CHAPER 6 METRIC CONVERSIONS

Metric	Imperial Equivalent
3 m	10 feet
5 m	16.5 feet
8 m	26 feet
10 m	32 feet
30 m	100 feet
30.5 m	100 feet
122 m	400 feet
50 m^3/ha	4,500 gal/acre
50 tonnes/ha	22 tons/acre
300 µg/ml	300 ppm
15 µg/g	15 ppm
20 µg/g	20 ppm
30 µg/g	30 ppm
45 µg/g	45 ppm
50 kg/ha	45 lbs/acre
150 kg/ha	135 lbs/acre
200 kg/ha	180 lbs/acre
300 kg/ha	270 lbs/acre

Conversions in this table are rounded to a convenient number.
See Appendix E for exact conversion factor.

Values from tables and examples are not included in Metric Conversions

CHAPTER 6 TABLE OF CONTENTS

CHAPTER **6**

NUTRIENT APPLICATION

INTRODUCTION

This chapter discusses nutrient management practices for protection of the environment. It contains introductory information on the relationship between nutrient sources used in agriculture and the environment. It also contains information on environmental concerns, legislation, and beneficial management practices related to:

- Application of nutrient sources, including fertilizers and soil amendments.
- Nutrient management planning.

NUTRIENT SOURCES AND THE ENVIRONMENT

- The primary role of fertilizers and soil amendments is to provide nutrients for crop growth or to provide materials for soil improvement. Misuse of fertilizers and soil amendments can result not only in damage to crops but can also cause negative impacts on the receiving soil, water, air, or habitat environment. Pertinent environmental subjects related to soil amendments are listed in alphabetical order below.

Amendments

For the purposes of this publication, soil amendments are distinguished from commercial fertilizers and broadly defined as materials applied to soil for the purpose of supplying nutrients or improving soil characteristics. How an amendment is managed will depend on the characteristics of the material itself.

Note: The term "soil amendment" as defined in the *Code of Practice for Soil Amendments* refers to specific materials (Table 6.5) which must be managed in accordance to the AEM Code. The term "soil amendment" is used in this Chapter in a much broader sense.

➔ see Legislation, **page 6-4**

Legumes and Nitrogen Fixation

Legume crops form associations with soil bacteria which provide a source of nitrogen for the plants. The rhizobium bacteria colonize the plant roots in nodules, and carry out nitrogen fixation, where atmospheric nitrogen is transformed into plant available nitrogen.

When innoculated and colonized by the correct rhizobium bacteria, legumes are less dependent on nitrogen from the soil or in amendments. However, legumes will take up nitrogen from the soil if it is available, therefore the use of on farm nutrient sources like manure can still provide benefit to the crop when applied at the correct rate.

Micronutrients and Metals

Common sources of micronutrients and metals are manure and chemical fertilizer. Some metals are plant micronutrients while some can become contaminants (toxic to soil microorganisms or plants). The availability of these elements varies, depending on soil type and soil pH.

Value of Micronutrients and Metals in Manure. The major micronutrients and metals found in manure are iron, manganese, boron, chlorine, zinc, copper and molybdenum. Under both neutral soil pH and average organic matter conditions, most micronutrients in manure are available to the crop. Soil pH webpage

Micronutrients and Metals as Contaminants. Some micronutrients and metals can pollute the soil if found at excessive levels. At high levels, necessary trace elements such as boron, zinc, and chromium may be of concern for plant growth. Some metals, which are not plant nutrients, can be toxic to plants when applied in excess. These include arsenic, lead, and cadmium..

Nitrogen (N)

Common sources of nitrogen are manure, chemical fertilizer and nitrogen-fixing plants like legumes and legume residues. Nitrogen is contained in a variety of agricultural by-products and other materials.

Value of Nitrogen in Manure. Manure contains nitrogen in both the inorganic and organic forms. Until the organic matter is biologically decomposed in the soil, nitrogen in the organic form remains unavailable for plant use. Nitrogen in this form exists as a reserve in the soil and is slowly released for plant use. Soil microbes must decompose the organic nitrogen compounds in manure before they are available to plants. A proportion of the nitrogen that enters the soil following application is available during the year of application. Most of the remaining nitrogen becomes available within the five years following application.

Livestock manure loses some inorganic nitrogen in the barn and during storage as ammonia by volatilization to the atmosphere. When manure is spread onto land for crop production, some of the remaining inorganic nitrogen may also be subject to volatilization losses, particularly if not incorporated into the soil.

Nutrient Source

The term "nutrient source" as defined in the *Code of Practice for Agricultural Environmental Management* refers to sources of nitrogen or phosphorus which must be managed in accordance to the AEM Code.

Materials which may be considered nutrient sources include: fertilizers and soil conditioners, agricultural by-products, compost produced through agricultural composting or materials produced in accordance with the *Organic Matter Recycling Regulation*, soil amendments as defined in the *Code of Practice for Soil Amendments*, digestates from anaerobic digesters, wastewater, irrigation water, and reclaimed water.

➔ see Legislation, **page 6-4**

Particle Size

The particle size of materials used as soil amendments affects the efficiency of their utilization in soil and their impact on the environment. Fine particle sized materials such as sawdust can easily be incorporated into the soil and decompose rapidly in comparison to coarser materials such as wood chips. The more rapidly an amendment decomposes, the sooner nutrients from that material are made available for plant uptake.

Particle size can also play a role in the loss of soil amendments from fields. Smaller particles are easily suspended in water or wind and are therefore carried away by runoff or erosion

Phosphorus (P)

Common sources of available phosphorus are manure and chemical fertilizer. The expression of phosphorus concentrations and rates is often confusing and can lead to serious calculation errors. Refer to **Table 6.1**, below.

TABLE 6.1 Phosphorus: Converting P to/from P_2O_5

- phosphorus content in soil or plant material, either total or plant-available form, is often expressed in terms of elemental phosphorus (P)
- phosphorus application rates for commercial fertilizers are given in terms of P_2O_5 (phosphate)
- the conversion factors are:

P_2O_5 = P x 2.291

P = P_2O_5 x 0.436

Phosphorus is contained in a variety of agricultural by products and other materials.

Value of Phosphorus in Manure. While most phosphorus contained in manure is in the inorganic form, it is the remaining organic form that is the most available. Availability is dependent on the rate at which soil organisms break down organic matter and release plant available phosphorus.

Phosphorus is normally bound strongly by soil particles and therefore not readily available to plants, in mineral soils. The ability of soils to bind phosphorus varies based on certain soil properties. For example, phosphorus is generally bound more than two times as tightly in Fraser Valley soils in comparison to Okanagan soils, due to differences in soil pH, geology, and soil characteristics. In situations where soil phosphorus levels are high, more than 70% of the phosphorus in manure may be available to plants in the year of application. In contrast, on soils with low soil phosphorus levels, less than 70% of the phosphorus in manure may be available to plants in the year of application.

Although manure phosphorus adds to the soil's reserve of organic phosphorus, the availability of phosphorus is low in the early spring when phosphorus uptake may be important for plant growth. This is because phosphorus availability depends on the rate at which soil microbes break down organic matter and release plant-available phosphorus, which depends on favourable soil temperature and moisture.

Potassium (K)

Common sources of potassium are manure and chemical fertilizer. The expression of potassium concentrations and rates is often confusing and can lead to serious calculation errors. Refer to **Table 6.2**, below.

TABLE 6.2 Potassium: Converting K to/from K_2O

- potassium content is often expressed in terms of elemental potassium (K)
- potassium application rates for commercial fertilizers are given in terms of K_2O (potash)
- the conversion factors are:
  K_2O = K x 1.205
  K = K_2O x 0.83

Value of Potassium in Manure. All potassium in manure is available immediately after application.

pH

Soil amendments have varying influences on soil pH. Many inorganic fertilizers, particularly nitrogen and sulfur based fertilizers, have an acidifying effect. Potassium and phosphorus-based fertilizers have a neutral effect on soil pH. However, phosphoric acid, a phosphorus-based fertilizer, has an acidifying effect. Organic-based soil amendments such as manure have a high buffering capacity and therefore have a neutral or alkaline effect on soil pH.

Salts

Most soil amendments contain salts. The salt content will vary depending on the nature of the amendment. Manure, for example, contains between 10% and 13% salts on a dry weight basis. Composted manure is characterized by higher concentrations. The presence of salt in manure is often directly related to nutrient concentrations within livestock feed.

Excess application of amendments onto land can lead to negative impacts on soil quality and crop production caused by salt effects alone. Salt levels are gauged by a manure's or soil's electrical conductivity. Salt content in soil can also be expressed as exchangeable sodium percent.

In areas of low precipitation, high annual doses of manure can adversely affect many crops by increasing soil salinity. In areas of high precipitation, salts may cause short-term problems until they are leached from the root zone.

Secondary Nutrients

Calcium (Ca). Common sources of calcium are lime, poultry manure and some chemical fertilizers.

Magnesium (Mg). Common sources of magnesium are dolomite lime, magnesium sulfate (i.e., Epsom salts) and some chemical fertilizers.

Sulphur (S). Manure and many chemical fertilizers are a source of sulphur.

SOIL AMENDMENTS: IS IT A NITROGEN SOURCE OR A SOIL CONDITIONER?

The characteristics of a soil amendment will determine how the material should be managed. A major distinction among soil amendments is the release rate of nitrogen from the material after it is applied to the soil.

All other factors being equal, a soil amendment that releases nitrogen quickly in soil (nitrogen source) poses a higher degree of nitrate leaching risk than a soil amendment in which the nitrogen releases slowly in soil (soil conditioner). The purpose of this section is to provide information that will assist in making decisions about whether a soil amendment should be used primarily as a nitrogen source or as a soil conditioner.

Soil Amendment Sources

Numerous soil amendment sources are available to producers. These materials may or may not come from the farm.

On-Farm Sources. These amendments are typically agricultural by-products and include bedding, compost, crop residue, manure, silage juice, spoiled feed, washwater, spent soilless media, spent mushroom media, and spent nutrient solution. Table 6.4 describes various sources of on-farm soil amendments

Off-Farm Sources. These are usually purchased and include chemical conditioners such as lime, soilless media constituents such as perlite, manure from other farms, compost, wood residue, and non-agricultural by-products such as municipal biosolids. Table 6.5 describes various sources of off-farm soil amendments.

Manage as a Nitrogen Source or as a Soil Conditioner?

Specific soil amendments have inherent characteristics that determine whether they are to be used primarily as a nitrogen source or as a soil conditioner.

Nitrogen Source. Some organic materials, such as manure or composts, that are added to soil will result in a release of mineral nitrogen which may be taken up by plants, stored in the soil, or lost to the environment. The primary goal of applying these materials is to provide available nitrogen which contributes to or meets a crop's nitrogen requirement.

Organic materials that are classified as nitrogen sources have a carbon-to-nitrogen ratio of less than 30:1. Table 6.3, next page, outlines criteria based on the carbon-to-nitrogen ratio for determining whether soil amendment materials should be managed as a nitrogen source or soil conditioner.

Soil Conditioners. These are materials that provide limited amounts of nitrogen, but are managed primarily for their beneficial impact on the biological, physical, or chemical nature of the soil. Soil conditioners can be organic such as compost or wood residue or inorganic such as lime or perlite..

Certain materials have properties that allow them to be used as both a nitrogen source and a soil conditioner. If this is the case, they should be managed primarily as a nitrogen source.

Organic soil conditioners typically have high levels of organic matter but are not an immediate or significant source of plant-available nitrogen and have a carbon-to-nitrogen (C:N) ratio greater than 30:1. Addition of soil amendments with a high C:N ratio may result in crop-available nitrogen being tied up (immobilized). Nutrients will be temporarily tied up in the soil, unavailable for plant use unless nitrogen is added to the soil to decrease the C:N ratio.

Case Study: Use of Poultry Manure on Berry Fields. Poultry manure has been used in the replanting of berry fields. The raw manure provides benefits of a soil conditioner, including the addition of organic matter. However, poultry manure is a nitrogen source, and the first-year berry plants have a low nitrogen requirement. Consequently, much of the nitrogen in the poultry manure is not used and at high risk of being leached, even at application rates as low as 10 yards^3/acre (20 m^3/ha). To minimize this risk, use alternate sources of organic matter with lower nitrogen levels, compost the poultry manure before application, or limit the amount of poultry manure being used. Calculate the nitrogen availabile from applications of manure or compost:

Nutrient Management Calculator web page

TABLE 6.3 Management of Soil Amendments Based on Carbon-to-Nitrogen Ratio

C:N ratio	Management Recommendations
Less than 20:1	Manage as a nitrogen source
Between 20:1 and 30:1	Material has properties of a nitrogen source and a soil conditioner but should be managed primarily as a nitrogen source
Greater than 30:1	Manage as a soil conditioner

Neither a Nitrogen Source or a Soil Conditioner Some products, such as vegetable washwater, have very little or no value as a nitrogen source or soil conditioner, causing any application of such material to be for disposal purposes. Such products require ENV authorization.

➔ see Farm Waste, **page 2-19**

Accumulation of Soil Phosphorous

Soil conditioners present a lower risk of nitrogen loss compared to nitrogen sources. However, soil conditioners, particularly if produced from animal manures (e.g., composted manure), may still contain significant amounts of other nutrients, including phosphorus (P). The accumulation of P in soil eventually leads to small but potentially significant amounts of P that may leave the fields via runoff, erosion or drainage water that flows through subsurface tile drains. Applying the right rate principles in the Beneficial Management Practices section of this chapter can mitigate long-term risks of P losses from soil and prevent water quality challenges downstream of the farm.

➔ see Right Rate, **page 6-17**

Contaminants in Soil Amendments

Soil amendments can have salt, pH or metal levels that will cause soil pollution. Before bringing any non-agricultural waste onto a farm operation, be aware of any regulations or restrictions related to the use of these materials. For all soil amendments, determine the biological, chemical or physical properties of the materials and determine before hand if they can be used beneficially on the farm.

➔ see Soil Contamination, **page 8-15**

Producers should be aware of the provisions of the federal *Fertilizers Act* and *Fertilizers Regulations* as they relate to the quality of fertilizers and supplements (note the definition of supplement in the Act is less inclusive than this publication's definition of soil conditioner). Any products bought or sold in Canada where a claim is being made as to the contents of the product to supply plant nutrients, aid in plant growth, or improve the physical condition of soil are required to be registered under the Act. The *Fertilizers Act* and *Fertilizers Regulations* require that all regulated fertilizer and supplement products must be effective and safe for humans, plants, animals, and the environment. They must also be properly labeled. For farms operating anaerobic digesters and importing off-farm products to supplement their energy production, please refer to the following resources:

- An Overview of On-Farm Biogas Production
- BC On-Farm Anaerobic Digestion Benchmark Study
- Biogas Association of BC

TABLE 6.4 Managing On-Farm Soil Amendment Sources as a Nitrogen Sources or Soil Conditioners

Soil Amendment Source	Managed Primarily as		Comments (check nutrient content before land application)
	Nitrogen Source	Soil Conditioner	
Bedding ▪ With little or no manure.	x	✓	▪ Low nutrients.
Building Drains ▪ Floor or roof.	x	x	▪ Check chemistry of water.
Compost	✓	✓	▪ Characterized by slow nutrient release, ▪ Often applied as both a nitrogen source and soil conditioner.
Contaminated Surface Runoff ▪ Water from yards, corrals.	✓	x	▪ Low in nutrients, ▪ Usually incorporated with liquid manure.
Crop Residue ▪ Green leaves or stems, ▪ Dry (i.e. straw or prunings).	✓ x	x ✓	▪ Characterized by variable nutrient levels and C:N ratios.
Inert Growing Media ▪ Rockwool.	x	x	➔ Farm Waste, **page 2-19**
Leachate ▪ From manure, compost, ▪ Or wood residue.	?	x	▪ Usually incorporated with liquid manure, ▪ Variable nutrient levels, ▪ Normally acidic and high Biochemical Oxygen Demand (BOD).
Manure – Liquid	✓	x	▪ Variable nutrient levels.
Manure – Solid ▪ Includes bedding containing significant amount of manure.	✓	✓	▪ Normally a nitrogen source but may be used as a soil conditioner if low in nutrients and if C:N ratio greater than 30:1.
Milking Centre Wash Water	✓	x	▪ Low in nutrients, ▪ Usually incorporated with liquid manure.
Mortalities ▪ Composted, ▪ Not composted.	✓ x	✓ x	▪ Handle as a compost (see above). ➔ Livestock Mortality Disposal, **page 3-49**
Silage Effluent	✓	x	▪ High nutrients and very high BOD.
Used Mushroom Growing Media	✓	✓	▪ Variable nutrient levels, ▪ Normally a nitrogen source but may be used as a soil conditioner if low in nutrients and if C:N ratio greater than 30:1.
Spent Nutrient Solution	✓	x	▪ Variable to low nutrient levels.
Spent Soilless Media ▪ Peat/wood residue based.	x	✓	▪ Variable nutrient levels.
Spoiled Feed	x	✓	▪ Variable nutrients levels, high BOD.
Wash water ▪ From washing and grading fruit and vegetables.	x	?	▪ Low in nutrients but may contain silt, chemical contaminants or high BOD. ▪ Apply at rates not exceeding water absorption capacity of soil to avoid runoff.
Wood Residue ▪ (not regulated by the AEM *Code of Practice for Soil Amendments*) fresh or composted.	x	✓	▪ Normally high C:N ratio.

? means material must be tested to determine if it is a nitrogen source or a soil conditioner

TABLE 6.5 Managing Off-Farm Soil Amendment Sources as Nitrogen Sources or Soil Conditioners

Soil Amendment Source	Managed Primarily as		Comments (check nutrient content before land application)
	Nitrogen Source	Soil Conditioner	
Biosolids ▪ Class A compost or biosolids. ▪ Other forms.	✓ ?	✓ ?	▪ May exhibit slow nutrient release. ▪ Often applied as both nitrogen source and soil conditioner. *Organic Matter Recycling Regulation* Schedule 12
Compost ▪ Class A compost. ▪ Other forms.	✓ ?	✓ ?	▪ May exhibit slow nutrient release. ▪ Often applied as both nitrogen source and soil conditioner. *Organic Matter Recycling Regulation* Schedule 12
Fish Wastes ▪ Class A compost. ▪ Other forms.	✓ ?	✓ ?	▪ May exhibit slow nutrient release. ▪ Often applied as both nitrogen source and soil conditioner. *Organic Matter Recycling Regulation* Schedule 12
Food Processing Wastes ▪ Class A compost. ▪ Other forms.	✓ ?	✓ ?	▪ May have slow nutrient release. ▪ Often applied as both nitrogen source and soil conditioner. *Organic Matter Recycling Regulation* Schedule 12
Liming Materials	x	✓	▪ May contain metals. ▪ PH impact varies with source.
Off-Farm Manure – Liquid	✓	x	▪ Variable nutrient levels.
Off-Farm Manure – Solid ▪ Includes bedding containing significant amounts of manure.	✓	✓	▪ Normally a nitrogen source but may be used as a soil conditioner if low in nutrients and if C:N ratio greater than 30:1.
Off-Farm Spoiled Feed	x	✓	▪ Variable nutrients levels, high Biochemical Oxygen Demand.
Sand or Other 'Clean' Soil Material	x	✓	▪ Check nutrient and metal levels. ▪ Consult Agricultural Land Commission and local government regarding bylaw requirements.
Used Mushroom Growing Substrate	✓	✓	▪ Variable nutrient levels. ▪ Normally a nitrogen source but may be used as a soil conditioner if low in nutrients and if C:N ratio greater than 30:1.
Whey	✓	x	▪ Normally blended with liquid manure. *Organic Matter Recycling Regulation* Schedule 12
Wood Residue fresh or composted	x	✓	▪ Normally high C:N ratio.
			continues...

TABLE 6.5 cont. Managing Off-Farm Soil Amendment Sources as Nitrogen Sources or Soil Conditioners

Soil Amendment Source	Managed Primarily as		Comments (check nutrient content before land application)
	Nitrogen Source	Soil Conditioner	
Materials Regulated by the Code of Practice for Soil Amendments	x	✓	▪ Consult ENV for authorization for materials not covered by the: Organic Matter Recycling Regulation Schedule 12
▪ Fly ash, lime mud, residuals from primary or secondary treatment of liquid waste from a pulp or paper mill, including domestic sewage if it is mixed with those residual solids, water treatment, industrial residues of wood.			
▪ Pulp and paper residuals.	✓	x	
All Other Organic Materials	?	?	▪ Consult ENV for authorization for materials not covered by the: Organic Matter Recycling Regulation Schedule 12
All Other Inorganic Materials	?	?	▪ Consult ENV or Agricultural Land Commission for authorization.

? means material must be tested to determine if it is a notrogen source or a soil conditioner
Class A compost or biosolids are defined in *Organic Matter Recycling Regulation*

NUTRIENT APPLICATION

NUTRIENT APPLICATION ENVIRONMENTAL CONCERNS

Primary environmental concerns related to nutrient application are:

- Application rate exceeding the soil's ability to assimilate nutrients or certain soil conditioner components (i.e., salts, pH, C:N ratio, contaminants) resulting in water and/or soil pollution.
- Over-application of nutrients when managing as a soil conditioner that results in water pollution.

Inappropriate application method or timing that results in:

- Water or air pollution,
- Erosion or soil compaction on wet fields,
- Release of nitrous oxide from saturated and warm field conditions, contributing to climate change,
- Damage to the crop, leading to poor nutrient uptake or soil erosion,

Ineffective buffers or impacts caused by inappropriate placement or location (e.g., close proximity to watercourse, wrong soil type, unsuitable topography, sensitive habitat) that results in:

- Water pollution,
- Nuisance odours to neighbours,
- Habitat impact.

For information on these concerns:

➔ see Crops and the Environment, **page 4-1**, and refer to Crop Quality
➔ see Impacts on Biodiversity and Habitat, **page 7-7,** and refer to Impacts to Biodiversity and Habitat
➔ see Soil Quality Factors, **page 8-1,** refer to Contaminants
➔ see Water Quality and Quantity Factors, **page 9-1**, and refer to Contaminants
➔ see Air Quality Factors, **page 10-1**

NUTRIENT APPLICATION LEGISLATION

The following is a brief outline of the main legislation that applies to nutrient application.

➔ see **page A-1** for a summary of these and other Acts and Regulations

Agricultural Land Commission Act

The *Agricultural Land Commission (ALC) Act* S.B.C. 2002, c. 36, and *Agricultural Land Reserve (ALR) Regulations* are the legislative framework for the establishment, administration, and procedures of BC's agricultural land preservation program. The ALC Act does not replace other legislation and bylaws that may apply to the land. Local and regional governments, as well as other provincial agencies, are expected to plan in accordance with the provincial policy of preserving agricultural land.

The *ALR General Regulation, B.C. Reg. 171/2002*, identifies the procedures for submitting applications and notices of intent.

The *ALR Use Regulation, B.C. Reg. 30/2019* specifies land uses permitted in the ALR.

The policies of the Commission provide interpretation and clarification of the regulations; outline guidelines, strategies, rules or positions on various issues and provides clarification and courses of action consistently taken or adopted, formally or informally.

ALC Policies and Bylaws

Drinking Water Protection Act

The *Drinking Water Protection Act* and its Regulations have requirements to protect drinking water quality and regulate domestic water systems (those serving more than one single-family residence).

- SECTION 23(1): subject to subsection (3), a person must not (a) introduce anything or cause or allow anything to be introduced into a domestic water system, a drinking water source, a well recharge zone or an area adjacent to a drinking water source, or (b) do or cause any other thing to be done or to occur if this will result or is likely to result in a drinking water health hazard in relation to a domestic water system.

Environmental Management Act

Under the *Environmental Management Act*, the *Code of Practice for Agricultural Environmental Management* requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricultural operations, for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health. The AEM Code includes provisions on nutrient application, setbacks, and soil sampling,

This Act empowers ENV to control pollution within BC. Waste is defined to include "air contaminants, litter, effluent, refuse, biomedical waste, hazardous wastes" and any other substance designated by Lieutenant Governor in Council, or the minister. Pollution is defined in the Act as "the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment."

The *Code of Practice for Agricultural Environmental Management* requires persons to use environmentally responsible and sustainable agricultural practices when carrying out agricultural operations, for the purpose of minimizing the introduction of waste into the environment and preventing adverse impacts to the environment and human health. The AEM code contains specific requirements regarding the application of nutrient sources. The AEM code defines nutrient sources as materials that are a source of nitrogen or phosphorus including fertilizers and soil conditioners, agricultural by-products, compost produced through agricultural composting or materials produced in accordance with the *Organic Matter Recycling Regulation,* soil amendments as defined in the *Code of Practice for Soil Amendments*, digestates from anaerobic digesters, wastewater, irrigation water, and reclaimed water.

- SECTION 17: outlines the setbacks required (see table 6.6) between the application of nutrient sources and drinking water sources or watercourses.

TABLE 6.6 Setback distances required for Application of Nutrient Sources	
Drinking Water Source*	Watercourse
30 m from a well or diversion point	1.5 m for commercial fertilizer and manure injection
3 m in any other case, or if commercial fertilizer is used	3 m in any other case
*as defined in the *Drinking Water Protection Act*	

- SECTION 49: prohibits the application of nutrient sources to land on areas having standing water, on saturated soils, on frozen or partially snow-covered ground, or in a manner that may cause nutrient sources or contaminated runoff, or leacheate to enter a watercourse, cross a property boundary, or go below the water table.
- SECTION 51: requires operations which apply nutrient sources to land to ensure that (a) nutrient sources and leachate do not escape during transport, (b) nutrient sources are not discharged or applied directly into a watercourse, across a property boundary, or below a water table, and (c) drift from broadcasted nutrient sources does not enter a watercourse, cross a property boundary, or go below a water table. Nutrient sources applied to land must also be applied at a rate where the total amount of available nitrogen from soil and all nutrient sources is equal or less than the nitrogen needed by the crop.
- Operations with a land base greater than 2 hectares applying nutrient sources are required to maintain records of when, where, and how much of each nutrient source is applied. Records of crop yields, crop nutrient requirements, and soil tests are also required for the fields receiving nutrients.
- SECTION 53: of the AEM Code requires operations with a landbase greater than 2 hectares to perform specific soil tests of fields if nutrient sources are applied to the land. Fields which are flooded after harvest (e.g., cranberries) or comprised of organic (peat or muck) soils are not subject to the soil testing requirements. At minimum, soils should be tested for:
  - Post-harvest nitrate test or equivalent (see **page 6-15** for more information) every three years, unless a field's post-harvest nitrate test result is greater than 100 kg N/ha, in which case the test must be conducted again the following year.
  - Soil test phosphorus every three years.

The AEM Code includes requirements for operations when applying nutrient sources in specific areas of the Province related to environmental risk. In high precipitation areas (see Appendix B) application of nutrient sources is restricted in the fall and winter months by section 27 of the AEM Code.

In high precipitation areas in October and February-March (shoulder seasons) nutrients may only be applied if they are needed and will be available to the intended crop, and an assessment has been completed to ensure the risk of contamination of surface or groundwater sources is low. In October 2022, the AEM code will be amended to prescribe exact requirements for the assessment.

No application of nutrient sources is permitted from November to January in high precipitation areas, with the exception of wood residues.

Nutrient Management Plans. Results from soil tests required by the code and an operation's location relative to Vulnerable Aquifer Recharge Areas and Phosphorus Affected Areas are used to determine if a nutrient management plan is required for an operation in SECTION 56. The application of these criteria is gradually phased in. Early phase in of the of nutrient management plan requirements apply to livestock operations triggered by high Post-Harvest Nitrate Test values in certain vulnerable aquifer recharge areas, and gradually expand to include all sectors, soil test phosphorus triggers, and phosphorus affected areas.

A nutrient management plan is required for farms operating in vulnerable aquifer recharge areas or phosphorus-affected areas where:

- The operation is a total of five hectares or more.
- Nutrients (such as commercial fertilizer and manure) are applied to the land.
- Soils test results are at or over the following thresholds:
  - In vulnerable aquifer recharge areas, ≥100 kg nitrate/ha, or
  - In phosphorus-affected areas, ≥200 ppm phosphorus.
- The area and type of operation are being "phased-in" according to the schedule contained in the code, with:
  - Vulnerable aquifer recharge areas starting in 2020.

phosphorus-affected areas starting in 2024

Phase in of Agricultural Environmental Management Code of Practice nutrient management planning requirements

Vulnerable Aquifer Recharge Areas and Phosphorus Affected Areas

Nutrient Management Plans prepared for the requirements of the *Code of Practice for Agricultural Environmental Management* must be prepared at minimum by an experienced person (defined as someone with at least 4 years experience carrying out agricultural operations, or a combination of 4 years of operational experience and post secondary training in agricultural sciences). If the soil test values for a field which trigger a nutrient management plan are very high, the Nutrient Management Plan must be prepared by a Qualified Professional.

Very high soil test values which would trigger an Nutrient Management Plan prepared by a Qualified Professional are outlined as

- Post-Harvest Nitrate Test of 150 kg N / ha or more in a Vulnerable Aquifer Recharge Area.
- Soil Test Phosphorus of 300 ppm or more in a Phosphorus Affected Area (2025 onwards).

If a nutrient management plan is required for an operation under the AEM code, SECTION 59 outlines the implementation of the plan. Implementation includes maintenance of farm records relevant to the plan, notification of a Director under the Act if a Qualified Professional was needed to prepare the plan, and annual review of the plan by the operation. Plans are required to be formally updated every 5 years according to the criteria established by SECTION 56, or if significant changes have been made in the agricultural operation.

The *Code of Practice for Soil Amendments* regulates the storage, sampling, application, and record keeping pertaining to specific types of soil amendments. These include:

- Fly ash derived from the burning of wood, other than wood that has been immersed in marine waters.
- Residuals from primary or secondary treatment of liquid waste produced after 1995 from a pulp or paper mill, including domestic sewage if it is mixed with residual solids.
- Lime mud derived from pulp or paper mill processes or waste lime.
- Residuals from the treatment of water for domestic use or use in industrial processes.
- Industrial residue of wood that has not been treated with glue, paint, a preservative, or another substance harmful to humans, animals, or plants.

The *Organic Matter Recycling Regulation* has further requirements related to the land application of additional defined nutrient sources such as Class A Biosolids, Class B Biosolids, Class A Compost, and Class B Compost:

SECTION 5: a Land Application Plan must be developed prior to application of Class A Biosolids, Class B Biosolids, and Class B Compost

SCHEDULE 12: lists organic materials covered by the Regulation

Public Health Act

Administered by the Ministry of Health, this Act has a specific prohibition that "a person must not willingly cause a health hazard, or act in a manner that the person knows, or ought to know, will cause a health hazard". This prohibition would apply to farm practices that may result in a health hazard, such as when nutrients, contaminants or pathogens are discharged to land, water or air so as to pose a public health problem. Any situation that entails a health hazard will enable health officers to investigate using their powers under the Act. Under the *Public Health Act,* the local Health Authority must investigate any health hazard and has authority to order that a person prevent or stop a health hazard, or mitigate the harm or prevent further harm from a health hazard amongst other powers. Similar regulatory provisions exist for addressing health hazards to drinking water supplies under the *Drinking Water Protection Act*.

The Act has conditions under the *Health Hazards Regulation*:

- SECTION 8(1): provides separation distance from wells to be at least
- 30 m from any probable source of contamination (probable source of contamination could include nutrients from agricultural by-products)
- 120 m from any dumping ground

Wildlife Act

The provincial *Wildlife Act* protects wildlife designated under the Act from direct harm, except as allowed by regulation (e.g., hunting or trapping), or under permit. Legal designation as Endangered or Threatened under the Act increases the penalties for harming a species. The Act also enables the protection of habitat in a Critical Wildlife Management Area:

- SECTION 7: it is an offense, in a wildlife management area, to alter, destroy, or damage wildlife habitat, or to deposit a substance harmful to wildlife or wildlife habitat

Fisheries Act

Administered by both Fisheries and Oceans Canada and Environment and Climate Change Canada, this Act is established to manage Canada's fisheries resources, including fish habitat. The Act can also be administered provincially by FLNRORD and ENV. The Act applies to all Canadian waters that contain fish, including ditches, channelized streams, creeks, rivers, marshes, lakes, estuaries, coastal waters and marine offshore areas. It also applies to seasonally wetted areas that provide fish habitat such as shorelines, stream banks, floodplains, intermittent tributaries and privately owned land. The Act includes provisions for stiff fines and imprisonment to ensure compliance.

The purpose of this Act is to provide a framework for (a) the proper management and control of fisheries; and (b) the conservation and protection of fish and fish habitat, including by preventing pollution.

This Act was updated in 2019 and now empowers the Minister to make regulations for the purposes of the conservation and protection of biodiversity.

The definition of fish habitat is: "water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas". The quantity, timing and quality of the water flow that are necessary to sustain fish habitat are also deemed to be a fish habitat. Furthermore, serious harm to fish includes the death of fish or any permanent alteration to, or destruction of, fish habitat.

Provisions of the *Fisheries Act* relevant to agricultural operations include:

- Protection for all fish and fish habitats;
- Prohibition against the death of fish or the 'harmful alteration, disruption or destruction of fish habitat';
- A permitting framework and codes of practice to improve management of large and small projects impacting fish and fish habitat;
- Protection of fish and/or fish habitats that are sensitive, highly productive, rare or unique; and
- Consideration for the cumulative effects of development activities on fish and fish habitat.

Specific sections of the Act include:

SECTION 34.2(1) The Minister may establish standards and codes of practice for:

(a) The avoidance of death to fish and harmful alteration, disruption or destruction of fish habitat;

(b) The conservation and protection of fish or fish habitat; and

(c) The prevention of pollution.

SECTION 34.4(1) No person shall carry on any work, undertaking or activity, other than fishing, that results in the death of fish.

SECTION 35 (1) No person shall carry on any work, undertaking or activity that results in the harmful alteration, disruption or destruction of fish habitat.

Every person who contravenes subsection 34.4(1) or 35(1) is guilty of an offence and liable

Notifying authorities about serious harm to fish or deposit of a deleterious substance:

SECTION 38 (4.1) Every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations of a harmful alteration, disruption or destruction of fish habitat that is not authorized under this Act, or of a serious and imminent danger of such an occurrence, if the person at any material time:

(a) Owns or has the charge, management or control of the work, undertaking or activity that resulted in the occurrence or the danger of the occurrence; or

(b) Causes or contributes to the occurrence or the danger of the occurrence.

SECTION 38 (5) If there occurs a deposit of a deleterious substance in water frequented by fish that is not authorized under this Act, or if there is a serious and imminent danger of such an occurrence, and detriment to fish habitat or fish or to the use by humans of fish results or may reasonably be expected to result from the occurrence, then every person shall without delay notify an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations.

SECTION 38 (7) As soon as feasible after the occurrence or after learning of the danger of the occurrence, the person shall provide an inspector, a fishery officer, a fishery guardian or an authority prescribed by the regulations with a written report on the occurrence or danger of the occurrence.

Species at Risk Act

The *Species at Risk Act* has sections that protect listed species, their residence, and critical habitat. It applies to federal lands, internal waters (i.e., all watercourses), territorial sea of Canada, and the air space above them.

The provisions of the Act (known as the "safety net") could be invoked on BC Crown and private lands using a federal order under the Act if provincial action is not sufficient to protect listed species.

On private land, unless an order is made by the government, the Act's prohibitions apply only to:

- Aquatic species at risk;
- Migratory birds listed in the *Migratory Birds Convention Act, 1994* and also listed as Endangered, Threatened or Extirpated in Schedule 1 of the Act.

NUTRIENT APPLICATION BENEFICIAL MANAGEMENT PRACTICES

The "4R concept" provides a framework for beneficial management practices for application of nutrient sources such as manures, fertilizers, and composts. The goals of the concept are to improve the efficiency of crop nutrient use and to protect the environment. The four R's include the following:

Right Source - Right Rate - Right Time - Right Place

Read about 4R Nutrient Stewardship

Right Source

The Right Source is the combination of nutrient sources that provide a supply of nutrients in the balance that crops require. In determining which materials should be used to supply a crop's nutrient requirements, highest priority should be given to on-farm sources such as animal manures. Consider supplementation with off-farm manure sources only to top up deficiencies from the on-farm source.

If intending to apply an amendment primarily as a soil conditioner, ensure the product meets all of the following conditions:

- Does not fit the criteria of a "fertilizer".

➔ see Is it a Nitrogen Source or a Soil Conditioner? **page 6-4**

- Can be managed to improve physical, biological, and chemical soil properties.
- Has been checked for salt and contaminant levels.

Particularly in fields where soil phosphorus levels are high and manure is to be applied annually, consider replacing some of the manure nitrogen with chemical nitrogen fertilizer. Chemical fertilizers can provide a faster, more predictable release of nitrogen than manures, especially if the weather is cold and wet, and it is often easier to ensure a more uniform spread of chemical fertilizer than manure. Reducing manure application rates to soils with high phosphorus levels will reduce the risk of phosphorus contaminating adjacent surface waters.

Soil Sampling for Nutrient Management

Highly Soluble vs. Slow-Release Nutrient Sources. Soil type is a primary consideration in determining application rates and nutrient sources.

Alternatively, consider using slow-release nutrient sources such as polymer-coated urea or compost. These nutrient sources are most suitable in areas of high rainfall or where leaching risk is greater, as is the case for coarse soils.

Particle Size. Incorporate small-sized nutrient material into the soil or apply only to sites with vegetative cover that prevents erosion losses by wind or runoff flow. The advantage of using finely-sized soil amendments is that nutrients are available more readily.

Contaminants. Investigate contaminant levels whenever applying chemical fertilizers or other off-farm nutrient sources.

➔ see Soil Contamination, **page 8-17**

Soil Conditioners Give the highest priority to using on-farm materials for soil conditioning. If such materials are not available, select the soil conditioner that will best achieve the desired outcome.

➔ see Tables **6.4** and **6.5**, pages **6-6** and **6-7**, for a list of frequently used soil conditioners

Right Rate

Fine-textured soils such as clays have higher nutrient holding capacities and thus are better suited to receive higher application rates of highly soluble nutrient sources than medium- and coarse-textured soils such as silts and sands. On coarse-textured soils, apply highly soluble nutrients at lower rates but at more frequent intervals.

Apply nutrient sources at rates to meet but not exceed a crop's nutrient needs. A crop's nutrient needs may be described in crop production guides and they may be based on soil testing research. Generally, the crop's nutrient needs are based on soil fertility levels, expected yields, and the crop type. The Nutrient Management Calculator is an online tool that incorporates advice from crop production guides and soil testing research, to compare crop nutrient needs with the rates of nutrients supplied by fertilizers and soil amendments.

The Right Rate concept applies to amendments used as soil conditioners, even if the main intent of the soil conditioner is not to supply nutrients. When applying soil conditioners to correct a soil's deficiency (in organic matter content, for example), phosphorus may be applied in excess of crop needs. The Nutrient Management Calculator can be used to help determine whether the crop phosphorus needs are exceeded, in which case extra precautions may need to be taken to minimize the risk of phosphorus losses from the field.

- Nutrient Management Calculator
- Soil Sampling for Nutrient Management
- Crop Production Guides

Implement the following general practices to apply at the Right Rate:

- Apply at rates that do not lead to crop toxicity or crop smothering.
- For liquid nutrient sources (such as liquid manure or liquid fertilizer) or high-moisture soil conditioners (such as crop wash water), do not apply at rates that exceed the soil's infiltration capacity.
- For grass legume mixes, the application of nitrogen can be reduced in proportion to legume content. Alternatively, the application of nitrogen will replace the nitrogen supply by legumes (via biological nitrogen fixation), but avoid exceeding the nitrogen uptake rate of the grass-legume.
- If plants are grown in soilless media with water-soluble fertilizers such as in greenhouses, choose nutrient application rates based on nutrient levels in plant drainage water, foliar analysis, or electrical conductivity.
  - On-Site Testing of Growing Media and Irrigation Water
- For application of solid organic, inorganic, slow-release, or rapid-release fertilizers, do not apply at rates that exceed the soil's or soilless media's ability to assimilate salts.
  - Crops will be damaged by high rates of nutrient availability or release.
  - To avoid salt toxicity or physical damage to plants, limit nutrient application rates of specialized fertilizer products to the manufacturer's or industry's recommended rate or less.
  - In areas where the risk of leaching or runoff is high due to excessive rainfall or irrigation, adjust application rates to reduce that risk.

➔ see Irrigation, **page 9-22**

➔ see Runoff, **page 9-50**

Implement the following manure-specific practices to apply at the Right Rate:

- If manure is the primary nutrient source, determine the rate of application by using the Nutrient Management Calculator.
- Note that application of manure to meet crop nitrogen requirements will generally lead to over-application of phosphorus.
- Manure alone should not be used to meet the agronomic nitrogen requirement of crops, if the field receiving the manure has high soil phosphorus levels and water drains from the field into a watercourse.
- If surface sealing of the soil reduces infiltration of water into soils significantly, particularly finer-textured soils, consider reducing one-time application rates below 50 m3/ha (5300 U.S. gallons/acre) of slurry or 50 tonnes/ha of solid manure.
- To reduce the risk of nutrient losses in contaminated runoff, one-time application rates of liquid manure should not exceed the soil's available water holding capacity in the upper 20 cm (8 inches) of soil.

Using the Post-Harvest Nitrate Test to Determine Right Rate

Crop production guides and the Nutrient Management Calculator provide a reasonable starting point for determining a crop's nitrogen requirements. However, the Right Rate for nitrogen is found by adjusting nitrogen applications year-after-year to minimize the amount of nitrate not used by a specific crop for a specific field, while optimizing crop yield and quality. This amount of nitrate is measured for most field crops by soil sampling for the residual soil nitrate through a post-harvest nitrate test (PHNT).

The amount of post-harvest nitrate varies among crops based on the plant and cropping system's inherent nitrogen use efficiency, the year-to-year variation in climate, and management. The amount of expected post-harvest nitrate typically should only be compared within a crop type and growing region.

In the Lower Mainland, for example, expected PHNT values within the top 0-30 cm of soil are 15 ppm nitrate-nitrogen (NO_3-N) for perennial forages and 20 ppm NO_3-N for silage corn. PHNT values that indicate that nitrogen may have been applied in excess of their agronomic N rate are those greater than 30 ppm NO_3-N for perennial forages and 45 ppm NO_3-N for silage corn.

Typically, soil sampling for post-harvest nitrate will be taken from a 0-30 cm soil depth, but sometimes will have to be taken from deeper depths. Additionally, samples should only be taken from crops grown on mineral soils (as opposed to peat or muck soils, to which the PHNT does not apply).

Post-Harvest Soil Nitrate Testing

Right Time

Apply nutrients to make them available when crops need them. Depending on how quickly nutrients are released from a specific nutrient source, the Right Time for nutrient application may be immediately before or months before crop nutrient uptake occurs. The Right Time also needs to consider the risk of nutrient losses immediately following any particular nutrient application. For example, application to a wet soil or before a thunderstorm would likely result in a loss of the fertilizer value of manure and contamination of water quality.

Implement the following practices when selecting the Right Time for nutrient application:

- For annual and perennial crops that grow from early spring through late fall, apply nutrients in multiple applications (e.g., **Tables 6.7** and **6.8**, **pages 6-18** and **6-19**).
- In areas of high rainfall or high leaching risk (e.g., coarse-textured soils), apply nutrients in multiple applications.
- Match nutrient application to the developmental stage and rate of growth of the crop:
  - Plants at the beginning and end of their growth cycle require fewer nutrients than during active growth stages.
  - Apply nutrients prior to the period of rapid uptake.
  - In the south coast region the T-sum Calculator can inform the timing of the first nitrogen fertilizer applications to grassland (see information box below).

To inform the timing of first applications of nitrogen fertilizer on grassland in the Coastal region, it is appropriate to wait until "T-Sum 200." Beginning in late January each year, use the T-Sum Calculator to monitor the T-Sum in a specific area:

www.farmwest.com (Climate/Adaptation tab).

For a given field, a risk assessment should be completed prior to early season manure applications in the Coastal Region.

See legislation: *Code of Practice for Agricultural Environmental Management*

Manure-specific considerations:

- Leave at least three weeks between applications of manure to reduce the risk of soil surface sealing (allows the soil microbes to break up the manure).
- To avoid the transfer of pathogens to crops, berry and vegetable growers should maximize the time between manure application and the crop harvest.
- Manure should be well incorporated into the soil and kept from contacting non-root vegetables.
- Apply manure prior to planting vegetables.
- Apply manure prior to bloom on berries.
- Do not apply manure or fertilizer on excessively wet soils and soils which are frozen, since the nutrients are likely to remain on the surface and be vulnerable to loss in contaminated runoff.
- If applying manure in the fall, wait until after soil temperatures decrease below 10°C and before the soil freezes, to minimize the conversion of manure nitrogen to nitrate that can leach.

TABLE 6.7 **Timing Manure Applications to Match Crop Nitrogen Requirements in Coastal Regions**

Crop	Suggested Manure Application as a Percentage of Annual Crop Nitrogen Requirement [a]				
	Feb - March [d]	April - May	June - Aug	Sept - Oct [f]	Nov - Jan [f]
Perennial Grass	up to 25%	up to 100%	up to 50%	up to 25%	0%
Silage Corn	0%	up to 100%	up to 20%	0%	0%
Berries	up to 30%	up to 100%	0%[b]	0%	0%
Vegetables	up to 10%	up to 100%	up to 100%	up to 10%	0%
Cover Crop [c]					
Emerged before Aug 15	0%	0%	up to 60%	up to 100%	0%
Emerged before Sept 15	0%	0%	0%	up to 100%	0%
Emerged after Sept 15	0%	0%	0%	0%	0%

[a] Total available nitrogen applied to the soil (from manure and chemical fertilizer) is not to exceed the crop's annual requirement (i.e., the sum of percent applied for each time period through the year is not to exceed 100%)
[b] For new plantings, up to 100% of that year's nutrient need may be applied from June to August
[c] Includes relay crops; post-harvest nitrate test should be below 20 ppm (0–30 cm) if fertilizing a fall-planted cover crop
[d] Manure application is not advised in early spring on sites of fine-textured soil, especially if the site is not yet trafficable or if it drains to a watercourse (Chapter 8)
[e] Manure application is generally not advised from mid-October on sites of coarse-textured soil (Chapter 8)
[f] *Code of Practice for Agricultural Environment Management* prohibits application of nutrient sources (including manure) in the coastal region during this time period

TABLE 6.8	Timing Manure Applications to Match Crop Nitrogen Requirements in Interior Regions				
Crop	Suggested Manure Application as a Percentage of Annual Crop Requirement [a]				
	Feb	March - May [e]	June - Aug	Sept - Oct [e]	Nov - Jan
Perennial Grass	up to 5%	up to 100%	up to 75%	up to 50%	0%
Silage Corn	0%	up to 100%	20%	0%	0%
Cereals (Spring Planted)	0%	up to 100%	0%	0%	0%
Cereals (Fall Planted)	up to 5% [b]	up to 100%	up to 100%	0%	0%
Berries, Tree Fruits and Grapes	0%	up to 100%	0% [c]	0%	0%
Vegetables	0%	up to 100%	up to 100%	0%	0%
Cover Crop [d]					
Emerged before Aug 15	0%	0%	up to 60%	up to 100%	0%
Emerged before Sept 1	0%	0%	0%	up to 100%	0%

[a] Total available nitrogen applied to the soil (from manure and chemical fertilizer) is not to exceed the crop's annual requirement (i.e., the sum of percent applied for each time period through the year is not to exceed 100%)
[b] February and March application in the year following planting
[c] For new plantings, up to 100% of that year's nutrient need
[d] Includes relay crops; post-harvest nitrate test should be below 20 µg/g (0–30 cm) if fertilizing a fall-planted cover crop
[e] Manure application in the late fall and March is only advisable on some fields (see table 6.10)

BC Application Risk Management (ARM) Tool

A risk assessment prior to the application of nutrient sources is recommended as a beneficial management practice. **The BC Application Risk Management tool** can guide producers located in high precipitation areas through this process which involves three steps: 1) Check the short-term weather forecast for precipitation; 2) Assess field conditions (crop cover, soil moisture, proximity to watercourses, setbacks); 3) Document for records and take appropriate steps.

BC Application Risk Management tool

Manure or other fertilizer application is not acceptable during times when the environmental risk of nutrient losses is elevated for the field receiving the manure or fertilizer. Cold soil temperatures result in low crop nutrient uptake and low rates of conversion of manure nitrogen into the leachable nitrate form of nitrogen, so it may be acceptable to apply manure during cold periods as long as the manure infiltrates into the soil and stays there for crop uptake during the next growing season. The *Code of Practice for Agricultural Environmental Management* contains regulatory requirements which outline restrictions for nutrient application from October 1 to March 31.

➔ see Legislation, **page 6-9**

Refer to Monthly Manure Spreading Practice Tables **6.9** and **6.10**, **pages 6-20** and **6-21**. These tables summarize the considerations to be taken into account for nutrient application for various months for Coastal and Interior regions of BC.

Apply soil conditioners at the appropriate time of year that will avoid the following situations:

- High risk of runoff caused by excessive rainfall or irrigation.
- Soil compaction on fields where moisture conditions are above field capacity.

TABLE 6.9	Monthly Manure Spreading in Coastal Regions and High Precipitation Areas Relative to Environmental Risks of Contaminating Surface and Drinking Water
September moderate rainfall hence moderate risk	Spreading on grassland to meet crop nutrient needs for this time of year is acceptable. When cropping after corn, cover crops or grassland planted after September 1 should not receive manure unless the need for nitrogen has been proven by a soil test. There is usually enough nitrogen remaining in the soil for a cover crop or newly seeded grass. Not acceptable to spread on bare land (harvested corn, vegetables, berries, etc.) or cover crops that emerged after September 15th. Solid manure with high carbon-nitrogen ratios may be spread and incorporated into the soil as a soil conditioner. Manure should not be managed as a soil conditioner unless a manure test confirms a carbon-nitrogen greater than 30 to 1.
October moderate to high risk	Spreading is not acceptable past mid-October unless: ▪ Grass is actively growing (mean daily temperature above 5°C), AND ▪ Soil is trafficable with no significant rain forecast for next 5 days. If spreading, apply only on grass fields which are not subject to flooding and/or runoff and only at rates matched to crop nutrient needs. A risk assessment must be completed and documented before each application. BC Application Risk Management tool
November to January high rainfall hence high risk	**NO SPREAD PERIOD** Spreading on any crop is not acceptable due to the risk to surface and/or groundwater.
February and March moderate rainfall hence moderate risk	Spreading may only take place if the nutrients are needed by, and will be available to, the intended crop. For grassland and well-established cover crops, it is generally recommended that the first application of manure as a fertilizer should occur near or after the $Tsum_{200}$* has been reached and at a rate which meets crop nutrient needs. Not acceptable to apply manure: to fields that are subject to flooding or runoff; or to soils that are frozen or saturated. Not acceptable to spread manure on bare land. Spreading can only occur if planning to plant a crop in the near future. A risk assessment must be completed and documented before each application. BC Application Risk Management tool
April to August moderate to low risk	According to crop and soil conditions, apply manure throughout the growing season to meet crop nutrient uptake. Avoid spreading on wet fields or saturated soils. Manure applications should be planned to ensure that storage facilities will be as close to empty as possible by October. To avoid food safety concerns, do not spread manure on berry fields between flowering and harvest or on vegetable fields after planting.

*Find information on the Tsum at www.farmwest.com

TABLE 6.10	Monthly Manure Spreading in the Interior region Relative to Environmental Risks of Contaminating Surface and Drinking Water
September and October low rainfall hence low risk	Spreading on crops is acceptable if soil is not frozen, as most of the manure nutrients will be available for the crop next spring. Not acceptable to spread on bare land (harvested corn, vegetables, berries, etc.) or cover crops that emerged after September 1st Avoid wet areas.
November to February extreme risk of runoff at snow-melt hence high risk.	NO SPREAD PERIOD AEM Code prohibits spreading on soils that are frozen, saturated or snow covered. Spreading is not recommended due to the extreme risk of snowmelt runoff and surface water contamination
March to May moderate to high risk of runoff hence moderate to high risk.	Not acceptable to apply manure: to fields that are subject to flooding or runoff; or to soils that are frozen, saturated or snow covered; or to bare land in March. If field access is possible, avoid wet soils which could compact and lead to poor nutrient utilization or poor crop growth. Meet crop nutrient needs for this time of year is if conditions are acceptable to spread. (See **Table 6.8, page 6-19**) A assessment prior to application is recommended during this season to mitigate runoff risk. Risk Assessment
June to August moderate to high peak rainfall events hence moderate risk	According to crop and soil conditions, apply manure throughout the growing season to meet crop nutrient uptake. (See **Table 6.8**, page **6-19**) Avoid spreading on wet fields, saturated soils or fields prone to flooding. Manure applications should be planned to ensure that storage facilities will be as close to empty as possible by October. To avoid food safety concerns, do not spread manure on berry fields between flowering and harvest or on vegetable fields after planting.
April to August moderate to low risk	According to crop and soil conditions, apply manure throughout the growing season to meet crop nutrient uptake. Avoid spreading on wet fields or saturated soils. Manure applications should be planned to ensure that storage facilities will be as close to empty as possible by October. To avoid food safety concerns, do not spread manure on berry fields between flowering and harvest or on vegetable fields after planting.

Right Place

Accurate and uniform placement as well as the capability to calibrate for desired application rate is essential.

When selecting chemical fertilizer or manure application equipment, ensure the equipment will not apply nutrients beyond the target crop by taking into account the spreading width of broadcast applicators.

Manure Application. The advantages and disadvantages of various manure spreading methods are shown in **Table 6.13**, **page 6-30**. Choose methods that provide uniform placement and which achieve the desired rate of application. Methods that ensure accurate placement on the soil surface or within the crop canopy require smaller buffer distances to sensitive areas.

Injecting liquid manure or manure slurries into the soil can reduce the level of ammonia and nitrous oxide (greenhouse gas) emissions. However, injection combined with the over-application of nitrogen will increase the nitrous oxide emissions from medium to fine-textured soil or increase the nitrate leaching from medium to coarse-textured soil.

To reduce damage to crops from manure smothering or soil compaction, place manure under the canopy in as dilute a consistency as possible. As well, use high flotation tires and low soil disturbance equipment.

Banded Nutrients. For intensively managed row crops such as vegetables, nursery plants, and orchard trees, apply nutrients in bands along the crop rows and in circles around the bases of trees.

Broadcast Nutrients. Broadcast methods of application are suitable for crops such as grass or annually planted vegetables.

Grazing Animals. If grazing livestock are managed at appropriate stocking densities and for appropriate durations, manure deposited by the animals should be evenly distributed and at rates that do not exceed crop requirements. Implement the following practices:

- Manage for uniform manure distribution by regularly moving water supplies and supplemental mineral and feed sources.
- Ensure livestock are moved frequently to avoid overgrazing and to evenly distribute manure for both rotational and conventional grazing systems.
- For seasonal feeding areas, where livestock may have grazing supplemented by outside feed.

➔ see Outdoor Livestock Areas, **page 3-8**

Advanced Forage Management

Rangeland Handbook for BC

BC Rangeland Seeding Material

Methods. Optimal methods of application and placement of soil conditioners are dependent on the crop being grown and the reason for applying the material. Implement the following practices:

- For most field crops such as annual vegetables and forages, broadcast soil conditioners uniformly and incorporate into the soil as soon as possible.
- For soil conditioners applied as "mulches" to improve water conservation or to alter soil conditions within the target crop's rooting zone, use equipment that will uniformly and adequately cover the primary rooting area (e.g., sawdust placed around blueberry plants).
- For perennial crops for which certain soil conditioners such as lime cannot be incorporated regularly, implement the following practices:
  - Reduce the annual application rate to avoid toxicity.
  - Increase the frequency of application to compensate for reduced rate.

➔ see Nutrient Application Methods, **page 6-26**

➔ see Soil Management, **page 8-7**

Nutrient Application Setbacks from watercourses. Application of nutrient sources should consider the location of watercourses and provide enough setback to protect the watercourse. Under the *Code of Practice for Agricultural Environmental Management* minimum setbacks are required:

- 1.5 m: Minimum setback for broadcast of commercial fertilizer or sub-surface injection of manure.
- 3 m: Minimum setback for all other nutrient applications, including manure.

Increase setback width to provide a buffer and avoid any contaminated runoff based on climate conditions, soil, soil cover conditions, and slopes greater than 3%. See Chapter 11: Buffer Beneficial Management Practices.

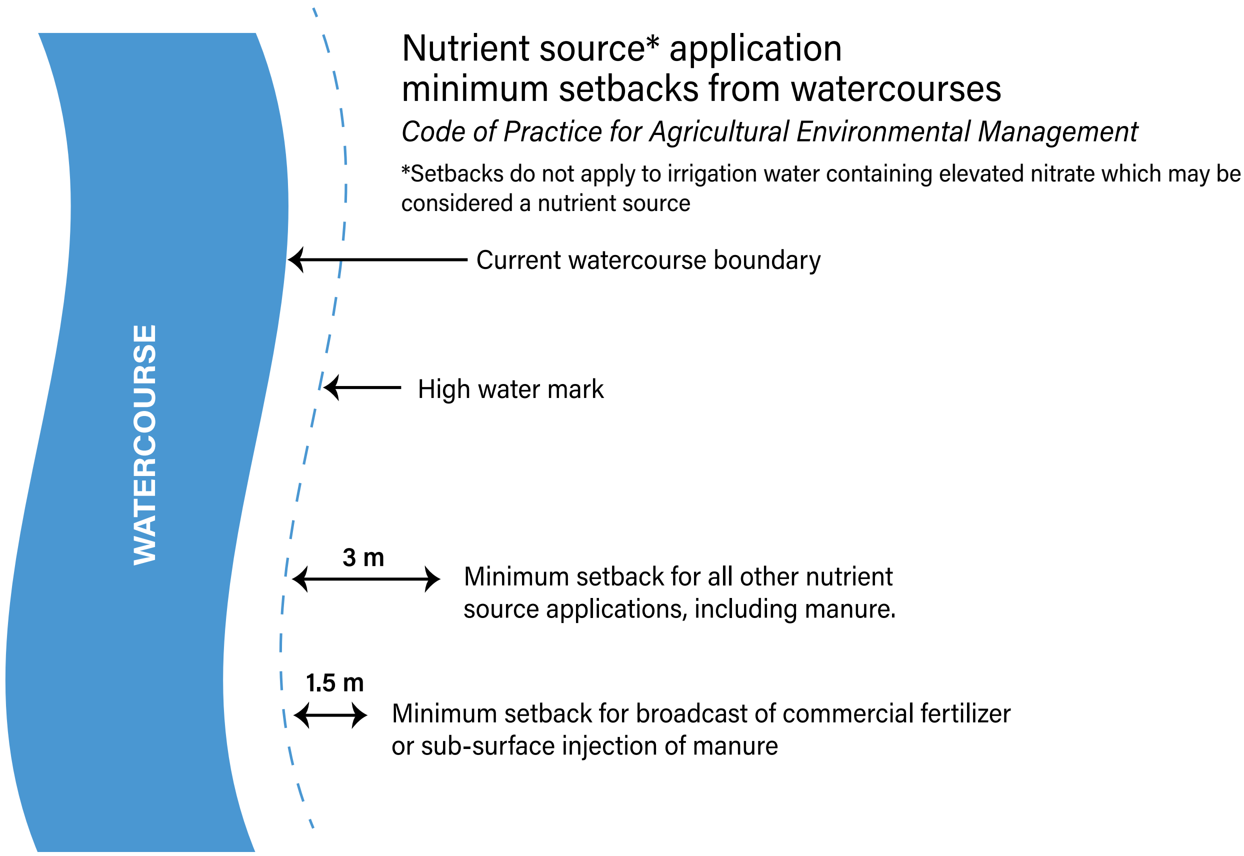


FIGURE 6.1 Nutrient Application Setbacks to a Watercourse

TABLE 6.11 Liquid Manure Application Methods by Order of Preference

Method	Advantages	Disadvantages
1. Band Applicator with or without Soil Aerator (e.g., Sleighfoot or Aerway SSD)	▪ Easy calibration, ▪ Uniform application, ▪ Accurate placement, ▪ Low ammonia loss, ▪ Fertilizer value maximization, ▪ Wider spreading window, ▪ Nitrous oxide release minimization.	▪ Higher cost, ▪ Slow application, ▪ Crop damage from wheels if applied when crop is tall, ▪ Soil compaction from tanker.
2. Injector	▪ Easy calibration, ▪ Uniform application, ▪ Accurate placement, ▪ Highest potential to maximize nitrogen fertilizer value, ▪ Fast application (with hose reel or umbilical systems), ▪ Ammonia and odour reduction.	▪ Increased potential for nitrous oxide release under saturated soil conditions, if nitrogen is over-applied; ▪ Only suitable for some soil and crop conditions; ▪ Higher cost; ▪ Slow application (with tanker system); ▪ Low application rate difficult to achieve; ▪ Short application window; ▪ Soil compaction from tanker.
3. Splash Plate	▪ Easy calibration, ▪ Lower cost, ▪ Low nitrous oxide release.	▪ Soil and crop compaction, ▪ Short application window, ▪ High ammonia loss, ▪ Non-uniform application.
4. Irrigation Gun Greatest challenges with odour, calibration, uniformity, and drift, among the four methods described	▪ Lower cost, ▪ Fast application, ▪ Provides opportunity for nutrient application in spring, to fields that are poorly trafficable, as long as environmental runoff risk is low (See Runoff Factors, page 9-54).	▪ Difficult to calibrate; ▪ Non-uniform application; ▪ Inaccurate placement means that manure application should be at least 10 m from watercourses; ▪ Short application window; ▪ High ammonia loss loss in warm (summer) temperatures or during windy conditions; ▪ High risk of pathogen, aerosol, and odour drift.

Table 6.12 Solid Manure Application Methods by Order of Preference

Method	Advantages	Disadvantages
1. Spinning Disks	▪ Easy calibration, ▪ Accurate placement, ▪ Fast application.	▪ Need dry manure, ▪ High dust production.
2. Flail Broadcast	▪ Can spread variable moisture content.	▪ Inaccurate placement, ▪ Non-uniform application.
3. Dump and Grade Not recommend for use due to poor uniformity	▪ Low cost.	▪ Cannot be calibrated, ▪ Non-uniform application, ▪ Difficult to control rate.

Fertigation. The application of nutrients through an irrigation or nutrient circulation system is known as fertigation. Fertigation uses the same principles for determining rate and timing of application as any other nutrient application method. Ensure that nutrients are applied only to the target crop and that watercourses are totally avoided. In addition, check the system for leaks on a regular basis.

- Chemigation Guidelines for British Columbia (1993)
- Plug Fertilization Strategies

Nutrient Application Equipment Calibration

In order to manage nutrients effectively, both manure and fertilizer spreaders need to be maintained and calibrated to ensure uniform distribution. Calibration is a determination of the amount of solid or liquid applied to a given area for a specific piece of application equipment. To properly calibrate a manure spreader, it is important to know the capacity of the unit, the distance traveled, the spreading band width, and the time it takes to unload the spreader at a chosen tractor speed. When calibrating for solid manure, the manure density must also be known.

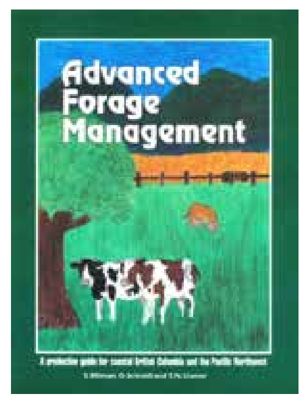
Uniformity is the evenness of application across the band spreading width from the beginning to end of each pass. To test uniformity, place buckets, tarps or some other form of collection system at a variety of locations in areas over which the manure is to be spread. The volume or weight of manure can then be measured, and an average can be calculated. A generally acceptable level of uniformity is when all samples are within 15% of the average within the direct spreading area (an area not influenced by previous or subsequent overlapping passes). Minor uniformity problems can be overcome by varying the entry point or direction of travel when spreading manure in a particular field.

- Choosing and Calibrating Manure Application Equipment

Application Equipment Calibration. To achieve the desired result with any soil conditioner, calibrate application equipment to ensure that the actual rate of application and placement of material match the intended rate and placement.

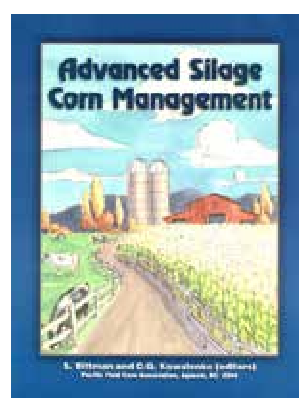
Forage Nutrients

Annual and Perennial Forage Crop Nutrient Uptake. Basic plant growth characteristics and structure play a role in nutrient uptake and soil management. Annual crops by their nature generally have shorter nutrient uptake periods than perennial crops. For example, a perennial forage grass may take up nutrients for as long as 240 days while an annual corn crop will take up nutrients for less than 80 days.



Nutrient uptake in annual forage crops is not constant, but typically follows an S-shaped curve with very low uptake for a period of about 30 days, then increases sharply until flowering, then decreases rapidly with maturity. In a perennial forage crop the curve may be elongated, or in the case of a forage grass or grass/legume mix there will be several periods of varying uptake in response to multiple cuttings. Figure 6.1 illustrates such patterns. Forage grasses are generally subject to a range of harvesting options, which include variations in numbers of cuts, times of cutting, and cutting height. Each of these influences the effectiveness of a grass crop to take up nutrients.

Harvest Date. The time of harvest plays a critical role in nutrient uptake for perennial forages such as grass. Perennial forages produce dry matter and protein in response to cutting frequency, cutting height and grazing practices. These factors can be varied to achieve either maximum dry matter yields or maximum protein yield.



- Advanced Forage Management
- Advanced Silage Corn Management
- Cool Forages

For annual crops harvested at maturity, such as corn, harvest date does not affect nutrient uptake. However, if annual crops are planted late and harvested at an immature stage the full potential nutrient uptake will not be achieved. If the crop was fertilized for mature yields and harvested at an immature stage, there may be excess nutrients remaining in the soil after harvest.

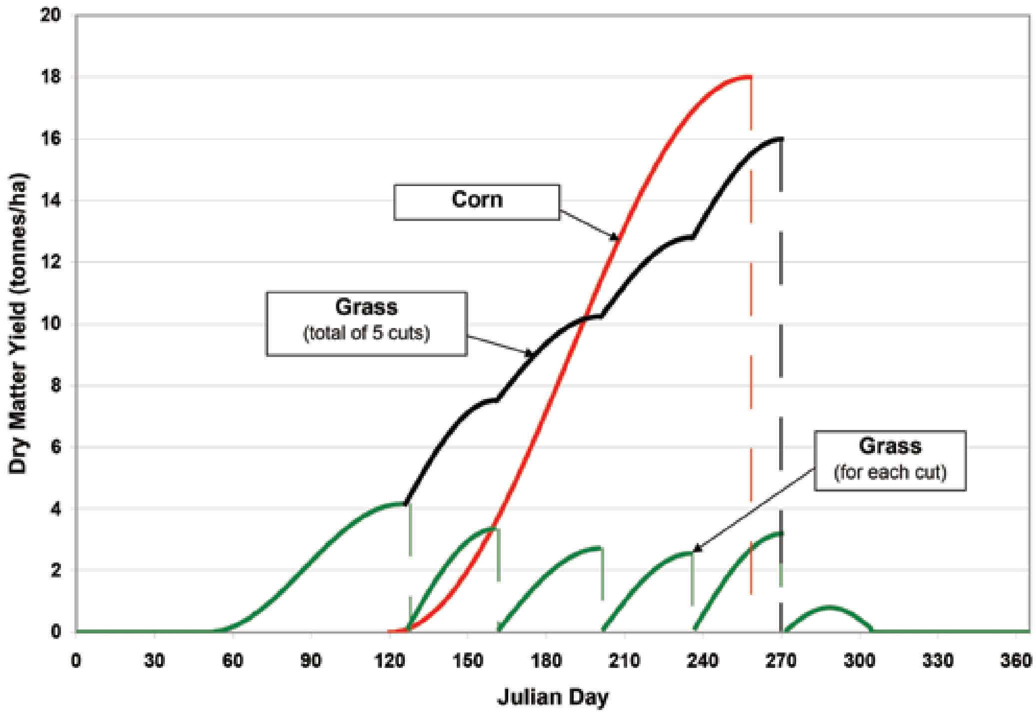


FIGURE 6.2 Generalized Dry Matter Accumulation versus Time of Year

Horticultural Crop Nutrients

Nutrient uptake by horticultural crops varies with the type of crop grown. Some tree fruit and berry crops require most of their nutrients in the spring and early summer. Some vegetable crops take up large amounts of nutrients later in the summer and early fall. Manage nutrient applications so that they are available when required to both maximize crop growth and minimize any potential for leaching.

Risk of Pollution During Nutrient Application

Surface Water. Any nutrients that enter a watercourse can degrade water quality and impact fish and fish habitat. Select application rates and management practices that keep nutrients out of watercourses.

The rate at which liquid infiltrates into the soil is important in evaluating the risk of runoff. Poorly drained soils become saturated quickly with the result that precipitation can no longer enter the soil, leading to increased stormwater flows. Water ponding on any soil surface is an indication that the liquid is being applied faster than it can infiltrate into the soil. In addition, runoff risks are greater on sloping land. In certain conditions, even a small amount of rain can create runoff problems. If runoff due to site and weather conditions occurs, stop application, or reduce the application rate. Enlarge buffers to address persistent runoff events.

➔ see Buffers, **page 11-4**

If liquid manure is pumped through pipes over or within 10 m of a watercourse, secondary containment on the pipes is suggested to prevent any leakage from entering the watercourse. Where possible pipes should be located 10 m or more (suggested) away from a watercourse.

Manure application should not occur within:

- 3 m or more of a bank or a slope leading to a dry ditch or dry watercourse *(Code of Practice for Agricultural Environmental Management).*
- 5 m or more of a bank or a slope leading to wet ditch or wet watercourse (suggested).
- Applications must be setback at least 30 m from any well or water intake used for domestic purposes because it is deemed a potential source of contamination *(Health Hazards Regulation)*.

Commercial fertilizer application should not occur within:

- 1.5 m or more of a bank or a slope leading to a dry ditch *(Code of Practice for Agricultural Environmental Managment).*
- 3 m or more of a bank or a slope leading to wet ditch or any watercourse (suggested).
- At least 30 m from any well or water intake used for domestic purposes because it is deemed a potential source of contamination (*Health Hazards Regulation*).

In certain circumstances, setback distances to watercourses for manure and commercial fertilizer may need to be increased to avoid contaminated runoff. The determination of an appropriate setback should be based on:

- Soil texture, porosity and moisture;
- Soil cover conditions;
- Slope toward a watercourse, particularly if slope exceeds 5%;
- Sensitivity of the watercourse.

Spring Runoff. In areas of the Province where soils are frozen and where snow accumulates during the winter months, snowmelt has the potential to enter adjacent watercourses. Do not apply manure to frozen or snow covered land if manure can be carried with the melt water and contribute to water contamination.

Subsurface Drains and Macropores. Fields with effective subsurface drainage systems pose a particular pollution risk. Liquid wastes applied to the soil can find its way through macropores in the soil (e.g., cracks, worm holes and mouse or mole holes) into drains and eventually to watercourses. This risk applies to any drained field regardless of slope or its proximity to a watercourse.

➔ see Drainage Water Quality, **page 9-48**

Where lowland fields with clays or silt loams have had drainage systems installed at some time in the past, the pipes may still work even if a modern system has not been installed. Where the risk of macropore flow to watercourses is elevated, implement the following practices:

- Do not spread manure on grass or bare fields when fields are wet and tile drains are running.
- Cultivate bare fields to break up macropores shortly before spreading manure (within 7 days).
- Reduce one-time manure application rates, depending on soil conditions.
- If contamination still occurs, it may be necessary to block the outflow or contain the contaminated drain water and apply to fields as irrigation water when the tile drains are not running.

Preferential Flow of Manure in Tile Drainage

Greenhouse/Nursery Container Beds. Check drainage discharge water from greenhouse floor drains or from under nursery container beds and capture and recirculate any contaminated water.

Ground Water. In the presence of coarse-textured sandy or gravelly soils or fractured bedrock aquifers, the movement of nutrients and pathogens to groundwater is accelerated, creating the potential for pollution. Timing and rate of manure or fertilizer application are important. Follow a nutrient management plan for manure and fertilizer applications in areas over moderately or highly vulnerable aquifers that are used for drinking water.

➔ see **Table 6.6, page 6-11**

To avoid the risk of contaminating wells from macropore or runoff flow, implement the following practices:

- Maintain a 30 m manure or chemical fertilizer "no-spread-zone" around well sites (*Public Health Act*).
- Protect the well by constructing a secure berm to divert runoff flows away from the well head, and ensure that the well and well casing are properly constructed and maintained.

Weather. Applications in adverse weather conditions will increase the risk of manure leaving target areas, which may cause pollution. Implement the following practices:

- Avoid spreading in diverting winds.
- Avoid spreading during heavy rains or if significant rain (i.e., greater than 10 mm of rain or its equivalent in snow) is forecast any of the next 3 to 5 days.

Soil, Crop or Crop Residue. Implement the following practices to reduce the risk of nutrient loss (by surface sealing, ponding, runoff flow and leaching) during and after application:

- Apply to an actively growing crop, cover crop or significant crop residue.
- Apply to soil that is free of surface and subsurface compaction.

Air. A large portion of the total ammonia and odour emissions from manure occur during land application. The control strategies that can be used include timing and method of spreading.

Choosing an appropriate time to spread manure can go a long way in minimizing complaints due to odour. Using the following as general guidelines, spread manure:

- As soon as is appropriate to reduce methane emissions.
- When prevailing winds blow away from close urban areas or neighbouring residences.
- On cool days to reduce the rate of odour release.
- Prior to an expected light rainfall or before irrigation.
- Early in the day to take advantage of increased wind turbulences later in the day that can dilute odours.
- Midweek, rather than on weekends or holidays, as this time is less likely to be a nuisance to neighbours pursuing outdoor activities.

➔ see Nutrient Application, **page 6-9,** and refer to Timing

Most soil conditioners present a reduced risk of pollution when compared with fertilizers. Since many soil conditioners have a high percentage of plant fibre and are very light when dry, they are easily wind blown when applied to land. Work them into the soil as soon after application as possible. As a precaution establish and maintain an adequate buffer between soil conditioner application areas and sensitive areas to prevent nuisance or pollution risks.

➔ see Buffers, page **11-4**

Rapid-cover manure application techniques may ultimately be the best solution in long-term reduction of odour complaints and concerns. Such methods of application are more costly than conventional practices but will maximize returns from the manure as a fertilizer in nutrient savings and won't release as many odours or gaseous emissions.

- On plowed land, follow the spreading of manure closely with a disc or tiller.
- On perennial forages, consider using a sleighfoot attachment or an attachment that combines a dribble bar with a soil aerator.
- Make more frequent manure applications at lower application rates using sleighfoot or shallow injection equipment for more efficient use of nitrogen.

➔ see Nutrient Application, **page 6-9**, and refer to Nutrient Application Methods

Nutrient Application Impact on Climate Change

The nitrogen from manure and fertilizer can be converted into the greenhouse gas nitrous oxide (N_2O) during periods where the soil is saturated or will become saturated within a short time period with the onset of fall and winter rains or rise in water tables due to subirrigation.

- Avoid spreading manure or fertilizers in conditions where soil is saturated.
- Avoid spring or winter grazing on areas subject to high water tables or flooding, and complete a risk assessment of seasonal feeding areas to ensure the risk of off-site transport of manure and greenhouse gas emissions from wet soils are minimized.

➔ see Climate Change Factors, **page 12-1**

Crop Monitoring and Nutrient Application

Monitor plant health and nutritional status throughout the growing period on an ongoing basis. Implement the following practices:

- Record all application amounts, conditions, practices, and crop results to assess effectiveness of nutrient application strategies.
- Under highly intensive crop production systems (i.e., greenhouses), monitor pH and electrical conductivity of the rooting medium weekly to determine plant nutritional status throughout the growing period.
- Record all applications, conditions, practices, and crop results. Due to soil conditioners' lower nutrient value, over application or organic matter at high rates frequently occurs.

NUTRIENT MANAGEMENT PLANNING

Nutrient management planning is a process to optimize the relationship between farm management techniques, crop requirements, and land application for the purpose of maximizing nutrient use while minimizing environmental impact. The process attempts to balance nutrients on an individual crop or field basis across the farm.

The Code of Practice for Agricultural Environmental Management may require an operation to prepare and implement a Nutrient Management Plan (NMP) (see legislation **page 6-9**), however the process is more broadly recommended as a beneficial management practice.

The components of a NMP are outlined in **Table 6.6.** NMPs include both on-farm risk assessments and recommended nutrient application strategies using planning tools which aid in the estimation and accounting of nutrient use on the farm. For a self-guided introduction to nutrient management planning, use the following web-based tool to help choose the right rate and nutrient source for your crops:

- Nutrient Management Calculator web page

Online Resources related to Nutrient Management Planning

- Soil Nutrient Testing web page
- Soil Sampling for Nutrient Management
- Understanding Different Soil Test Methods
- Nutrient Testing Laboratories in BC

A NMP is a component of an iterative process. Once a plan is created, monitoring the implementation of the plan with record keeping is an important component of nutrient management. The plan should be revised and improved based on farm records and experience with any changes implemented from the plan.

TABLE 6.13 Components of a Nutrient Management Plan (NMP)

Farm Description:

The description should include a total number of acres cropped under the NMP, number and type of animals on the farm. If manure is collected on-farm, the NMP should describe the handling system and storages. If the farm is located in a vulnerable aquifer recharge area, and/or a phosphorus affected area, and/or a high precipitation area as defined in the *Code of Practice for Agriultural Environmental Management* it should be noted in the farm description.

A farm map should identify the location of manure storages and animal housing in relation to any watercourses, wells, or other areas of concern. Field maps identifying each field and their relation to environmental risk (watercourses, topography, recommended locations for nutrient application setbacks) should be included. Additional field information which may be included in maps or a text/tabular form includes the spreadable area of each field, soil characteristics, and cropping history.

Nutrient Source Inventory and Use:

The inventory of nutrient sources includes estimated annual amounts of manure generated by animals (or other agricultural by-products associated with them) kept on-farm. Nutrient sources that are imported to the farm are also accounted for in the inventory.

Nutrient sources should be categorized in the inventory according to how they are land applied. In most cases, this aligns with their handling and storage. Several sources of materials may contribute to manure in a storage system, however, it is the characteristics and volume of the material as it is applied to land which are used for the allocation of nutrients in the planning process.

Where nutrient sources are generated on farm, the quantity generated is compared with the recommended quantity being applied to land. The balance of manure generated and applied will indicate if there is too much or too little manure for the farm's landbase.

Field Specific Nutrient Source Application Rates:

The core recommendations of a NMP provide guidance for nutrient source applications on every field. The plan will contain recommended rates, timing, and sources of nutrients which are informed by management history, soil testing, and nutrient source testing.

Application rates which meet the crops production requirements, and reduce the risk of over application of nutrients of environmental concern are set by estimating Agronomic Nutrient Balances, and if applicable, Crop Removal Nutrient Balances for each field.

- The Agronomic Nutrient Balance process considers the estimated availability of Nitrogen, Phosphorus, and Potassium for the crop(s) from the soil and determines a crop requirement for each nutrient. This requirement is balanced by the estimated availability in the nutrient sources which are applied throughout the year.
- The Crop Removal Balance is used to assess the potential for accumulation (or depletion) of nutrients in soil, and considers the total amounts of Nitrogen, Phosphorus, and Potassium removed by the harvested crop, contrasted with the total nutrients applied to soil as the nutrient sources.

Plan Recommendations:

In addition to field specific guidance, the NMP will include recommendations to address any issues with manure storage, handling, or application. This may entail changes to practices (when and where nutrients are applied) or equipment and infrastructure improvements. For farms that have an imbalance between the use and generation of nutrient sources, the NMP should provide guidance on where excesses will go, or what sources may be used to address any deficits.

Results of soil tests and materials analysis:

Test results from the analytical lab for soils, manure, or other materials should be kept with the NMP.

Environmental Farm Plan Nutrient Management Plan Triggers

Within the Environmental Farm Plan program, producers in any of the following four situations are recommended to complete a Nutrient Management Plan:

1. **Farms Out of Compliance with Nutrient Application Legislation.** This applies to farms that answer "no" to any of the legislative questions on the Nutrient Application Worksheet in the Environmental Farm Plan Workbook. The proposed action is the development of a Nutrient Management Plan.
2. **Livestock Producers and Producers of Intensively Managed Outdoor Crops** Livestock producers and intensively managed outdoor horticulture crop producers applying nutrients over a moderately to highly vulnerable aquifer used for drinking water.
3. **Users or Generators of Significant Manure Nitrogen.** Producers that generate or use manure should complete one of the following two assessments:

   Manure Assessment 1 (Worksheet #4): A manure nitrogen assessment for farms that generate manure (if some of the manure is land-applied on the farm), or

   Manure Assessment 2 (Worksheet #5): A manure nitrogen assessment for farms that use manure as a fertilizer but do not generate manure.

   The objective of the assessments is to determine if manure nitrogen generation or utilization are above the values in **Table 6.14,** below. Farms that apply manure at rates below these values are considered to be at a low risk of causing pollution as long as the manure is being stored, handled, and applied in compliance with the *Code of Practice for Agricultural Environmental Management*.

TABLE 6.14 Baseline Values Used for Assessing the Requirement for a Nutrient Management Plan (used in Worksheets #4, #5)

Crop Type	Baseline Manure Nitrogen Application Rate (kg N/ha/yr)★
Non-forage (e.g., berries, tree fruits, vegetables)	50
Forage grass (South Coastal BC)	300
Forage grass (rest of BC)	200
Forage corn	150
★ Value based on Total Manure N	

   Farms that apply manure at rates above these values may also be managing their nutrients in full compliance with the Code, but the risk of over-applying nutrients and potentially causing pollution is higher. The actual risk would be specific to the farm being assessed, depending on a variety of factors including crops being grown, yield potential, topography, proximity to watercourses, and climate. For farms that apply manure at rates above these values, a NMP is recommended.

4. **Farms with High Soil Phosphorus.**

Manure Nitrogen Assessment 1: Farms that Generate Manure

Using Worksheet #4, **page 6-33**, with the appropriate information from **Table 6.8**, this assessment compares:

- The amount of manure nitrogen generated by a farm with livestock with the calculated baseline value required by the crops on that farm.

Follow these four steps on **Worksheet #4**:

Step 1: estimate the annual manure nitrogen excretion to be applied to the farm.

Step 2: calculate the manure nitrogen application for each crop area.

Step 3: add the manure nitrogen application values for each crop area to get the application for the whole farm.

Step 4: a Nutrient Management Plan is recommended if the farm's manure nitrogen generation is greater than the calculated value for the farm.

WORKSHEET #4
Manure Nitrogen Application Assessment for farms that Generate Manure

Workbook Question 274

Question: **Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.**

Information:

Indicate the type of animal (Refer to Table 6.7*)			
Number of animals	50000	2	
Percentage of manure remaining on the farm after manure export (a percentage expressed as a value between 0 and 1)	0.10	3	
Assumed annual N excretion per animal place (Refer to Table 6.7*)	0.25	4	kg N/animal

Calculation: Step 1 **Estimate the manure N excreted and remaining on farm, using Equations below:**

EQUATION: Annual N Excreted & remaining on Farm (kg)

Number of Animals		x	portion of manure left		x	Annual N Excretion/ animal place (kg)			=	Annual N Excreted & remaining on Farm (kg)		
50000	2	x	0.10	3	x	0.25	4	kg/animal	=	1250	5	kg N

Step 2 **Calculate annual baseline manure N application for crops grown on farm, using Equation below:**

EQUATION: Manure N Application for Farm (kg)

Area Manure Spread on (ha)				x	Manure N Application Rate (kg N/ha)		=	Manure N Application for Farm (kg)		
non-forage area		6	ha	x	50	kg N/ha	=	0	10	kg N
forage grass (Fraser Valley) area		7	ha	x	300	kg N/ha	=	0	11	kg N
forage grass (rest of BC) area		8	ha	x	200	kg N/ha	=	0	12	kg N
forage corn area	5	9	ha	x	150	kg N/ha	=	750	13	kg N

Step 3 **Calculate Annual Baseline Manure N application for whole farm**

(Sum of boxes 10 to 13) = 750 [14] kg N

Answer:

Step 4 Is the annual N excretion remaining on the farm 1250 [5] less than 750 [14] the baseline application value?

No **a NMP is recommended** **or** YES **a NMP is Optional**

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.

Note: Refer to Tables in BC Environmental Farm Plan Reference Guide

Manure Nitrogen Assessment 2: Farms that Do Not Generate Manure

Using **Worksheet #5** with the appropriate information from **Table 6.7**, this assessment compares:

- The amount of manure nitrogen used by a farm without livestock with the calculated baseline value required by the crops on that farm.

Follow these four steps on **Worksheet #5**:

Step 1: estimate the annual manure nitrogen use for the farm.

Step 2: calculate the manure nitrogen application for each crop area.

Step 3: add the manure nitrogen application values for each crop area to get the application for the whole farm.

Step 4: a Nutrient Management Plan is recommended if the farm's manure nitrogen use is greater than the calculated value for the farm.

WORKSHEET #5 Manure Nitrogen Application Assessment for Farms that Use Manure but do not Generate Manure

Workbook Question 274

Question: **Proceed through the following worksheet calculations to assess whether or not a Nutrient Management Plan (NMP) would be recommended for this farm.**

Information:

Indicate the type of animal (refer to Table 6.7)*	Poultry Broiler	1	
Manure Volume	100	2	m^3
Average manure N concentration (Refer to Table 6.7*)	15.8	3	kg N/m^3

Calculation: Step 1 **Estimate total N content of manure supply, using Equations below:**

EQUATION: Annual N Excreted & remaining on Farm (kg)

Manure Volume (m^3) x Assumed manure N concentration (N/m^3) = Total N content (kg)

100 [2] m^3 x 15.8 [3] kg N/m^3 = 1580 [4] kg N

Step 2 **Calculate manure N application value for crops grown on farm, using Equation below:**

EQUATION: Manure N Application for Farm (kg)

Area Manure Spread on (ha)			x	Manure N Application Rate (kg N/ha)		=	**Manure N Application for Crop (kg)**		
non-forage area 10	5	ha	x	50	kg N/ha	=	500	9	kg N
forage grass (Fraser Valley) area	6	ha	x	300	kg N/ha	=	0	10	kg N
forage grass (rest of BC) area	7	ha	x	200	kg N/ha	=	0	11	kg N
forage corn area	8	ha	x	150	kg N/ha	=	0	12	kg N

Step 3 **Annual Baseline Manure N application for whole farm** = 500 [13] kg N

Answer:

Step 4 Is the annual N content remaining on the farm 1580 [4] less than 500 [13] the baseline application value?

No **a NMP is recommended** or YES **a NMP is Optional**

A Nutrient Management Plan (NMP) is suggested to optimize nutrient utilization and protect the environment.

Note: Refer to Tables in BC Environmental Farm Plan Reference Guide

TABLE 6.15	Assumed Annual Manure Nitrogen Excretion Values and Manure Nitrogen Concentrations in Storage for Various Animal Types ★		
Type of Animal		Use with Worksheet #4, Box 3	Use with Worksheet #5, Box 3
		Assumed Annual Manure N Excretion (kg N/animal)	Average Manure N Concentration (kg N/m^3)
Beef Cattle	Cows and Bred Heifers	73	3.4
	Feeder 340 to 500 kg	52	3.4
	Yearling 230 to 340 kg	35	3.4
	Calves 50 to 230 kg	17	3.4
Dairy Cattle	Milking cow including associated replacements	200	1.6 (watery)
			2.8 (medium slurry)
			4.0 (thick slurry)
Ducks		0.40	11.8
Goats		10.5	2.9
Horses		55	3.3
Poultry	Broiler	0.25	15.8
	Layer plus associated pullets	0.67	10.9
	Hatching Egg Layer plus associated pullets	1.25	9.2
	Turkey	1.12	11.5
Sheep		6.1	2.9
Hogs	Sow – Farrow to Finish	92	3.5 Liquid
	Sow – Farrow to Wean	19	2.9 Liquid
	Grower / Finisher	10	3.5 Liquid
Veal		9.9	2.1

★ Where available, values are based on BC data. Otherwise, based on *Manure Production and Characteristic Standards (2005)* by American Society of Agricultural Engineers. If the actual farm situation differs significantly from the foregoing, the value in this table should be adjusted up or down in consultation with your Planning Advisor.

Liquid For swine, it is assumed that the manure is in the liquid form. Manure nitrogen concentrations can be extremely variable in liquid systems. The values for liquid manure in this table are based on uncovered manure storage facilities. For farms in high rainfall areas with covered manure storage, multiply the manure nitrogen concentration values by 1.5 or get a manure analysis done and use the on-farm value.