Land Application of Municipal Sewage Sludge Guidelines

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Water Security Agency

1. Introduction

1.1 Purpose

The guideline's purpose is to provide adequate instructions and requirements to the owner/operators of wastewater treatment works, individuals and consultants who plan to apply/spread municipal sewage sludge onto agricultural land for beneficial use. The guideline's objective is to ensure the application of municipal sewage sludge onto agricultural lands is done in a beneficial and environmentally acceptable manner, protecting the environment and human health from adverse effects. The guidelines do not apply to industrial wastes.

1.2 Land Application of Sewage Sludge – Benefits and Concerns

Sewage sludge is a solid, semi-solid, or liquid residue generated during treatment of domestic sewage in a treatment works. It consists of 90 to 99 per cent water and an accumulation of settleable solids, mainly organic that are removed during primary, secondary or advanced wastewater treatment processes but does not include grit and screenings. Sewage sludge contains significant amounts of nitrogen and phosphorus, two of the essential plant nutrients, as well as lesser quantities of heavy metals such as copper and zinc.

Sewage sludge is a potential source of nitrogen and phosphorus for use in crop production. The application of sewage sludge at a controlled rate can improve the physical and chemical properties of soils because sludge typically possesses excellent soil amendment properties.

Sewage sludge also contains constituents that may pose a risk to soil, water, plants, animals or public health. The same constituents in sludge that benefit the soil and crops may also produce detrimental effects if they are applied at excessive rates or under improper conditions. Pathogenic organisms, heavy metals, soluble salts and other trace constituents present in sewage sludge pose serious concerns.

Sewage sludge containing pathogenic organisms should be handled and applied in a proper manner to reduce the risks to human and animal health. Pathogens are destroyed over a period of time at a rate that is dependent on the environmental conditions to which they are exposed. By waiting the appropriate length of time after the sludge has been applied before working the land or planting and harvesting a crop, the risks can be reduced.

2. Application/Permit Requirements

A permit to construct, extend or alter municipal sewage sludge application works must be obtained from the Water Security Agency (WSA) before starting construction of such works. A Permit to Operate Sewage Works that includes approval to land apply sewage sludge, must be obtained from the WSA prior to commissioning and operation. Applications for a Permit to Construct and/or Operate Sewage Works EPB 268 are required to be made on prescribed forms obtained from the WSA.

The following additional information will be required to supplement the application:

- legal description of the land to be used for municipal sewage sludge application, together with plans showing topography, watercourses, general soils classification, water wells within one kilometer radius of the land, residences and other buildings;
- representative analyses of municipal sewage sludge that is produced at the sewage treatment facility and a summary of the analytical results in comparison to the criteria specified in this guideline;
- details about sewage sludge stabilization methods and results of sludge analysis;
- the quantity of sewage sludge that will be applied onto the land and application rate;
- representative chemical and physical descriptions of the soil that will receive sewage sludge;
- data on water table locations, together with any available information (such as flow and usage) on underlying aquifers;
- the proposed use of municipal sewage sludge including intended crops, application system description and any special management/operation considerations;
- a copy of land control agreements, if applicable;

- contingency plans including details about storage facilities or alternate methods when sewage sludge application is not possible at certain instances and remedial measures to be taken in the event of any emergency situations; and
- the results of hydrogeological investigation where one is considered necessary.

The water table in the sewage sludge application area should be sufficiently deep to prevent water table rise to the root of the plants. Use of land for sewage sludge application overlying shallow aquifers utilized for water supplies should be avoided.

WSA's review of municipal sewage sludge applications focuses mainly on the quality of sewage sludge used and protection of public health and environment. WSA does not review the projects with regard to crop production and impacts to soil chemistry for agriculture. Project proponents are strongly advised to contact agrologists to determine the long-term sustainability of soil productivity for agricultural purposes.

All new sewage sludge projects shall be screened to determine if an Environmental Impact Assessment is required. The proponent often does screening with regards to application of *The Environmental Assessment Act* (EAA) as the onus is on the proponent to comply with the EAA. The two most likely items to trigger the EAA would be the sections with regards to impact on rare or endangered species such as if spreading were to occur on native prairie (Burrowing Owls etc.) or if spreading caused widespread public concern because potential environmental change such as with regards to impacts on local waterways, etc. Following these guidelines should help to ensure that the EAA is not triggered. Further information on screening requirements under *The Environmental Assessment Act* is available from the Ministry of Environment's Environmental Assessment Branch (306-787-6132).

3.Land Application Sewage Sludge – Design Guidelines

3.1 General

The following guidelines are based on currently available technology, information and experience. Exceptions to the guidelines will be reviewed on the basis of special circumstances and supporting technical documentation.

3.2 Sludge Treatment

Sewage sludge must be treated in such a manner so as to minimize the odour potential, reduce the number of pathogenic organisms and other potentially harmful constituents to an acceptable level before spreading it onto agricultural lands. All sewage sludge must be stabilized before spreading it onto agricultural or non-agricultural lands.

Sludge processes categorized as thickening, conditioning' or dewatering are considered as volume reduction processes and are mainly carried out to remove water from the sludge or reduce the moisture content. Water removal from the sludge improves efficiency of subsequent treatment processes, reduces storage volume and decreases transportation costs. Sludge drying beds, the most widely used method of sludge dewatering, rely on natural evaporation and percolation to dewater the solids. Other dewatering methods using belt filter press, vacuum filter and centrifuge are considered as mechanical and the solids content of mechanically dewatered sludge is higher than that of sludge drying bed.

Sludge stabilization is the treatment given to sludge and aimed to reduce pathogenic organisms, vector-attraction potential, odours and putrescibility of the sludge; acceptable stabilization processes include anaerobic digestion, aerobic digestion, composting, heat drying, heat treatment and chemical stabilization. Sewage sludge is also considered as stabilized sludge if one of the following requirements is met: [1]

- the mass of volatile solids in the sewage sludge has been reduced by at least 38 per cent;
- the specific oxygen uptake rate (SOUR) for the sewage sludge is $\leq$ 1.5 milligrams of oxygen per hour per gram of total solids on a dry weight basis, corrected to 20^0 C;
- demonstration through additional anaerobic digestion in a bench-scale unit that volatile solids reduction for anaerobically digested sludge is less than 17 per cent;.

- demonstration through additional aerobic digestion in a bench-scale unit that volatile solids reduction for aerobically digested sludge is less than 15 per cent;
- addition of alkaline materials to raise the pH of the sewage sludge to $\geq$ 12 and the sludge then remains at pH 12 or higher for two hours and then at pH 11.5 or higher for an additional 22 hours; and
- the sewage sludge has been treated in an aerobic composting process for 14 days or longer. During that time, the temperature of the sewage sludge must be higher than 40^0 C and the average temperature of the sewage sludge must be higher than 45^0 C.

For small lagoon systems that are common in the province, the use of a sludge drying bed in conjunction with composting may be appropriate before sludge application onto the lands. However, composted sludge should be tested for parameters such as volatile solids content to determine the efficacy of composting process.

3.3 Siting and Site Restrictions

Land selected for the application of municipal sewage sludge must meet the minimum separation distances as indicated below:

- the minimum distance between the land and public areas (i.e. parks and playgrounds) must be 90 metres;
- the minimum distance between the land and institutional buildings (i.e.: schools and hospitals) must be 200 metres;
- the minimum distance between the land and residential areas must be 450 metres.
- the minimum distance between the land and individual residences and commercial buildings must be 90 metres;
- the minimum distance between the land and public roads, railway lines and seasonal/drainage courses must be 30 metres;
- the minimum distance between the land with a sustained slope of zero to three per cent and watercourses, water bodies and water wells must be 90 metres; and
- the minimum distance between the land with a sustained slope of more than three to eight per cent and watercourses, water bodies and water wells must be 200 metres.

An easement agreement between the permittee of the wastewater/sludge treatment facility and landowners with a minimum term of 10 years is the preferred. Provision should be made in the agreement for general liability, liability for any future soil related problems, operating procedures/restrictions, monitoring and other responsibilities as deemed appropriate by the circumstances of the project.

The landowners who spread/apply the municipal sewage sludge onto the land for agricultural use must comply with the harvesting/grazing times as indicated below:

- food crops with harvested parts that touch the sewage sludge/soil mixture and are above the land surface shall not be harvested for 14 months after application of sewage sludge;
- food crops with harvested parts below the surface of the land (edible portions below the soil surface) shall not be harvested for 38 months after application of sewage sludge;
- food crops with harvested parts that do not touch the sewage sludge/soil mixture, feed crops and fiber crops shall not be harvested for 60 days after application of sewage sludge; and
- animals shall not be grazed on the land for 30 days after application of sewage sludge.

3.4 Sewage Sludge Quality Criteria

The sewage sludge quality is determined by the presence of pathogenic organisms and concentrations of heavy metals and is dependent on the wastewater characteristics and the type and quality of treatment. The concentrations of heavy metals such as arsenic, cadmium, copper and cobalt in sewage sludge vary depending on the contributions from industries and households to the sewer system and the efficiency of wastewater/sludge treatment system. Because of their sparingly soluble nature and their limited uptake by plants, heavy metals tend to accumulate in the surface soil and become part of the soil matrix [2]. With repeated applications of sewage sludge, heavy metals could accumulate to levels toxic to crops and build up to potentially harmful levels in humans, animals and wildlife that consume the crops.

The concentrations of heavy metals in sewage sludge that is used for land application in Saskatchewan shall not exceed the Maximum Acceptable Concentrations (MAC) of metals in sewage sludge specified in Table 1. The metal concentrations in soil where sewage sludge is applied onto land for agricultural use shall not exceed the criteria specified in Table 2. The pathogen reduction requirement of sewage sludge is shown in Table 3.

Table 1. Maximum Acceptable Concentrations of Metals in Sewage Sludge

Metal	MAC of metals in sewage sludge (mg/kg of dry weight) [3]
Arsenic	75
Cadmium	20
Chromium	1060
Cobalt	150
Copper	760
Mercury	5
Molybdenum	20
Nickel	180
Lead	500
Selenium	14
Zinc	1850

Table 2. Maximum Acceptable Concentrations of Metals in Soils

Metal	MAC of metals in soils (mg/kg of dry weight) [4]		
	Agricultural land use	Commercial land use	Industrial land use
Arsenic	12	12	12
Cadmium	1.4	22	22
Chromium	64	87	87
Cobalt	40	300	300
Copper	63	91	91
Mercury	6.6	24	50
Molybdenum	5	40	40
Nickel	50	50	50
Lead	70	260	600
Selenium	1	3.9	3.9
Zinc	200	360	360

Table 3. Pathogen Reduction Requirements [5]

The density of fecal coliform in the sewage sludge must be less than 1000 most probable numbers (MPN) per gram of total solids (dry weight basis).
or
The density of salmonella in the sewage sludge must be less than three MPN per four grams of total solids (dry weight basis)

Typically, treated sewage sludge contains one to six per cent and 0.8 to 6.1 per cent of nitrogen and phosphorus, respectively. It is recommended the nitrogen application rates during application of sewage sludge onto agricultural lands should not exceed the agronomic rate (a rate equivalent to the amount of fertilizer nitrogen applied to the soil for the crop grown). Sludge should not be applied onto ice-covered, snow-covered or frozen soils. Sludge application should not take place during or immediately after a rainfall.

3.5 Monitoring Requirements

- prior to application of municipal sewage sludge onto land, sewage sludge is to be analyzed for the metals specified in Table 1 and the level of pathogenic organisms. Sewage sludge sampling and analysis shall be done as per the approved methods of the United States Environmental Protection Agency (USEPA) [6, 7, 8] and Standard Methods for the Examination of Water and Wastewater [9];
- composite soil samples to be collected from the land and analyzed for the metals specified in Table 2 at least once every two years. Soil sampling and analysis shall be done as per Carter (1993) [10] and other standard approved analytical methods;
- all of the drinking water wells located within 500 metres from the land boundary shall be monitored and samples from the wells shall be analyzed every year for physical, chemical and bacteriological parameters presented in Saskatchewan's Drinking Water Quality Standards and Objectives EPB 507;
- records related to the quantity of sewage sludge applied onto the land, application rate, results of sewage sludge, soil and water quality analysis, crops grown and yield details shall be maintained and a monitoring report with the details shall be submitted to the WSA once every two years; and
- monitoring wells will be required depending on the results of sewage sludge, soil and water investigations.

In the case of infrequent applications sewage sludge onto the land, monitoring requirements may be adjusted based on the frequency of sludge application onto the land.

References

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