NUTRIENT MANAGEMENT PLANNING FOR SEWAGE BIOSOLIDS

This chapter directly addresses Ontario farmers considering having sewage biosolids applied to their fields. We'll walk through the details of developing and implementing a nutrient management plan for a farming operation where biosolids are used. Checklists for haulers and applicators are included. (A case study of such an operation appears later on page 102 to help illustrate the steps and the real-life management implications.)

On September 18, 2009, Ontario Regulation 267/03 (the nutrient management regulation) was amended. The majority of the amendments were related to the management of the application of non-agricultural source materials (NASM), including sewage biosolids, on agricultural land.

Most of the regulatory changes related to the land application of NASM will take effect January 1, 2011. These changes include the requirement of a NASM plan for all NASM application areas unless a valid Organic Soil Conditioning Site Certificate of Approval issued by Ontario Ministry of Environment is in place.

This chapter reflects the regulations related to the application of NASM on agricultural land under O.Reg. 267/03 as of January 1, 2011.

10 STEPS TO MAKING IT WORK

Nutrient management planning for sewage biosolids is an in-depth process. But it doesn't have to be overwhelming – especially when you take it step-by-step.

Sometimes the best spokesperson for the use of municipal biosolids in a crop fertility program is the farmer who is using the material. Here, Harry Buurma presents his thoughts on the subject.

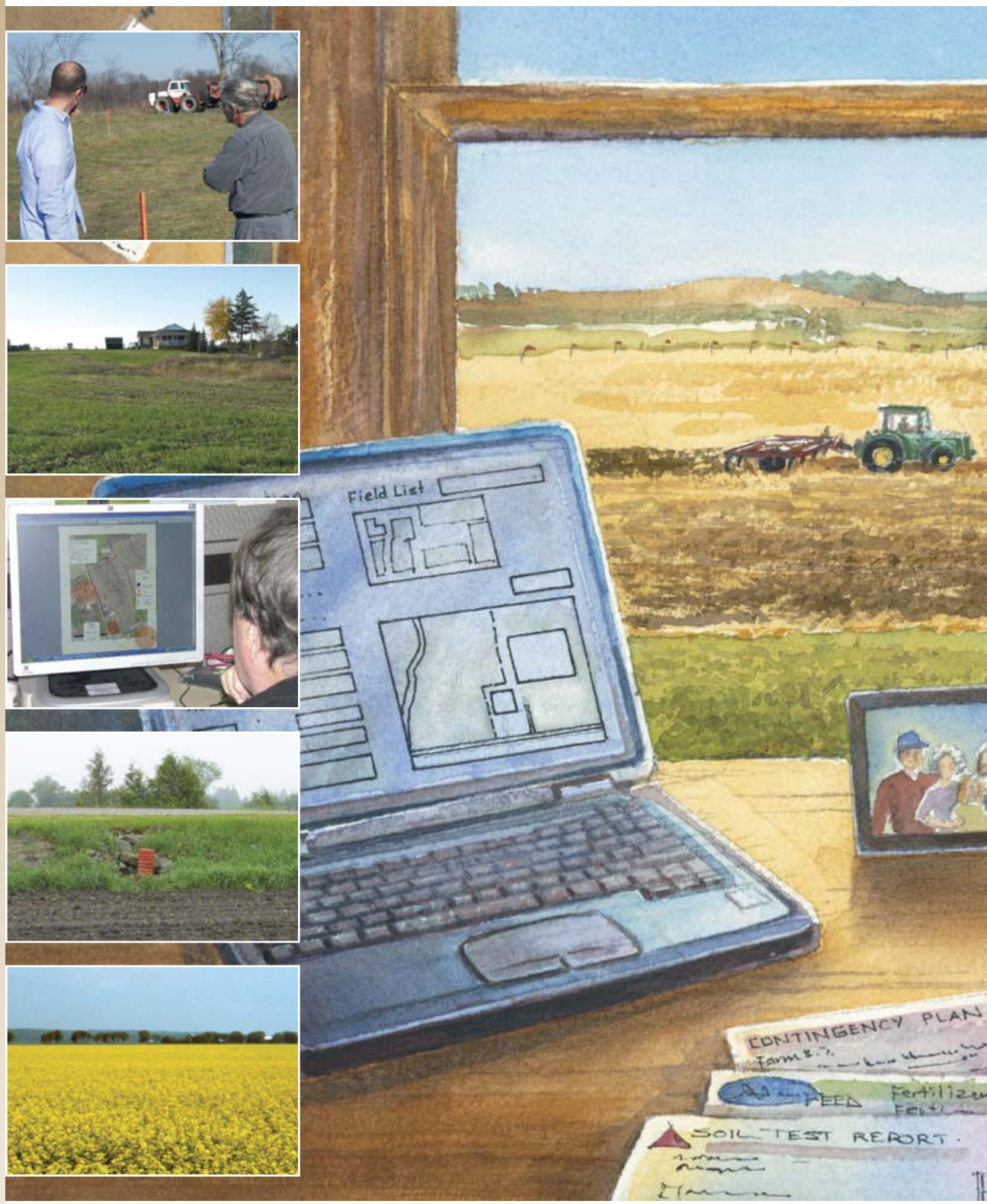
Step 1 – Set goals
Goal-setting states your direction for nutrient management planning and helps with decision-making. Seek advice from trusted sources to help form goals.

Step 2 – Take inventory
This step includes resource description, taking soil samples for analysis, and an accounting of current management practices.

Step 3 – Input and analyze data
Use the information collected in Step 2. OMAFRA software (pg. 70) will help evaluate application practices and help develop suitable application rates.

Step 4 – Develop options
Based on the results of your data analysis, develop options to manage risk, decrease input costs, and handle all nutrients generated.

Step 5 – Make decisions
Select management options to meet your goals. Choose and plan proper application rates and maintain separation distances.



Step 6 – Take action
"Walk the talk" to meet your goals. Make an operational plan and adjust for weather conditions.

Step 7 – Keep records
Show due diligence while keeping records for future planning. Maintain records for application rates, biosolids analyses, cropping, and monitoring results.

Step 8 – Monitor
Monitor the operation and resources to verify crop quality yield expectations and resource protection, and ensure the operation is not a nuisance for neighbours.

Step 9 – Make adjustments to your NASM plan
Fine-tune your plan, and upgrade technology where appropriate. Use information from record-keeping and monitoring to modify plan. Repeat Steps 3–6 if necessary.

Step 10 – Plan for the unexpected
Develop a contingency plan, document actions, and communicate to others involved.

STEP 1 – SET GOALS

Nutrient management plans for the land application of sewage biosolids are normally developed to do one or more of the following:

- determine where biosolids are best used in your operation
- optimize economic yields
- manage input costs
- protect soil and water resources
- ensure compliance with nutrient management regulations.

Identify which of these considerations relates to your farming operation now so that you can continue to focus on these throughout the planning process.

If you're less than comfortable with compiling the data required for your plan, or have a complex farm operation, you might consider creating a team of advisers (e.g., land application representative, crop consultant, a certified NASM plan developer, or hired help) to assist you.

In many cases, generators and licensed biosolids application companies work with, or have on staff, certified NASM plan developers who will develop a NASM plan for a biosolids-receiving operation. A NASM plan approved by the Ontario Ministry of Agriculture, Food and Rural Affairs is required for every sewage biosolids land application site.

Seek advice when setting goals for your NASM plan and biosolids application operation.

CITIZEN/LANDOWNER INVOLVEMENT

Generally a certain level of public involvement is encouraged when planning land application of biosolids. Neighbours who have been engaged and informed well in advance of biosolids use may be more tolerant than those left out of the loop. Ensure that neighbours are advised of your intentions to use sewage biosolids in your cropping program.

Biosolids haulers and professional agronomists work hand-in-hand with regulatory agency staff and other agencies to establish public education and outreach, oversee land application activities, and assist with citizen issues.

STEP 2 – TAKE INVENTORY

An inventory of your field resources is required to determine site suitability for land application of biosolids.

It's also an essential step in developing a useful NASM plan and choosing the most suitable BMPs for effective application.

Read on to learn what information you need to collect, and what resources can assist you in the process.

Site information is required to determine if specific fields are suitable (i.e., a manageable risk) for biosolids application. This information also helps the development of a comprehensive nutrient management program.

INVENTORY INFORMATION NEEDED TO DEVELOP A NASM PLAN

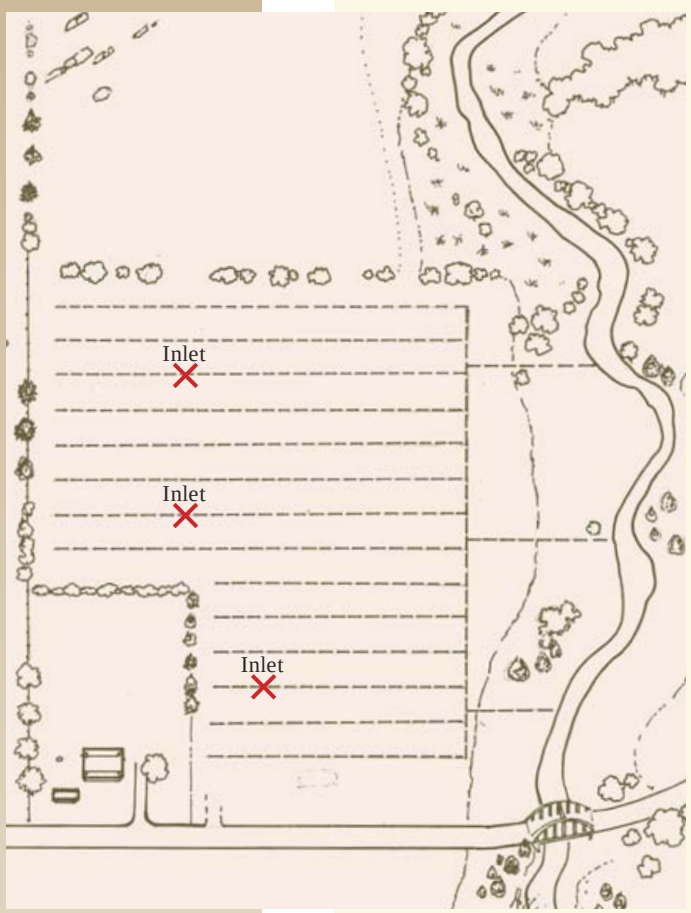
There are clear linkages between the information required for site approval and the site information that helps form the basis of a comprehensive and meaningful NASM plan.

Your nutrient management inventory will only be as good as the information you put into it. In this section you'll learn about:

- ▶ soils information
- ▶ field sketch
- ▶ crop inventory and yield information
- ▶ soil test
- ▶ biosolids analysis.

Check your local soil map to determine soil type, texture, and slope on your candidate fields. Take soil samples to test for nutrient levels (fertility).

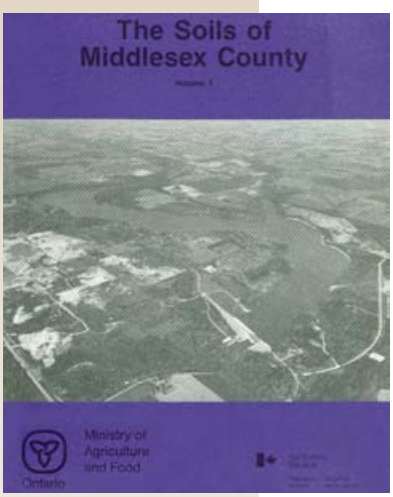
GETTING READY FOR INVENTORY



Having the following items on hand before getting started will speed up the process:

- contact names for laboratory services, sources for maps or aerial photos, and contact info for consulting services (if desired)
- county soil map and report
- topographic maps or aerial photographs for your property
- field measuring wheel or global positioning system (GPS)
- distance measurements – between facilities and lot lines, wells (all types), surface inlets and surface water bodies (e.g., creeks, streams, ponds)
- field slope measurements or tools for measuring slope in the field – clinometer, stake and string
- locations of tile outlets, buffer strips, surface inlets, wells
- crop records – crops grown, yield, recent nutrient application, soil test results
- soil sampling equipment – shovel or soil sample probe, bucket, soil test bags/boxes.

Knowing where subsurface drainage features are located is important to help applicators follow the application plan and maintain separation distances from inlets.



SOIL INFORMATION

Soil maps show your soil types, their properties (materials, slopes, natural drainage class, stoniness), and extent of these soils on your farm or application site.

Soil reports can provide important information on:

- slope and erosion risk
- hydrological groups for use in a NASM plan, and in some cases,
- liquid loading limits for application rates.

NITROGEN INDEX (N INDEX)

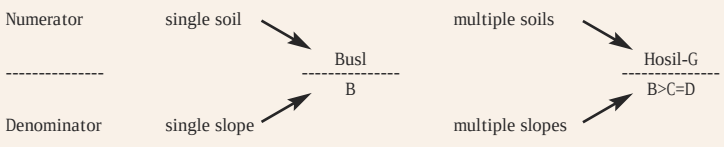
The N Index is a tool for reducing the risk of nitrate contamination of groundwater. It evaluates the vulnerability of nutrient management practices with respect to the movement of nitrates. The N Index combines source and transport factors to assess the risk of nitrate movement to groundwater on a field-by-field basis.

PHOSPHORUS INDEX (P INDEX)

The P Index is a tool for reducing the risk of phosphorus contamination of surface water. It assigns a value to the risk of surface water contamination from nutrient application to cropland. The value is based on soil phosphorus levels, amount and method of phosphorus application, soil type and site characteristics, and tillage management in the vicinity of the surface water body.

Both maps and reports can also help you recognize potential environmental risks and unseen areas of your soil (subsoil and geology) that may impact application management.

SOIL MAP SYMBOLS



SOIL TEXTURE ABBREVIATIONS

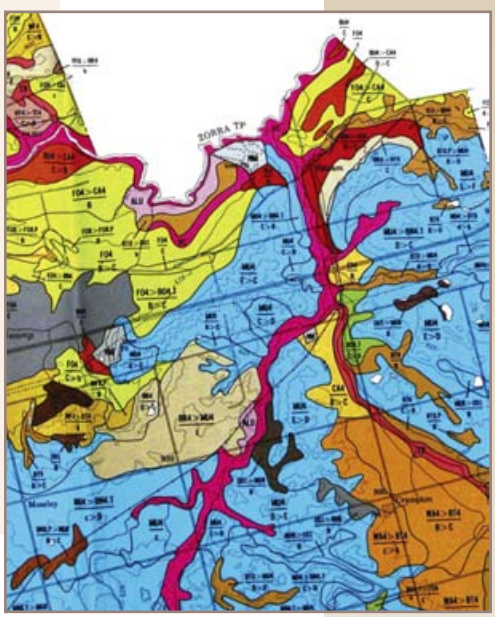
l	=	loam
sl	=	sandy loam
ls	=	loamy sand
cl	=	clay loam
sil	=	silt loam
s	=	sand
c	=	clay
si	=	silt

SLOPE CLASSES

A, a.....0–0.5% slope	Level
B, b.....0.5–2% slope	Level to nearly level
C, c .....2–5% slope	Very gently sloping
D, d.....5–9% slope	Gently sloping
E, e .....9–15% slope	Moderately sloping

Upper case = Long (>50 m or 164 ft) simple slopes

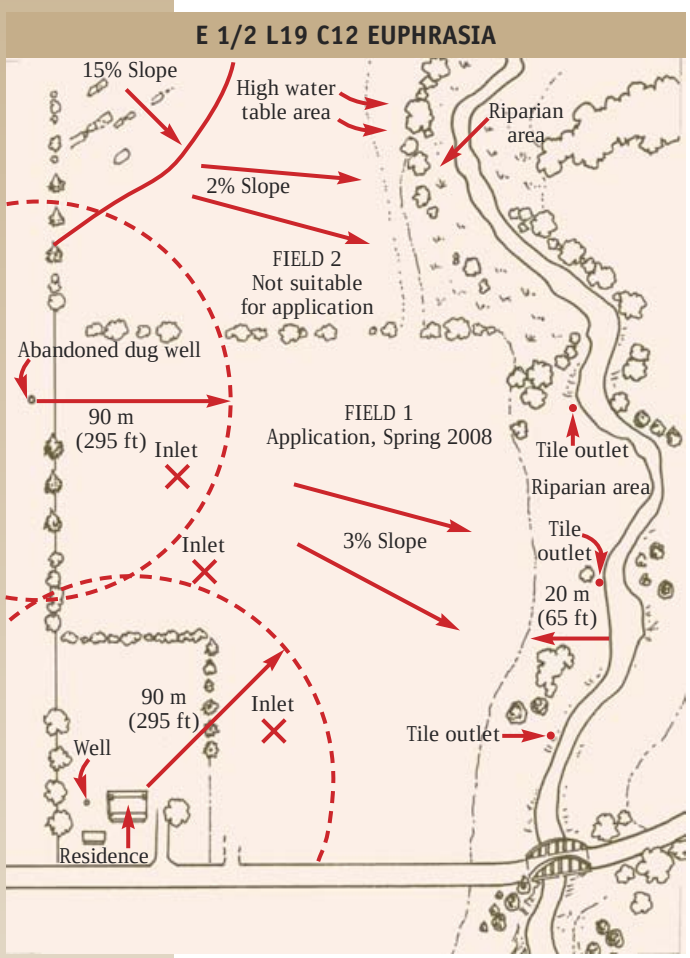
Lower case = Short (<50 m or 164 ft) complex slopes that intersect each other



How to use soil survey information:

- **locate map units for area**
- **determine soil series and slope information from legend found on soil map**
- **use soils report and *Drainage Guide* for descriptions and interpretations.**

FIELD SKETCH



A field sketch should identify location(s) of the following:

- lot and concession
- field sections
- presence of tile drains within a field
- tile inlets and outlets
- surface water within 150 metres (492 ft) of the field
- non-agricultural land uses
- all wells within the field and within 100 metres (328 ft) of a field boundary
- slopes
- other physical features such as rock outcrops.

SETBACKS FROM HICKENBOTTOMS, CATCHBASINS AND OTHER TILE INLETS

A 20-metre (65 ft) setback from surface inlets must be maintained.

Surface tile inlets such as Hickenbottoms are not defined as surface water, but they are direct conduits to surface water, and therefore should be protected when spreading sewage biosolids.

They should be treated as surface water (given a setback and maybe even a vegetated buffer). Doing nothing isn't an option.

CROP INVENTORY AND YIELD INFORMATION

You should have accurate crop and yield information to develop an effective nutrient management plan. You'll need to know:

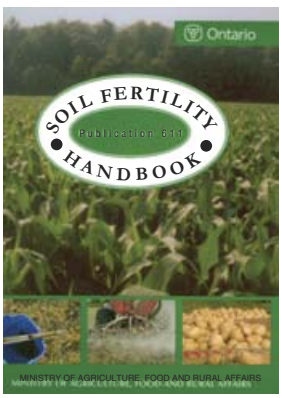
- crop rotation
- average yield (five-year average to cover weather impact) – to determine nutrient needs and to estimate nutrient removal
- previous crop (e.g., are there any nitrogen credits?)
- field soil test results
- previous NASM applications within the past four years
- commercial fertilizer and other nutrients (livestock manure) applied or planned.

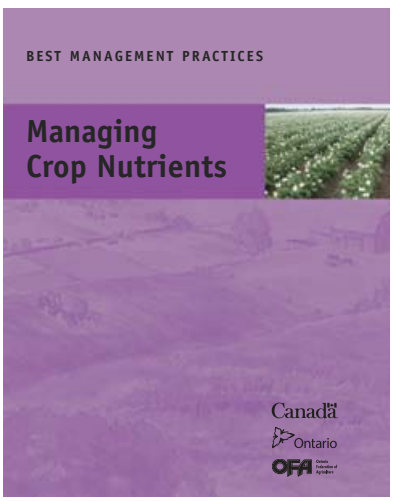
SOIL TEST

The soil test is a measure of the major nutrients and micronutrients and will indicate the likelihood of crop response to applied nutrients. Soil test results are the starting point for future determination of crop needs and potential environmental areas of concern.

Soil from fields being considered for sewage biosolids application must be analyzed for phosphorus, pH, and the 11 regulated metals.

For more information regarding soil tests and fertility, refer to the *Soil Fertility Handbook,* OMAFRA Publication 611.





The BMP book *Managing Crop Nutrients* is also an excellent resource for information on soil testing.

Ontario Accredited Soil Test Laboratories Ltd.
FARM SOIL REPORT

Report 62269 for G Smith
Received 10/09/08
Printed 15/09/08

	Analytical Values					mg/kg	milligrams per		litre of soil (ppm)											
#	Field I.D.	Lab #	pH	BpH	O.M. %	NO_3-N	Phosphorus		K	Mg	Ca	Texture	Mn		Zn		% Base Saturation		
							$NaHCO_3$	Bray P					ppm	Index	ppm	Index	K	Ca	Mg
1	field 1 North half	998701	7.1		3.5		28 H		187 VH	112	2049	M					4.1	8.0	87.9
2	field 1 South half	998702	7.2		3.2		33 VH		220 VH	167	2236	M					4.3	10.6	85.1
3	field 2 North half	998703	6.9		4.0		35 VH		210 VH	127	1242	M					6.0	11.8	68.9
4	field 2 South half	998704	5.7	6.8	2.8		25 H		175 VH	158	897	C					5.2	15.2	51.8
5	field 3 North half	998705	7.0		3.8		14 M		108 VH	118	2710	F					1.9	6.6	91.5
6	field 3 South half	998706	7.1		3.3		26 H		160 VH	120	2814	F					2.7	6.5	90.9
7	field 1 eroded knoll	998707	7.6		1.8		50 VH		235 VH	150	3257	M	2.5	14	1	14	3.3	6.9	89.8

Soils with a test result of >60 mg/l (ppm) based on Olsen sodium bicarbonate P test are not eligible for sewage biosolids application.

BIOSOLIDS ANALYSIS

Municipal wastewater treatment plants are required to test their sewage biosolids on a regular basis. The biosolids must be analyzed at a lab, using accredited methodologies. The analysis includes:

- total Kjeldahl nitrogen
- ammonium–nitrogen
- ammonia–nitrogen
- nitrate–nitrogen
- nitrite–nitrogen
- pH
- total phosphorus
- the 11 regulated metals.

The results of the analysis are averaged over time and the average concentration of each of the 11 regulated metals cannot exceed strict regulatory limits. If they do, the biosolids cannot be applied to agricultural land.

The analysis must include E. coli., an indicator organism used to monitor the effectiveness of the treatment process in the reduction of potentially pathogenic organisms that may be in the sewage biosolids. Sewage biosolids intended to be land-applied must have a geometric mean concentration of E. coli of less than 2×10^6 colony-forming units per gram total solids.

STEP 3 – INPUT AND ANALYZE DATA

Step 3 aims to:

- ▶ determine usable land base and, for biosolids application, interpret the inventory information for site suitability
  - ▷ inventory information is interpreted to determine if there are sufficiently few restrictions to make candidate fields suitable for application
- ▶ establish the nutrients required for the planned crop on a field-by-field basis.

SITE SUITABILITY FOR APPLICATION

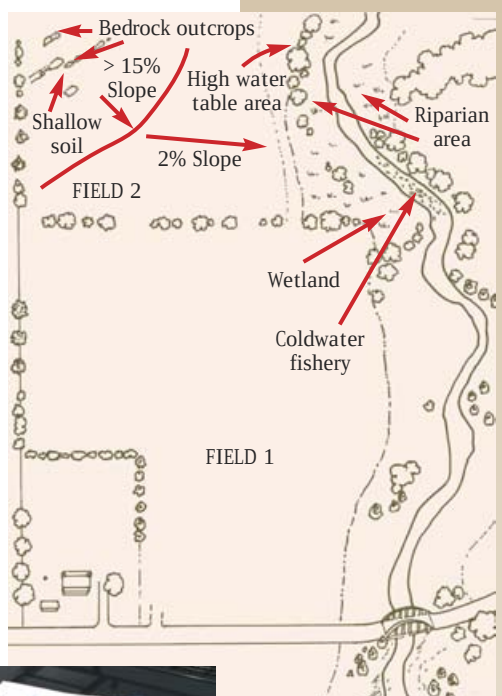
Site physical characteristics that influence the land application management practices include those physical properties that affect risk to groundwater or surface water contamination such as:

- ▶ topography
- ▶ soil permeability
- ▶ infiltration
- ▶ drainage patterns
- ▶ depth to groundwater and bedrock
- ▶ proximity to surface water and wells.

Regulations may place limits on land application based on these physical characteristics (see table on next page).

Areas where biosolids application is not permitted include:

- ▶ immediately adjacent to lakes, rivers, and streams without appropriate buffer areas (floodplains)
- ▶ wetlands
- ▶ steep slopes
- ▶ undesirable geology (karst, fractured bedrock) if not covered by a sufficiently thick layer of soil
- ▶ undesirable soil conditions (rocky, shallow, organic soils).



These areas need to be identified and indicated on maps or sketches for site approval.

CONSIDERATIONS FOR SITE SELECTION

ITEM	DETAILS
SITE SELECTION PRE-SCREENING **All of the site characteristics below have associated regulatory requirements involving setbacks or application rate restrictions depending on the specific characteristic. The requirements are set out in Ontario Regulation 267/03.**	
SEPARATION DISTANCES TO RESIDENCES AND RESIDENTIAL AREAS	• Maintaining adequate separation distances from residences, residential areas, and other areas of commercial or community use reduces the impacts of odours and dust on neighbouring properties. • There are required regulated minimum separation distances that must be followed in O.Reg. 267/03.
LAND USE RESTRICTIONS	• Farmer is willing to agree to crop restrictions following biosolids application as follows: ○ hay and haylage ➧ 3 weeks before harvest ○ commercial sod ➧ 12 months before harvest ○ tree fruits and grape ➧ 3 months before harvest ○ small fruits ➧ 15 months before harvest ○ vegetables and tobacco ➧ 12 months before harvest ○ horses, beef and dairy cattle ➧ 2 months before grazing ○ swine, sheep and goats ➧ 6 months before grazing.
SOIL DEPTH/TYPE	• Soil maps are reviewed to determine whether there is likely to be adequate and suitable (i.e., mineral) soil. • Application to organic soils (>17% organic matter) is not permitted. • Visual inspection of the soil type may be used instead of soil maps. • Hydrologic soil group must be determined if the application site is within 150 m (492 ft) of the top of bank of surface water. • Shallow soil depth may restrict application rates.
SOIL P LEVELS	• Sites with soil test P >60 mg/L (ppm) based on Olsen sodium bicarbonate P test are not eligible to receive sewage biosolids.
SOIL METAL LEVELS	• Sewage biosolids cannot be applied to a site if any of the regulated metal concentrations in the soil exceeds the maximum permissible concentration (see table on pg 38).
SITE ASSESSMENT	
SOIL DEPTH TO BEDROCK	• Soil depth should be measured by at least one test hole per 10 hectares (25 ac) evenly distributed over the property (minimum one location per site). • Locations of test holes are indicated on the site plan. • The optimum depth to bedrock should be at least 1.5 m (5 ft). Shallower depths may be considered if application rates are lowered and/or the soil is tilled prior to application of the sewage biosolids. • Where rock outcrops are visible, appropriate setbacks should be indicated on the site plan.
FIELD MEASUREMENT	• The field and buffer areas should be measured to within **5%** of actual using differential GPS or air photos and software capable of calculating the area. • Once buffer areas have been identified, their area is accurately measured and deducted from the total field area.

CONSIDERATIONS FOR SITE SELECTION	
ITEM	**DETAILS**
SITE ASSESSMENT (continued)	
LANDOWNER CONSENT	• Signed consent is obtained from the landowner indicating an understanding of: ○ waiting periods ○ crop restrictions ○ specific area where biosolids will be spread (shown on site plan) ○ amount of nutrients being provided by biosolids. • Where the landowner is different from the farm operator, the farm operator will also sign to indicate understanding of the above items. The signatures of both parties are required on a NASM plan.
FLOODPLAIN LOCATION	• Areas will not be selected that are subject to frequent flooding (annual or biannual) based on visual observations or floodplain mapping. • Where a portion of the site is subject to flooding as defined above, it will be delineated on the site plan and excluded from the spreadable area.
FIELD SKETCH	• An accurate field sketch should clearly delineate: ○ site boundaries, buffer areas around wells, and surface water ○ topographical features (slopes and rock outcrops) ○ location of residences, residential areas, and setbacks ○ wells – in field and within 100 m (328 ft) – by type (drilled, dug, municipal) ○ surface water and tile drain inlets and outlets ○ setbacks from sensitive features ○ test hole locations ○ staging area ○ field entrance ○ proposed stockpile location if applicable.

REQUIRED NUTRIENTS

Once the site is considered suitable, the next step is determining which nutrients are required for the planned crop. This requires an accounting of the amount of nutrients left from previous crops (soil test results and credits), and nutrients available from biosolids based on specific management practices.

Inventory information must also be considered to establish potential restrictions and/or setbacks from surface water sources and other sensitive features (wells and residences).

The analysis process involves calculating nutrient balances and ensuring they are within regulatory limits. OMAFRA has developed a software package to assist certified NASM plan developers in the development of NASM plans. The software uses a comprehensive, field-by-field approach that includes site characteristics, with information about crop rotation, tillage, and timing of operations.

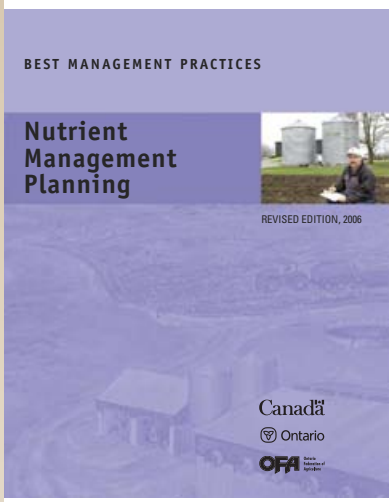
The OMAFRA software is the recommended program to be used to determine required nutrients, application rates, and usable areas (i.e., areas without restrictions or setbacks) in a field for nutrient application.

The software is available by calling OMAFRA, 1-877-424-1300.

The completion of Step 3 generates the information from which to determine the risks as well as the opportunities within the plan. The analysis step should highlight potential areas of concern that should be addressed in the plan.

The result will be only as good as the information entered. Analysis depends on a thorough understanding of the cropping management on your farm. It requires a commonsense approach to timing of nutrient application in light of the soil and cropping characteristics.

For more information on related topics, see the BMP book, *Nutrient Management Planning*.



When nitrogen (N) left over at crop harvest is combined with N from biosolids applied in late summer or early fall, the potential loss of N from the soil through leaching or denitrification could be significant.

Some of the information will be based on long-term knowledge of the land base and site conditions, and on personal observations.

Some key outcomes from the calculations that are of concern in biosolids application include the following four factors.

Application Rate

The biosolids application rate matches the P or N (whichever is lower) removed by the crop with allowance for soil buildup of crop nutrient removal for P. In order to build up phosphorus levels in the soil, a P application rate of up to 78 kg/ha (69 lb/ac) above what the crop removes per year is allowed.

P Index

If the P soil test is 30 ppm (mg/L) or higher, completing the P Index is a recommended BMP. The environmental impacts of P transport to surface water will be greater if the P Index is 30 or higher and significant erosion occurs. The P Index considers erosion potential and level of P in the soil to calculate a phosphorus separation distance.

If the P soil test is >60 ppm (mg/L), then biosolids application is not permitted.

P and N Indexes are tools to help limit the amount of nutrient lost from the field to the environment. Both are calculated as part of the software.

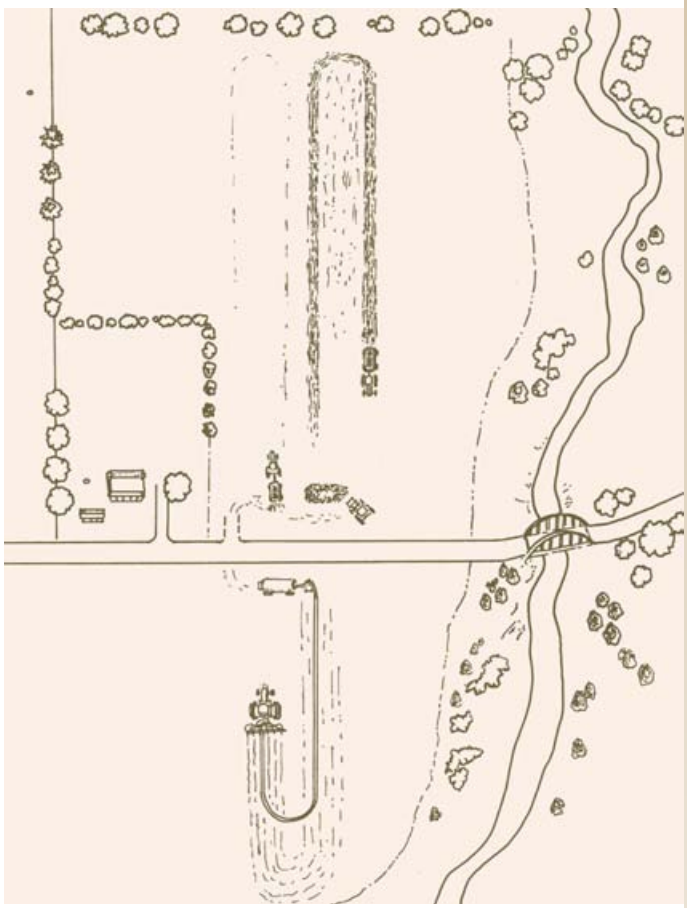
N Index

When N rates exceed crop removal, calculating the N Index is a recommended BMP to limit potential N loss by leaching during the non-growing season.

Separation Distances

Separation distances are specified in provincial regulations and were established to protect surface water and groundwater resources.

Surface-applied liquid biosolids may require a larger separation distance than dewatered solid biosolids or liquid biosolids pre-tilled, injected or immediately incorporated. See O.Reg. 267/03 for more details.



Surface-applied liquid biosolids separation may require a larger separation distance from surface waters than surface-applied dewatered (solid) biosolids.

"Liquid loading limit" is the maximum application rate at which liquid biosolids can be applied to minimize the risk of material moving over the surface. It's determined from the runoff potential (slope and soil texture), and limits the application rate to one that can be absorbed by the soil. This loading limit can result in a requirement for reduced or split applications (e.g., several days apart).

Cropland buffers can help in reducing red flag triggers.

GREEN, YELLOW AND RED FLAGS: WHAT ARE THEY?

The software program uses different-coloured flags to indicate risk level. Green means data are acceptable. Yellow means that information is missing or there are conditions that approach environmental risk or poor economic resource use.

Red BMP flags (identified by a lighter red colour or by a stop sign containing an "!") represents an area of environmental concern. Changes may be needed in the nutrient planning system to eliminate these flags.

Red legislative flags (identified by a deep red colour and a stop sign) indicate a legislative infraction according to Ontario Regulation 267/03. A regulated NASM plan submitted for approval with these warning flags may not be acceptable.

Here's a sampling of red flag triggers:

Biosolids application rate in one application exceeds the maximum liquid loading rate.

The nitrogen available for loss from fall-applied materials exceeds the lower of 120 lbs/ac or the maximum N Index value based on the field's hydrologic soil group.

Biosolids application rate results in a regulated metal application in excess of permitted limits.

The soil pH of the receiving field is <6.0 or the P soil test is >60 ppm or any of the regulated metal concentrations in the soil exceed the permitted concentration.

INTERPRETING SOIL TEST RESULTS

The recommended approach to nutrient application is applying nutrients at rates that optimize profitability while managing environmental risk. As fertility levels increase, crop response to added nutrients will decrease.

When nutrients are applied in excess of crop utilization, over time nutrient levels will gradually build up in the soil, or in the case of nitrogen, move out of the root zone.

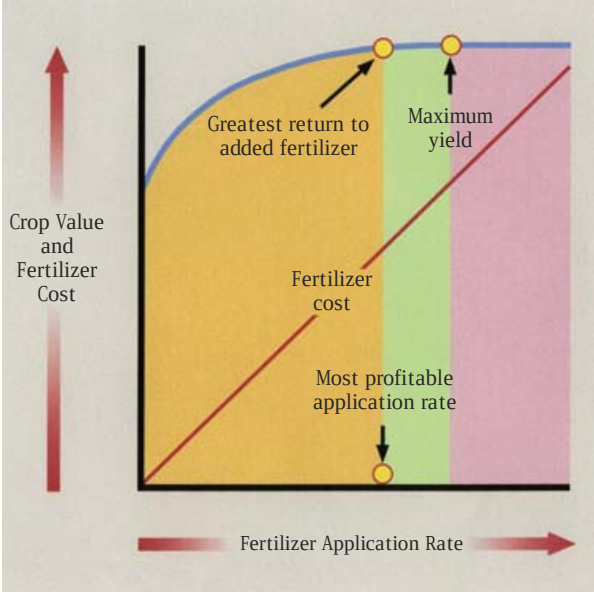
There are two distinct goals for interpreting soil tests.

For lower-testing soils: aim to ensure adequate nutrient levels to optimize production, crop quality, and returns.

For higher-testing soils: plan nutrient applications to protect water quality. For example, when planting corn or wheat into soils with adequate but not extreme fertility levels, applying a liquid pop-up with the seed provides required nutrients closer to the seed, but at much lower volumes and incorporated into the soil.

In Ontario, crop fertilizer recommendations are based on the results of field trials conducted for each crop to determine the optimum rate for each level of soil fertility.

Agronomic nutrient requirements for P and K are based on soil test results. OMAFRA recommendations are based on the "nutrient sufficiency" approach. Agronomic N requirements are based on researched response curves for highest economic yield.



Crop yields show a diminishing return from increasing soil fertility beyond the point of maximum economic yield.

Most soil test results contain the information cited in the following chart.

TYPICAL INFORMATION IN SOIL TEST RESULTS

ITEM	DETAILS
SAMPLE NUMBER	• a reference in case a sample needs to be re-analyzed
pH AND BUFFER pH	• buffer pH is also provided when sample has a pH of 6 or lower • buffer pH indicates lime requirements to bring the pH of the soil back to 6.5 or higher • **if soil pH is <6.0, sufficient lime must be applied to the field to raise the soil pH to >6.0 prior to the application of sewage biosolids**
ORGANIC MATTER	• useful as baseline – soil organic matter improves soil quality
P AND K LEVELS	• the symbol HR means a high probability of response • LR means a low probability of response • NR means no or negative response – pertains to soils where additional nutrients will not give any economic yield return ○ this occurs at 60 ppm for P (for most crops) and 250 ppm for K ○ soil test values over these levels could reduce crop yield or quality and may increase the risk of water pollution • sites with soil test P >60 ppm are not eligible to receive sewage biosolids • in Ontario, only the sodium bicarbonate P test is acceptable for nutrient management planning
REGULATED METALS	• soils at proposed sewage biosolids application sites must be tested for the 11 regulated metals (As, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Se, and Zn) ○ if any of the metal concentrations exceeds the regulatory limit, sewage biosolids cannot be applied to that field
NITRATES (for corn and barley only)	• in May to early June, take a 0.3 m (1 ft) depth soil sample • results indicate soil nitrate-nitrogen levels, and can reduce side-dress application rates

BIOSOLIDS TEST RESULTS

Biosolids test results are generally provided in parts per million on a dry weight basis. Be sure to use the correct basis (wet or dry weight) when inputting data.

Biosolids test results must be used to help determine total available nutrients and overall nutrient application rates.

The following principles must be addressed when interpreting biosolids test results:

► only a portion of the organic nitrogen is available for crop uptake in the year of application (estimated at 30%)

► residual N is derived from the organic fraction of biosolids.

It's estimated that 40% of the P from biosolids is available as fertilizer P in the form of P_2O_5 to crops in the year of application. An additional 40% will become available over the longer term and adds to the total of available soil P.

STEP 4 – DEVELOP OPTIONS

In Step 4, you interpret the flags and information you've received following the initial run-through of the nutrient management planning model. You develop and assess the options to come up with the best possible decisions for biosolids application on your farm operation.

Desired outcome of Step 4

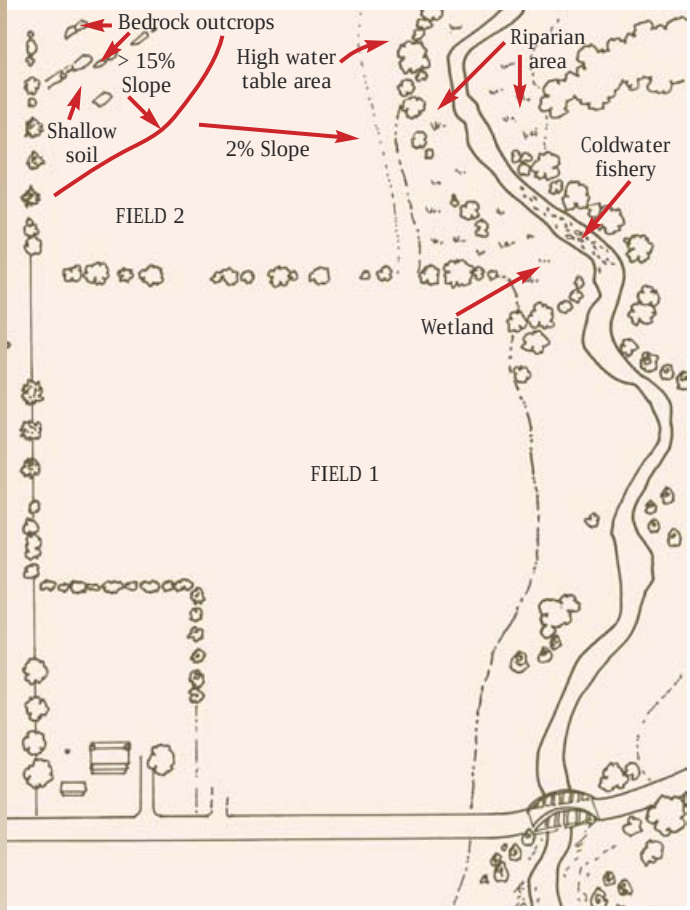
▶ **a systems approach that uses biosolids with the goal of maximizing economic benefit of these nutrients without compromising soil health, crop opportunities, and other farm operations**

Here you have the opportunity to explore options, to consider different management practices so that the impacts (e.g., on nutrient availability, application rates, environmental restrictions) can be compared.

Will some of the options result in changing your choice of cropland/fields for application? Or will they result in changes to application rates or setback distances?

Here are some of the areas you may wish to explore.

CONSIDERATION	DETAILS	IMPACT
APPLICATION RATES	• eliminating starter fertilizer	• increased application rate
	• soil test levels	• limited application rate • crop growth and quality • fertilizer rates reduced
CROP ROTATION	• specific crop nutrient requirements	• application opportunities • acreage adjustments
PHOSPHORUS INDEX	• tillage and residue management to reduce soil erosion – cross-slope	• reduced P Index
	• strip cropping and buffers	• reduced P Index
SEASON OF APPLICATION	• late fall application	• reduced application rate
	• use of cover crops with fall application	• increased application rate



Crop responsiveness to applied biosolids and the potential for contamination of surface water and groundwater vary with land and soil conditions.

Greater crop response to applied biosolids can be expected if:

- soil test P is low – sewage biosolids application can be used to increase P levels
- one or more micronutrients are deficient, and/or
- water infiltration is slow and runoff potential is high due to low organic matter and/or poor soil quality.

The **potential for environmental contamination is less** if:

- soil test P is low
- there is little or no chance of flooding
- the depth to water table exceeds minimum depth requirements and the soil has fine texture
- BMPs for erosion and runoff control are in place for fields with steep slopes, and biosolids are not applied when slope is more than 12%
- hydrologic soil group (HSG) is a B or heavier
- biosolids are not applied near wetlands, and/or
- the application is done with greater than the required minimum setback to sensitive features such as surface water or wells.

Sewage biosolids should be managed like other nutrient sources.

From the standpoint of nutrient management practices, sewage biosolids should be managed as other nutrient sources with regards to fertility levels, application rate, time of application, and maintenance of soil pH.

- ✔ Monitor soil pH when using biosolids on a regular basis. This is especially important when applying alkaline- or lime-stabilized sewage biosolids. If the soil pH goes above 7, zinc and manganese deficiencies could occur.
- ✔ Apply sewage biosolids at rates according to OMAFRA recommendations for nutrients and lime, based on soil test results and in accordance with limits set out in O.Reg. 267/03.
- ✔ Keep records of biosolids analyses, soil test data, dates and application rates.
- ✔ Review the metal analysis of soils before application. This may be useful for diagnostic purposes should problems arise. Follow application rate, setbacks, and other requirements in the approved NASM plan for the application site.

NITROGEN RECOMMENDATIONS (kg/ha) FOR SPRING BARLEY BASED ON NITRATE-NITROGEN SOIL TESTS

SPRING SOIL NITRATE-NITROGEN 0–30 cm (kg/ha)	PRICE RATIO* 8	7	6	5
10	138	147	156	165
20	107	114	122	129
30	76	81	87	93
40	44	49	53	57
50	13	16	18	21
60	0	0	0	0

* Price ratio is the cost of nitrogen in the fertilizer ($/kg) divided by the selling price of the barley ($/kg).

Nitrate-nitrogen soil test results can be used to adjust application rates of biosolids and reduce fertilizer costs.

COMMERCIAL FERTILIZER

In most cases where biosolids are applied, commercial fertilizer is still required for economic crop growth. This is especially true with corn crops if N needs can't be met with biosolids alone.

In many cases, phosphorus is the nutrient that limits the application rate. Because sewage biosolids are low in potassium, potash fertilizer may be required.

Management strategies for improving N and P utilization often concern starter fertilizers. Ask yourself:

- ► is the starter fertilizer required – is it giving any yield benefit?
- ► is there a benefit to using a low-rate liquid starter (if starter is required)?
- ► is there an opportunity to do a side-by-side comparison to determine if there is a benefit of using starter fertilizer – especially if soil P test is greater than 30 ppm (30 mg/L)?

P Index values and related flags may render otherwise preferred fields unsuitable for biosolids application. Consider soil conservation practices such as cross-slope strip cropping to retain eligibility for biosolids.

CONSERVATION PRACTICES

Several conservation practices and structures will reduce the risk of erosion and runoff.

- ✔ Manage residue – reduce tillage operations to increase the percentage of the soil surface covered by the residue of the previous crop, thereby reducing the risk of erosion and runoff.
- ✔ Consider contour and cross-slope tillage and planting (including strip cropping) to, in effect, reduce the impact of cropland slope.
- ✔ Install erosion control structures such as field terraces, water diversions, and water and sediment control basins to reduce the energy of overland flow, and shelterbelts using fast-growing trees such as hybrid poplars to reduce wind erosion.

CROPPING SYSTEMS

Cover crops will help to mitigate N loss and N Index flags. Some cover crops take up and hold (trap) nitrogen and other nutrients in their organic form during the off season.

Consider inter-row application of lower rates of biosolids into a growing crop. This system applies the N when the crop needs are highest, and when risk of loss is lowest. This is also a greenhouse gas mitigation BMP.

Crop rotation will give more opportunities for application.

No two farms are the same. This is why there is no recommendation that will fit every situation.

Here are some alternatives that fit into a whole farm management program and may help to schedule around timing of biosolids application.

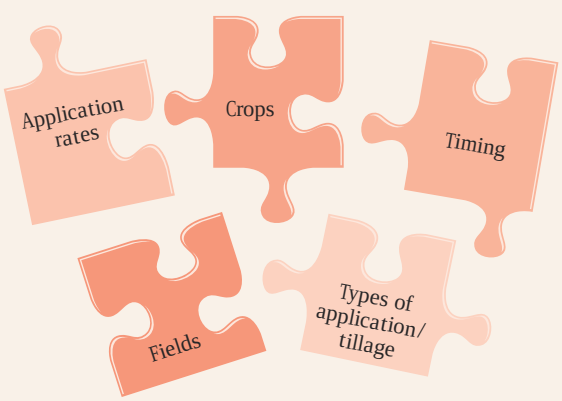
CROP	EARLY SPRING (after March 31st)	SPRING / SUMMER	FALL APPLICATION (before December 1st)
WINTER WHEAT	• drag hose • tanker – splash plate/ low-trajectory broadcast or dribble	• not suitable	• after harvest or prior to fall planting • pre-till to break macropores • tanker- or tractor-mounted injection system • suitable for dewatered biosolids
CANOLA	• pre-plant to help meet N requirements • avoid compaction • use tractor-mount drag hose	• not suitable	• after harvest or prior to fall planting • pre-till to break macropores • tanker- or tractor-mounted injection system • suitable for dewatered biosolids
SPRING GRAINS	• not suitable unless N requirement higher than average	• not suitable	• after harvest or prior to fall planting • pre-till to break macropores • tanker- or tractor-mounted injection system • suitable for dewatered biosolids
CORN	• suitable for pre-plant • may need to choose shorter-day varieties or silage • suitable for dewatered biosolids	• suitable if application equipment can adjust to standing crops • tanker – splash plate/low-trajectory broadcast or dribble	• after silage or grain corn harvest – most application equipment types can be used • suitable for dewatered biosolids
SOYBEANS	• only suitable for fields requiring low application rates • risk of lush growth leading to lodging and white mould	• not suitable	• after harvest • pre-till to break macropores • tanker- or tractor-mounted injection system • suitable for dewatered biosolids
FORAGE/PASTURE ensure regulation-required waiting periods are followed	• suitable for pre-plant or in conjunction with pasture renovation – where rotation provides grazing access delay	• between cuts – broadcast or injected – especially with high grass-content forage stands	• most suitable for forage that will be plowed down
COVER CROPS	• may be applied prior to tillage of a fall-established cover crop	• tanker – splash plate/low-trajectory broadcast or dribble	• tanker- or tractor-mounted injection system • suitable for dewatered biosolids

Most application equipment types can be used when sewage biosolids are applied after corn harvest.

Reducing tillage on candidate fields for biosolids application will reduce the P Index and provide more management options – including higher application rates and shorter separation distances.

STEP 5 – MAKE DECISIONS

Once the options are developed, it's time to make decisions on the best course(s) of action.



When selecting options for the application of biosolids, you need to consider:

- **which fields**
- **which crops and when in the rotation**
- **which soil and water conservation BMPs may be necessary to lower current N and P Index values**
- **timing and method of application – where negotiable**
- **whether to proceed**
- **application rate**
- **supplemental fertilizer.**

FIELD SELECTION

✔ Work with your agronomic consultant and/or certified NASM plan developer to select the most suitable fields among this list of candidates:

- ► fields without biosolids application within the past five years
- ► fields with properly documented application procedures
- ► fields with suitable soil and slope conditions
- ► fields without sensitive areas in the vicinity.

Fields without site limitations or without previous biosolids application may be ideal for application.

CROP SELECTION

✔ Choose crops that will benefit most:

- ► fertility records can help you determine fields requiring fertility buildup
- ► high N-use crops such as corn, cereals grains, and grassy forages will benefit from the N-supplying capability of biosolids
- ► although biosolids can be applied to fields where vegetable crops are to be grown, generally grain and forage crops are better choices for biosolids application due to the length of the required waiting period between biosolids application and harvesting of the vegetable crop

Schedule the timing of application to best match all operational considerations, such as field operations, weather patterns, and probable soil conditions.

TIMING OF BIOSOLIDS APPLICATION

The timing of biosolids land application must be scheduled around tillage, planting and harvesting operations, and will be influenced by crop, climate, and soil properties.

✔ Wait until conditions are suitable for tillage:

- ► traffic on wet soils immediately following heavy rainfalls may cause compaction and leave ruts in the soil, making crop production difficult and reducing crop yields
- ► muddy soils also make vehicle operation difficult and can create public nuisances by carrying mud out of the field and onto roadways.

✔ Apply when crops can use N:

- ► applications should also be made when crops will be able to utilize the N contained in the biosolids
- ► failure to do so could result in potential nitrate contamination of groundwater due to leaching of this water-soluble form of nitrogen.

✔ Use cover crops:

- ► fall applications should be followed with a cover crop to reduce erosion and runoff as well as leaching nitrogen.

✔ Use split applications:

- ► this may be required for liquid biosolids with low solids or nitrogen content
- ► in this way, a higher rate can be applied – in two or more applications when the soil cannot assimilate the volume of the higher rate at one time.

WHETHER TO PROCEED OR ADJUST

Remember that you have the right and responsibility to alter plans. You may want or need to if the site conditions, crop rotation, material quality, or other factors make the application operation unsuitable at the previously scheduled time. It's important to record all changes to the NASM plan at time of application.

Alternative timing of application to best match all operational factors is another consideration.

APPLICATION RATE

Biosolids application rates are based on crop removal or crop requirements ("agronomic N rate"). The relative concentrations of nutrients in biosolids are rarely present in the proportions required by the target crop. Supplemental fertilization may be needed to promote optimum vegetative growth and yield.

Nitrogen is required by crops in greater amounts than any other nutrient. That's why the crop requirements for most other nutrients are normally met when the agronomic N rate is applied. In addition, N is the nutrient most likely to be lost to surface water via tiles and groundwater if applied at greater than agronomic rates.

Some cautions regarding the determination of agronomic N rates are in order.

The amount of plant-available N can be underestimated or overestimated because the N composition of biosolids used to establish the average N concentration can vary during the period of time that samples are collected and analyzed to establish the agronomic N rate.

The equations used to calculate plant-available N are not site- or source-specific, and the actual amounts of plant-available N may vary from the target rates. These problems occur with other types of organic nutrient sources such as manures and yard waste composts, and are not unique to biosolids.

Only a portion of the total nitrogen present in biosolids is available for plant uptake. This plant-available nitrogen or PAN is the actual amount of N in the biosolids that is available to crops during a specified period. (See our earlier look at PAN on page 34.)

DETERMINING SUPPLEMENTAL FERTILIZER NEEDS

The amounts of plant-available nitrogen, phosphorus, potassium, and other nutrients added by the biosolids should be used to calculate the application rate. Supplemental fertilizers should be applied if the amount of any nutrients supplied by the biosolids is less than that recommended.

The amount of potassium (K) applied in biosolids can be calculated from biosolids composition data. Ninety percent of the K in biosolids can be assumed to be readily plant-available because K is a soluble element.

Example:

The following calculation is used to determine the amount of K_2O added in a biosolids application and supplemental K_2O required for a wheat field that has a K fertilizer recommendation of 100 kg K_2O/ha and receives biosolids containing 0.05% K at an agronomic N rate of 8 dry tonne/ha :

8 dry tonnes of biosolids supplies: 8000 kg/ha × 0.05% K = 4 kg K/ha

to convert K to K_2O:	K × 1.2 = K_2O 4 kg/ha × 1.2 = 4.8 K_2O/ha
Assuming 90% availability:	4.8 × 0.9 = 4.3 kg K_2O/ha
Assuming the fertilizer recommendation of 100 kg/ha the additional K_2O needed:	100 – 4.3 = 95.7 kg/ha

STEP 6 – TAKE ACTION

It's time to put your NASM plan to work. It may not be followed exactly as planned due to unforeseen circumstances, change in conditions, and so forth. But now you have a solid framework for nutrient use in your operation.

The best reason to implement and follow a plan is to meet the goals set out at the beginning of the process.

✔ To put your plan into action:

- ► write down or obtain a computer printout of your plan
- ► work with your NASM plan developer to review the details of the plan with you, the biosolids applicator, and anyone else involved in the farm operation
- ► keep the plan in a location where it can be easily accessed for review
- ► prioritize the actions and be prepared for the scheduled application date
- ► consider weather, site conditions, field operation precautions, and recent concerns or plans of your neighbours.

Have your NASM plan developer review the operational details of your plan with you.

FIELD CONDITIONS

✔ On the day of the scheduled application, check field conditions to ensure that:

- ► soil moisture is suitable for traffic and any pre-tillage operations
- ► field tiles are operating normally, e.g., no blowouts
- ► surface inlets are temporarily blocked – where necessary
- ► tile outlet controls are in place – where available
- ► tiles are not running. If water is flowing from the drainage tile outlet, consider pre-tilling the field.

WEATHER FORECAST

Weather, combined with soil moisture and drying conditions, can impact nutrient availability (especially nitrogen). Weather forecasts are useful when confirming pre-scheduled application dates.

✔ Monitor forecasts with special consideration of:

- ► wind direction (especially if there are residences downwind)
- ► relative humidity, and
- ► precipitation.

✔ Record this information at the time of application.

NEIGHBOURS AND NOTIFICATION

Many farm operations emit odours, produce noise or vibration, or cause dust. Some conflicts occur between biosolids users and neighbours. Unfortunately, such conflicts are not always handled as constructively as they might be. Conflict can be prevented: it takes a little know-how, a few skills and techniques, plus the right attitude.

The keys to preventing problems are neighbourly relations, good planning, and careful management.

✔ Get to know your neighbours. Help them feel comfortable enough to talk to you directly about their concern. This will help prevent the need for third-party involvement.

✔ Notify your neighbours of your intent to apply biosolids, and the precautions you are taking.

✔ Refer neighbours and other stakeholders to the biosolids generator or your certified NASM plan developer to answer technical questions regarding biosolids use.

✔ Follow your approved NASM plan, and ensure setbacks are maintained and in-field management minimizes offsite impacts.

SITE PLANNING

By following odour mitigation BMPs and taking neighbours' concerns into consideration, you'll be less likely to have odours as a point of contention.

✔ Locate transfer sites and field storage locations downwind from rural neighbours where possible.

✔ Keep stored materials and staging areas out of main view, if practical.

BMPs TO REDUCE ODOUR AND ODOUR COMPLAINTS
Odour management through setbacks and biosolids injection or incorporation is a regulatory requirement. These BMPs can assist in reducing odours and odour complaints.

BMP	DETAILS
INCORPORATE AFTER APPLICATION	• use tillage equipment to incorporate surface-applied materials • incorporate the same day of application to reduce the time for odour release
INJECT LIQUID BIOSOLIDS	• request that the materials are injected below the soil surface OR • incorporate the biosolids with a series of discs as they're applied on the soil surface
SCHEDULE YOUR APPLICATION	• carefully select the time of application – careful timing can decrease the opportunity for neighbours to experience the odour released • avoid spreading just prior to weekends or holidays when people are involved in outdoor activities • give special consideration to events planned at recreation areas near the land receiving the materials
CONSIDER WIND DIRECTION	• pay attention to the wind direction and, if practical, avoid spreading on days the wind is blowing toward neighbours or recreational areas
FOSTER NEIGHBOURLY RELATIONS	• maintain a co-operative public attitude • keep lines of communications open – hiding something generally arouses suspicion • be courteous even if your neighbours' requests are unrealistic • alert neighbours to date of application and discuss any plans they have for outside activities
KEEP RECORDS	• document all spreading activities so a record is available in case of problems • determine the cause of any complaint and work to correct it – good public relations go a long way toward improving acceptance of odours generated by biosolids application

For more ideas, see the OMAFRA factsheet *Farm and Neighbour Relations: Preventing and Resolving Local Conflicts,* Order no. 05-001.

When it comes to biosolids and neighbours, the good news is that BMPs for retaining biosolids-sourced nutrients – such as immediate incorporation, injection, and spreading on cooler days – will also reduce odours during application.

PRECAUTIONS FOR FIELD OPERATIONS

BMP Checklist for Application

✔ Notify residents within 450 m (1,476 ft) of the spreading site before application. Include:

- ► a copy of the site map
- ► estimated start and duration of operation
- ► contact name and number at the generating municipality or WWTP
- ► contact name and number for the contractor.

✔ Post signs in visible locations at the site entrance and along the frontage of land application sites.

✔ Have the contractor complete a pre-application checklist for each site verifying:

- ► buffers/setbacks have been flagged
- ► residents have been notified
- ► unsaturated soil depth has been verified
- ► the spreadable area is as planned
- ► proposed application rate and tonnage
- ► anticipated start date.

BMP Checklist for Hauling

✔ Cover dewatered biosolids loads during transport to the field.

✔ Inspect truck prior to entering public roadways to ensure biosolids are not present on the outside of the truck. Ensure end gates and shut-off valves are closed and secure.

✔ Ensure any biosolids inadvertently tracked onto public roadways are removed the same day.

✔ Stockpile dewatered biosolids:

- ► cover stockpiles with a contiguous cover of soil, hay or other approved material
- ► provide a 200-metre (656-ft) minimum separation distance from any residence
- ► provide a 450-metre (1,476-ft) minimum separation distance from a residential area.

✔ Ensure targeted application rate does not exceed the amount specified in the NASM plan, depending on biosolids quality and permitted application:

- ► incorporate within two hours of spreading under normal conditions, and in all cases, before sunset
- ► leave no more than 10% of the biosolids on the surface after incorporation.

Post signs when applying biosolids to cropland.

Cover dewatered biosolids loads during transport to the field.

Review your NASM plan and biosolids application plan with the applicator – specifically rates, separation distances and special site features.

SKETCHES FOR NMP AND BIOSOLIDS APPLICATION

Field sketches and maps are most useful during application when the applicator (yourself or someone hired) can see where materials will and will not be applied.

Sketches should have separation distances highlighted. Here are some examples:

- ► setback distances required from all wells
  - ▷ all wells within 100 metres (328 ft) of the field boundary for the field receiving biosolids
- ► direction of maximum sustained field slope – within 150 metres (492 ft) of the top of the bank of all surface water
- ► setback distances required from surface water established by the minimum separation distance
- ► location of all permanently vegetated buffer zones
- ► setbacks from rock outcrops and areas with shallow soil over bedrock
- ► identification of areas that are normally wet during the spring and fall
  - ▷ minimum depth of unsaturated soil conditions at time of application – this is required for fields where biosolids are applied
  - ▷ areas of a field where deep rutting occurs would be considered saturated
  - ▷ if a soil map shows poorly drained soils, this would indicate risk of saturated soil in the 30–60 cm (1–2 ft) range, while a soil map that indicates imperfectly drained soils would suggest a risk of saturated soils in the 60–90 cm (2–3 ft) range – unless the field has subsurface drainage
  - ▷ the other option to determine unsaturated soil depth is to dig test holes.

Using technology such as GPS mapping can significantly improve application accuracy and demonstrate compliance with regulated setbacks and application rates.

Preventing Preferential Flow

For the application of liquid biosolids on tile-drained soils, choose one or more of the following options.

- ✔ Monitor outlets and if biosolids are found in the tile drains, take appropriate action – stop application, block outlets (for at least 72 hours), and remove contaminated water (e.g., vacuum tanker).
- ✔ Pre-till to break macropores.
- ✔ Apply at a rate of less than 40 m^3/ha (3,600 gal/ac).
- ✔ Treat tile outflow to remove contaminants (e.g., biofilter, dispersion sandwich)
  - ► note that biosolids in subsurface drainage pipes can also become an issue when rainfall occurs shortly after application.
- ✔ Stop application immediately if discoloration is observed, then implement contingency plan.

For more information about monitoring tile flow, see Step 8.

On tile-drained soils, apply liquid biosolids at low rates when tiles are running.

WATERCOURSES

Regulation 267/03 under the Nutrient Management Act, 2002 requires a minimum 20-metre (66 ft) separation between the top of the nearest bank of a surface watercourse and the area of application of biosolids. Greater separation distances may be required depending on soil type, slope of the land, and application method used in the area near the watercourse. Separation distances are determined on a case-by-case basis.

STEP 7 – KEEP RECORDS

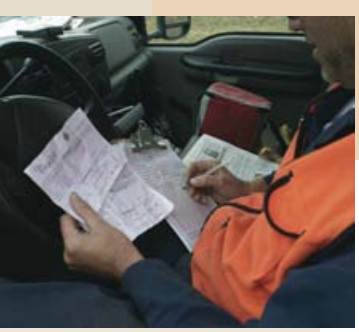
In order to review and revise a plan, you must know what was done. Record-keeping is the process of recording what **actually** took place.

Record-keeping is already a key component of many aspects of farming, such as financial book-keeping and recording crop and livestock yields. For NASM plans, there are several reasons for keeping records:

- proper records help to reconcile what was planned and the adjustments made at the time of application
- records demonstrate accountability and diligence – should something go wrong or if someone questions what was done (e.g., a nuisance complaint), having the records of what was done and when will help resolve questions and conflicts
- record-keeping is a regulatory requirement for biosolids application operations and NASM plans.

WHAT TO RECORD, POST-SPREADING

SUBJECT	DETAILS
SITE CONDITION	• conditions of the field entrance, staging area, and public roadways post-spreading • presence of biosolids on the road
POST-SPREADING CHECKLIST	• an inspection and checklist are completed by the contractor for each site indicating: ○ a visual confirmation that all biosolids have been incorporated with no more than 10% remaining on the surface ○ quantity of biosolids applied and location ○ date started and completed
COMPLAINT RESPONSE	• contractor should record all on-site responses and address all on-site queries and complaints by stakeholders
INFORMATION MANAGEMENT	• data from pre- and post-inspection reports are logged, including: ○ resident notification ○ lot and concession of site ○ date of start and end of spreading ○ area spread ○ total volume spread ○ rate of spreading ○ nutrient and metals loading



Record-keeping by the applicator is a regulatory requirement for biosolids application operations.

MONITORING AND RECORD-KEEPING

Computer-based and remote-sensing techniques have been developed to improve calibration, resource and input monitoring, as well as record-keeping techniques.

A map can be produced to verify setback distances. The data can be used by the local fertilizer dealer to compensate areas that did not receive biosolids with commercial fertilizer.

GPS technology improves precision of biosolid applications.

STEP 8 – MONITOR

Monitoring is the process of observing and recording. By using the records you've collected as a base, you can monitor your management practices for trends in your operation.

Over several years, the process will provide you with a solid foundation on which to base decisions and changes for meeting production and environmental targets.

WHAT TO MONITOR FOR	
SOIL	• increasing or decreasing soil phosphorus and potassium levels over a 10-year period • pre side-dress nitrogen tests to indicate nitrogen available for uptake by crops • compacted soils caused by application method or timing • changes in the concentration of regulated metals over time
CROPS	• yields and whether they're increasing or being maintained • side-by-side comparisons established and evaluated
WATER	• tile outlets: monitor before, during and after liquid application at one-hour intervals, 24–48 hrs after application to ensure that water is not contaminated • wells: sample well water regularly for fecal coliform and nitrates
BIOSOLIDS QUALITY	• biosolids analysis • concentrations of metals and nutrients applied
BUFFER STRIPS	• effectiveness of buffer strips: look for evidence of erosion and/or sedimentation or evidence of concentrated flow that indicates a grassed waterway may be more effective • effectiveness of buffer strips during intense or high rainfall events, which can result in surface runoff causing contaminated water
NEIGHBOURS	• comments/complaints from neighbours

Monitoring should take place whenever nutrients are applied to land. Most often, monitoring is simply a visual inspection just to make sure things are happening as planned.

APPLICATION ON TILED LAND – TILE OUTLETS

As touched on in Step 6, when applying to land with subsurface drainage, **monitor outfall (outlets) to ensure that biosolids are not entering surface water through preferential flow.** Look for discoloration of tile flow, relative to pre-application condition.

TILES SHOULD BE OBSERVED ON A REGULAR BASIS.

Here's a suggested schedule for observation:

- ► prior to application to determine the quality and quantity of flow (ideally there will be no flow)
- ► 10–20 minutes after start of application
- ► once each hour, if rate is greater than 90 m^3/hr (20,000 gal/hr)
- ► once each 90 m^3 (20,000 gal) if hourly application rate is less.

As an alternative to having a person monitor, consider using automated continuous monitors.

STEP 9 – MAKE ADJUSTMENTS TO YOUR NASM PLAN

After you've put your NASM plan into action, and the monitoring and record-keeping are underway, you're in a position to determine which decisions in the plan worked well and which did not.

As you contemplate making adjustments, remember to follow the systems approach to management.

A plan of this sort is a living document intended to change with time and technological advances, and with better understanding of the processes involved. It is most important to evaluate how well the plan met the goals set for it (Step 1).

Making adjustments to your plan is similar to repeating Steps 3 to 6 – the analysis, interpretation, decision and action processes. By going through the plan, making the required or desired changes, the end result will be a revised plan, ready for implementation.

When reviewing or making changes to your NASM plan, consider:

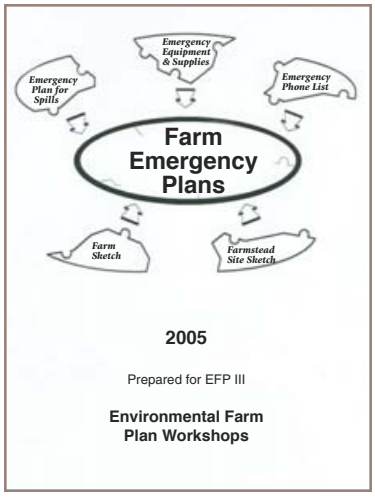
- changes to your plan – triggered by expanded acreages for biosolids application or the decision not to proceed with biosolids use
- personal changes that may affect long-term goals, labour availability, etc.
- greater understanding of the principles that may affect whether you, in consultation with your NASM plan developer, revise the plan
- market forces that may affect the livestock raised, crops grown, end use of products generated (including manure), acres of various crops, etc.
- neighbours' reaction and changes in the community (e.g., urban growth closer to the farm), bylaw changes, new regulations, etc. that may affect your choice to use biosolids
- biosolids sample analysis that may have changed since the initial results used for the original plan
- subsequent soil analysis that may show nutrient balance increasing over time
- commercial fertilizer rates or biosolids application rates that may have to be modified based on results from side-by-side comparisons
- new technology that may affect application rate or timing (e.g., application equipment, storage process such as anaerobic digesters or composting)
- purchase or rental of additional land base that may be required
- the changes made are in compliance with the most up-to-date version of O.Reg. 267/03.

If significant cropping management changes are planned, redo the NASM plan to reflect these changes.

STEP 10 – PLAN FOR THE UNEXPECTED

You need to be prepared for the unexpected. The best way to do that is to think ahead and plan what you would do if…?

A contingency plan is a written document that sets out actions to be taken in the event of an incident that presents an immediate environmental threat. For example, a tanker or biosolids nurse tank could leak or spill before application. Preparing a contingency plan in advance speeds up your ability to take corrective action on short notice. A NASM plan must contain a contingency plan that sets out actions in case of an emergency.



The EFP Emergency Plan is a good model for preparing for environmental hazards that could happen on your operation.

Spills Action Centre 1-800-268-6060

For additional information, please see the Ontario Ministry of the Environment's *Spill Reporting – A Guide to Reporting Spills and Discharges* (May 2007).

INCIDENT	ACTIONS
SPILL	
A spill is defined as a discharge of a pollutant into the natural environment that is abnormal in quantity or quality. Spills must be reported if they cause or are likely to cause any of the following: • injury or damage to property or animal life • impairment of quality of the natural environment – air, water, or land • adverse health effects • safety risk • making property, plant, or animal life unfit for use • loss of enjoyment of normal use of property • interference with the normal conduct of business.	In the event of a spill, the following steps will be taken: • spill area is contained to restrict public access • spill area is contained wherever possible to prevent movement to surface water or groundwater • contractor notifies Spills Action Centre • contractor cleans up the spill in consultation with Ministry of the Environment (MOE) • where there has been movement of biosolids into the natural environment, samples will be collected to assess the extent of contamination • all data collected is provided to MOE • incident report and chronology are logged.
ACCIDENTAL OVER-APPLICATION	
Over-application or application in restricted zones	In the event biosolids are over-applied or applied in restricted zones: • MOE is notified • the case is identified • affected areas are managed to ensure no or minimal environmental impact • MOE is provided with an incident report, including remediation if necessary, and changes to operating procedures to ensure incident does not recur.