324-1638)	322 Kent St. W. Lindsay K9V 2Z9
Napanee	613 354-3371 (613/354-3267)	41 Dundas St. W Napanee K7R 1Z5
Nepean	613 828-9167 (613/828-6083)	26 Thorncliffe Pl. Nepean K2H 6L2
Perth	613 267-1063 (613/267-2264)	10 Sunset Blvd. Perth K7H 2Y2
Peterborough	705 745-2403 (705/745-6657)	55 George St. N. Peterborough K9J 3G2
Picton	613 476-3224 (613/476-3370)	Box 470, Highway #33 West Picton K0K 2T0
Renfrew	613 432-4841 (613/432-7845)	315 Raglan St. S. Renfrew K7V 1R6
Stirling	613 395-3393 (613/258-0739)	Box 340, 234 North St. Stirling K0K 3E0
Winchester	613 774-2313 (613/774-3283)	Box 488, 457 Main Winchester K0C 2K0

APPENDIX 6

MINISTRY OF ENVIRONMENT AND ENERGY

REGIONAL AND DISTRICT OFFICES

APPENDIX 6
Ministry of Environment and Energy - Regional and District Offices

Central Region

Halton - Peel District Office
1235 Trafalgar Road, #401
Oakville, ON L6H 3P1
Tel:(905) 844-5747
Fax:(905) 842-1750

Central Region and Metro Toronto District Offices
5775 Yong St., 4th Floor
North York, ON M2M 4J1
Tel:(416) 424-3000
Fax:(416) 325-6345

York-Durham District Office
230 Westney Rd. S., 5th Floor
Ajax, Ontario L1S 7J5
Tel: (905) 427-5600
Fax:(905) 427-5602

West Central

Cambridge District Office
P.O. Box 219
320 Pinebush Road
Cambridge, ON NIR 5T8
Tel:(519) 622-8121
Fax:(519) 622-3119

West Central Region and Hamilton District Offices
Box 2112
119 King St. W., 12th Floor
Hamilton, ON L8N 3Z9
Tel:(905) 521-7650
Fax:(905) 521-7806

Welland District Office
637-641 Niagara St. N.
Welland, ON 13C 1L9
Tel:(905) 685-2658
Fax:(905) 732-4850

Mid-Ontario Region

Barrie District Office
54 Cedar Point Drive, Unit 1203
Barrie, ON L4N 5R7
Tel:(705) 726-1730
Fax: (705) 726-5100

Muskoka Haliburton District Office 483 Bethune Dr. N.
Gravenhurst, ON P1P 1B8
Tel:(705) 687-6647
Fax:(705) 687-3715

North Bay District Office
Northgate Plaza
1500 Fisher St.
North Bay, ON P1B 2H3
Tel:(705) 476-1001
Fax: (705) 476-0207

Mid-Ontario Region and Sudbury District Offices
199 Larch St., 11th Floor
Sudbury, ON P3E 5P9
Tel: (705) 675-4501 F
Fax:(705) 675-4180

Eastern Region

Belleville District Office 470 Dundas St. E.
Belleville, ON K6H 1C1
Tel:(613) 962-9208
Fax:(613) 962-6809

Cornwall District Office
105 Amelia St.
Cornwall, ON K6H 3P3
Tel:(613) 933-7402
Fax:(613) 933-6402

Eastern Region and Kingston District Offices
133 Dalton St.
Kingston, ON K7K 6C2
Tel:(613) 549-4000
Fax:(613) 548-6920
Fax:(807) 475-1754

Ottawa District Office
2435 Holly Lane
Ottawa, ON K1V 7P2
Tel:(613) 521-3450
Fax:(613) 521-5437
Fax: (705) 264-7336

Peterborough District Office
1477 Lansdowne St. W.
Peterborough, ON K9J 7M3
Tel:(705) 743-2972
Fax: (705) 748-4192

Southwestern Region

Southwestern Region and London District Offices
985 Adelaide St. S.
London, ON N6E 1V3
Tel:(519) 661-2200
Fax:(519) 661-1742

Owen Sound District Office
1180 - 20th St. E.
Owen Sound, ON N4K 6116
Tel:(519) 371-2901
Fax:(519) 371-2905

Sarnia District Office 1094 London Road
Sarnia, Ontario N7S 1P1
Tel:(519) 336-4030
Fax:(519) 336-4280

Windsor District Office

250 Windsor Ave., 6th Floor
Windsor, ON N6A 6V9
Tel:(519) 254-2546
Fax:(519) 254-5894

Northern Region

Kenora District Office
P.O. Box 5150
808 Robertson St.
Kenora, ON P9N 1X9
Tel: (807) 468-2718
Fax: (807) 468-2735

Sault St. Marie District Office
747 Queen St.
Sault Ste. Marie, ON P6A 2A8
Tel: (705) 949-4640
Fax: (705) 945-6868

Northern Region and Thunder Bay District Offices
P.O. Box 5000
435 James St. S., 3rd Floor
Thunder Bay, ON P7C 5G6
Tel: (807) 475-1205
Fax: (807) 475-1754

Timmins District Office 83 Algonquin Blvd. W.
Timmins, ON P4N 2R4
Tel: (705) 268-3222

APPENDIX 7

FACTORS FOR CONVERSION OF

METRIC UNITS TO IMPERIAL UNITS

APPENDIX 7

FACTORS FOR CONVERSION OF METRIC UNITS TO IMPERIAL UNITS

Metric Units	Approximate Conversion Factor	Imperial Units
	Linear	
centimetre (cm)	x 0.39	inch
metre (m)	x1.1	yard
kilometre (m)	x 0.62	mile
	Area	
hectare (ha)	x 2.5	acre
	Volume	
cubic metre (m^3)	x 1.3	cubic yard
litre (L)	x 0.22	gallon
	Weight	
Kilogram (kg)	x 2.2	pound
	Application of Units	
cubic metres per hectare (m^3/ha)	x 89	gallons per acre
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	pounds per acre