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6. PLACEMENT OF SEWAGE SLUDGE IN A MUNICIPAL SOLID WASTE LANDFILL UNIT

QUICK REFERENCE INDEX

6.1 INTRODUCTION

This chapter provides guidance to the permit writer on implementation of the Part 503 requirements for sewage sludge disposal in a municipal solid waste landfill (MSWLF). The permit writer will not find the specific requirements for disposal of sewage sludge in a MSWLF in Part 503. Instead Part 503 requires compliance with Part 258. The Part 258 Criteria for MSWLFs are jointly promulgated under CWA and RCRA authorities. The following are the Part 258 definitions of a municipal solid waste landfill unit and household waste.

Statement of Regulation

§258.2 **Municipal solid waste landfill unit means a discrete area of land or an excavation that receives household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile, as those terms are defined under 257.2. A MSWLF unit also may receive other types of RCRA subtitle D wastes, such as commercial solid waste, nonhazardous sludge, small quantity generator waste and industrial solid waste. Such a landfill may be publicly or privately owned. A MSWLF unit may be a new MSWLF unit, an existing MSWLF unit or a lateral expansion.**

Household waste means any solid waste (including garbage, trash, and sanitary waste in septic tanks) derived from households (including single and multiple residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas).

6.2 PART 503 REQUIREMENTS

Part 503 indicates that disposal of sewage sludge in a MSWLF and that meets the criteria in Part 258 constitutes compliance with section 405(d) of the CWA. Thus, Part 503 relies on the Part 258 criteria to protect public health and the environment in this case. The person who prepares sewage sludge for disposal in a MSWLF must ensure that the sewage sludge meets the Part 258 requirements for quality of materials disposed in a MSWLF unit.

Statement of Regulation

§503.4 Disposal of sewage sludge in a municipal solid waste landfill unit, as defined in 40 CFR 258.2, that complies with the requirements in 40 CFR Part 258 constitutes compliance with section 405(d) of the CWA. Any person who prepares sewage sludge that is disposed in a municipal solid waste landfill unit shall ensure that the sewage sludge meets the requirements in 40 CFR Part 258 concerning the quality of materials disposed in a municipal solid waste landfill unit.

6.2.1 REQUIREMENTS FOR QUALITY OF MATERIALS PLACED IN A MUNICIPAL SOLID WASTE LANDFILL UNIT

The Part 258 Criteria for MSWLFs do not establish pollutant specific numerical criteria for each toxic pollutant of concern in the sewage sludge that is co-disposed with household waste in the MSWLF. For a number of reasons[1], EPA concluded that it was not technically feasible to develop specific pollutant numeric limits for this sewage sludge disposal practice. Instead the design standards and operating standards for MSWLFs established in Part 258 serve as alternative standards for protection of public health and the environment.

The Part 258 criteria for quality of materials placed in a MSWLF unit that pertains to sewage sludge are in the following three sections:

- §258.20 - Procedures for Excluding the Receipt of Hazardous Waste
- §258.28 - Liquids Restrictions
- §258.21 - Cover Material Requirements

Because §503.4 requires the preparer of the sewage sludge to ensure that the sewage sludge meets the requirements in Part 258 concerning the quality of materials disposed, the preparer must ensure that:

- The sewage sludge is nonhazardous

- The sewage sludge does not contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test) in "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (EPA Pub. No. SW-846).

The owner or operator of a MSWLF unit must ensure that a material, including sewage sludge, used to cover the unit is suitable for that purpose (capable of controlling disease vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment). In some cases, the sewage sludge may have to be treated for vector attraction reduction prior to its use as cover material. Use of sewage sludge as an alternative cover material must be approved by the State agency regulating MSWLFs.

[1]A discussion of EPA's reasons for concluding that numerical limitations for co-disposed sewage sludge were not feasible can be found in the preamble to the final rule for Parts 257 and 258, Solid Waste Disposal Facility Criteria, *FR* 50997, Vol 56, No. 196, October 9, 1991.

Statement of Regulation

§258.20(a)	**Owners or operators of all MSWLF units must implement a program at the facility for detecting and preventing the disposal of regulated hazardous wastes as defined in part 261 of this chapter and polychlorinated biphenyls (PCB) wastes as defined in part 761 of this chapter. This program must include, at a minimum:**
§258.20(a)(1)	**Random inspections of incoming loads unless the owner or operator takes other steps to ensure that incoming loads do not contain regulated hazardous wastes or PCB wastes;**
§258.20(a)(2)	**Records of any inspections;**
§258.20(a)(3)	**Training of facility personnel to recognize regulated hazardous waste and PCB wastes; and**
§258.20(a)(4)	**Notification of State Director of authorized States under Subtitle C of RCRA or the EPA Regional Administrator if in an unauthorized State if a regulated hazardous waste or PCB waste is discovered at the facility.**
§258.20(b)	**For purposes of this section, *regulated hazardous waste* means a solid waste that is a hazardous waste, as defined in 40 CFR 261.3, that is not excluded from regulation as a hazardous waste under 40 CFR 261.4(b) or was not generated by a conditionally exempt small quantity generator as defined in §261.5 of this chapter.**
§258.28(a)	**Bulk or noncontainerized liquid waste may not be placed in MSWLF units unless:**
§258.28(a)(1)	**The waste is household waste other than septic waste; or**
§258.28(a)(2)	**The leachate or gas condensate derived form the MSWLF unit and the MSWLF unit, whether it is a new or existing MSWLF, or lateral expansion, is designed with a composite liner and leachate collection system as described in §258.40(a)(2) of this part. The owner or operator must place the demonstration in the operating record and notify the State Director that it has been placed in the operating record.**
§258.28(b)	**Containers holding liquid waste may not be placed in an MSWLF unit unless:**
§258.28(b)(1)	**The container is a small container similar in size to that normally found in household waste;**
§258.28(b)(2)	**The container is designed to hold liquids for use other than storage; or**
§258.28(b)(3)	**The waste is household waste.**
§258.28(c)	**For purposes of this section:**
§258.28(c)(1)	***Liquid waste* means that is determined to contain "free liquids" as defined by Method 9095 (Paint Filter Liquids Test), as described in "Test Methods for evaluating Solid Wastes, Physical/Chemical Methods" (EPA Pub. No. SW-846).**
§258.28(c)(2)	***Gas condensate* means the liquid generated as a result of gas recovery process(es) at the MSWLF unit.**

Statement of Regulation

§258.21(a) **Except as provided in paragraph (b) of this section, the owners or operators of all MSWLF units must cover disposed solid waste with six inches of earthen material at the end of each operating day, or at more frequent intervals if necessary, to control disease vectors, fires, odors,blowing litter, and scavenging.**

§258.21(b) **Alternative materials of an alternative thickness (other than at least six inches of earthen material) may be approved by the Director of an approved State if the owner or operator demonstrates that the alternative material and thickness control disease vectors, fires, odors, blowing litter, and scavenging without presenting a threat to human health and the environment.**

§258.21(c) **The Director of an approved State may grant a temporary waiver from the requirement of paragraph (a) and (b) of this section if the owner or operator demonstrates that there are extreme seasonal climatic conditions that make meeting such requirements impractical.**

6.2.2 PART 258 CRITERIA FOR LANDFILL UNIT

Part 258 establishes minimum national criteria for the location, operation, design, cleanup, and closure of MSWLFs. If a MSWLF fails to satisfy these criteria, it will be deemed to be in violation of section 4005 of RCRA. Sections 309 and 405(e) of the CWA will also be violated in this situation.

The specific siting, operating, and design requirements for a MSWLF unit are contained in Part 258 Subpart B (Location Restrictions), Subpart C (Operating Criteria), Subpart D (Design Criteria), Subpart E (Ground-Water Monitoring and Corrective Action), Subpart F (Closure and Post-Closure Care), and Subpart G (Financial Assurance Criteria). (MSWLFs that dispose of less than 20 tons of municipal solid waste daily are exempt from Subparts D and E under specific circumstances).

These requirements pertain to the MSWLF and/or the owner and operator of the MSWLF. Part 503 does not impose these requirements on the generator or preparer of sewage sludge. However, §503.4 makes the preparer responsible for ensuring that the sewage sludge is disposed in a MSWLF that meets the Part 258 criteria. Thus, a permit writer can require the preparer to dispose of sewage sludge only at MSWLFs that have been approved (as designated by a license or permit to operate) by the permitting authority.

6.3 FREQUENCY OF MONITORING, RECORDKEEPING, AND REPORTING REQUIREMENTS

Part 503 does not establish frequency of monitoring, recordkeeping or reporting requirements for sewage sludge that is placed in a MSWLF. Part 258 pertains to the MSWLF and the owner/operator of the MSWLF, and does not establish monitoring, recordkeeping, or reporting requirements for the user of the MSWLF.

Under Part 258, the owner/operator of the MSWLF is not required to sample and analyze the sewage sludge for hazardous characteristics (e.g., the toxicity characteristic leaching procedure [TCLP] test) or free liquids (Paint Filter Liquids Test).

The establishment of frequency of monitoring, recordkeeping, and reporting requirements for preparers of sewage sludge disposed in a MSWLF will require the use of best professional judgment (BPJ) and a rationale for these requirements in the fact sheet. Several EPA Regions and States require the preparer of sewage sludge to periodically (e.g., once a year) analyze the sewage sludge using the TCLP test to confirm that it is nonhazardous. A requirement to perform a TCLP and free liquids test and report the results is the only reliable way to ensure that these requirements are met. In general, permitting authorities that do not impose a TCLP monitoring condition have accepted published studies or in-house historical data that indicate sewage sludge is nonhazardous.

Vector attraction reduction treatment processes (such as lime addition and extended air drying) can produce a sewage sludge that contains no free liquids.

Some EPA Regions and States request that the preparer report the amount and destination of sewage sludge that is sent to a MSWLF. This reporting helps the permitting authority establish a sewage sludge inventory.

7. INCINERATION - PART 503 SUBPART E

QUICK REFERENCE INDEX

7.1 INTRODUCTION

This chapter provides guidance on the implementation of the Part 503, Subpart E regulations for incineration of sewage sludge. Each section states and discusses the corresponding Subpart E requirements. The permit writer must decide if the sludge to be fired in the incinerator meets the definition of sewage sludge as provided in Part 503, Subpart A. The definitions of sewage sludge and material derived from sewage sludge are included in Chapter 2 of this manual.

Next, the permit writer should examine pollutant concentrations in the sewage sludge to verify that the concentration of PCBs in the sewage sludge is less than 50 milligrams per kilogram of total solids (on a dry weight basis), and that the sewage sludge does not meet any of the characteristics of a hazardous waste as identified in Part 261, Subpart C (i.e., ignitable, corrosive, reactive, and toxic).

The permit writer must then determine whether the incinerator is regulated under Part 503. Sewage sludge mixed with other materials such as grit or screenings at the treatment works where the sewage sludge is generated is still considered to be sewage sludge. Sewage sludge whose quality is changed by either treatment or mixing with other material after the sewage sludge leaves the treatment works where it was generated is a material derived from sewage sludge. In this case, Part 503 applies if the material derived from sewage sludge is fired in an incinerator. Material fed separately to an incinerator in which sewage sludge or a material derived from sewage sludge is fired is auxiliary fuel. Part 503 also applies when sewage sludge and auxiliary fuel are fired together.

The permit writer should examine the information provided by the person who fires sewage sludge concerning the types and quantities of auxiliary fuel fired in the incinerator. Municipal solid wastes can be used as auxiliary fuel to fire sewage sludge in a sewage sludge incinerator as long as the quantity of the municipal solid waste is no more than 30 percent of the dry weight of the sewage sludge and auxiliary fuel together. For example, if 10 metric tons (dry weight) of sewage sludge and auxiliary fuel are fed to the incinerator per day, the quantity of municipal solid waste that can be used as auxiliary fuel must not exceed 3 metric tons (dry weight) per day. The use of additional auxiliary fuels such as fuel oil may allow a total of more than 3 tons/day of total auxiliary fuel. Co-incineration of sewage sludge with more than 30 percent municipal solid waste may be subject to the requirements of Part 60, Subparts C, E, and/or O.

Emissions of arsenic, cadmium, chromium, lead, and nickel into the atmosphere during the operation of a sewage sludge incinerator are regulated by limiting the concentration of these pollutants in the sewage sludge fired in the sewage sludge incinerator. The emissions of organic compounds from a sewage sludge incinerator are regulated by limiting the concentration of total hydrocarbons (THC) (dry weight basis and corrected for oxygen content) in the exhaust gas from the sewage sludge incinerator. In addition, Part 503 requires that the firing of sewage sludge in a sewage sludge incinerator not violate the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for beryllium and mercury in Subparts C and E, respectively, of Part 61.

On February 25, 1994, Part 503 was amended to allow TWTDS to monitor carbon monoxide (CO) instead of THC if they meet the following conditions. The exit gas from a sewage sludge incinerator must be monitored continuously and the monthly average concentration of CO, corrected for zero percent moisture and to seven percent oxygen, must not exceed 100 parts per million on a volumetric basis.

Sewage sludge incinerators also may be subject to the Clean Air Act (CAA) requirements of the Standards of Performance for Sewage Treatment Plants in Subpart O of Part 60. It is important to remember that these CAA regulations have separate applicability requirements (and separate permitting authority) from those of Part 503. Therefore, a sewage sludge incinerator that is subject to the Part 503, Subpart E requirements may not necessarily be subject to the Part 60, Subpart O regulations.

The permit to the person who fires sewage sludge in a sewage sludge incinerator should contain all of the Part 503, Subpart E requirements. If the sewage sludge incinerator receives sewage sludge from various sources, the person who fires the sewage sludge may have difficulty controlling the quality. Nevertheless, the person who fires the sewage sludge must meet the Part 503 requirements.

While Subpart E mainly addresses requirements for the actual firing of sewage sludge, any person who prepares sewage sludge is required to ensure that the applicable requirements of Subpart E are met when the sewage sludge is fired (§503.7). Thus, a treatment works that sends sewage sludge to an incinerator that it does not own or operate should be issued a permit. The permit should require the treatment works to ensure that the sewage sludge is sent to an incinerator that is in compliance with the Subpart E requirements.

7.2 SPECIAL DEFINITIONS

Section 503.9 contains general definitions applicable to Part 503. In addition, terms and definitions specifically applicable to the incineration of sewage sludge are set out in §503.41. This portion of the guidance manual elaborates on each of the §503.41 definitions.

Air Pollution Control Device

Statement of Regulation

§503.41(a) **Air pollution control device is one or more processes used to treat the exit gas from a sewage sludge incinerator stack.**

Although the Part 503 regulation does not require either the use or specific types of air pollution control devices, in most cases they are needed for a sewage sludge incinerator to comply with the Part 503 requirements. Typically, air pollution control devices used with sewage sludge incinerators control emissions of particulate matter (including metals) and organic compounds. Cyclones, wet scrubbers, dry and wet electrostatic precipitators, and fabric filters control particulates. Afterburners provide more complete combustion of organic compounds (EPA 1992a). Air pollution control devices are frequently arranged in series to provide better removal efficiencies of different pollutants from incinerator emission gases.

Auxiliary Fuel

Statement of Regulation

§503.41(b) **Auxiliary fuel is fuel used to augment the fuel value of sewage sludge. This includes, but is not limited to, natural gas, fuel oil, coal, gas generated during anaerobic digestion of sewage sludge, and municipal solid waste (not to exceed 30 percent of the dry weight of sewage sludge and auxiliary fuel together). Hazardous wastes are not auxiliary fuel.**

The heating value of sewage sludge is relatively high and the combustion of sewage sludge can be self sustaining if sewage sludge is both high in volatile solids content and low in moisture content (i.e., less than 70 percent). However, the high water content of most sewage sludges requires additional heat to sustain combustion of sewage sludge in the furnace. This additional heat is generated by burning auxiliary fuel in the combustion chamber. Auxiliary fuel is any fuel (or combination of different fuels) that can be used to maintain combustion in the furnace. Some examples of auxiliary fuels are provided in the regulatory definition of auxiliary fuel. Many other materials such as wood or waste oils are also auxiliary fuels. Hazardous wastes are specifically excluded from the regulatory definition of auxiliary fuel. Municipal solid waste can be used as the auxiliary fuel if the municipal solid waste constitutes no more than 30 percent of the dry weight of sewage sludge and auxiliary fuel together. If 30 percent or more of the material fired in an incinerator is municipal solid waste, the incinerator is not subject to the Part 503 regulation.

Control Efficiency

Statement of Regulation

§503.41(c) **<u>Control efficiency</u> is the mass of a pollutant in the sewage sludge fed to an incinerator minus the mass of that pollutant in the exit gas from the incinerator stack divided by the mass of the pollutant in the sewage sludge fed to the incinerator.**

Control efficiency must be determined from a performance test of the sewage sludge incinerator. Performance tests should be conducted under representative conditions at the highest expected sewage sludge feed rate within design specifications. Operations during periods of startup, shutdown, and malfunction do not constitute representative conditions.

During the performance test, the amount of the sewage sludge charged to the incinerator must be determined accurately. Samples of sewage sludge must be collected and analyzed to determine the pollutant content of the sewage sludge. Samples must be collected from the sewage sludge charged to the incinerator at the beginning of each test run and at a minimum of 30-minute intervals thereafter until the test run ends. The sewage sludge samples collected during each test run should be combined into a single composite sample. A minimum of three composite samples, representing three test runs, should be collected and analyzed to determine the pollutants and the mass of each pollutant that is fed to the incinerator. A representative measurement of pollutant emissions and total volumetric flow rate of the exit gas must also be obtained to determine the mass of each pollutant that exits from the incinerator stack. Normally, an appropriate sampling location where the exit gas stream is flowing in a known direction is selected, and the cross-section of the stack is divided into a number of equal areas. Exit gas is then collected from points located within each of these equal areas and analyzed for pollutants of interest. During a performance test, stack sampling is typically conducted at least 3 times, with a sampling period of one to four hours each. If more than one sewage sludge incinerator is located at a site, the control efficiency of each incinerator must be determined, unless they are identical in design and operation. The pollutant limits for each incinerator must be calculated using only the control efficiency determined for that incinerator (EPA 1989). If two or more identical sewage sludge incinerators are located at a site, a performance test can be run on one unit and used to determine the control efficiency for the all the identical units.

The permit writer should review performance test records to determine the conditions of the performance test and the appropriateness of the methods used. The protocol entitled "Methodology for the Determination of Metal Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Processes" in Appendix 9 of Part 266 should be used when control efficiency determinations are to be made.

Dispersion Factor

Statement of Regulation

§503.41(d) **<u>Dispersion factor</u> is the ratio of the increase in the ground level ambient air concentration for a pollutant at or beyond the property line of the site where the sewage sludge incinerator is located to the mass emission rate for the pollutant from the incinerator stack.**

The dispersion factor is used in equations presented in Part 503 to calculate the sewage sludge pollutant limits for metals. The dispersion factor is determined by using an appropriate air dispersion model. A dispersion model is a detailed air dispersion analysis. The model predicts the downwind ambient air concentration at a specified distance from the stack for a given set of site-specific meteorological conditions, stack height, and stack gas emission rates. Once the relationship between stack gas emission rates and the ambient ground-level concentration of a pollutant is established, through use of a dispersion model, the dispersion factor can be calculated. For example, if the model predicts that at a specified mass emission rate, the ground-level ambient air concentration will increase from X to Z, the dispersion factor can be calculated using the equation:

$$DF = \frac{Z - X}{Y}$$

where: DF = dispersion factor
X = ground-level ambient air concentration without mass emission rate
Y = mass emission rate from stack gas of sewage sludge incinerator
Z = ground-level ambient air concentration with mass emission rate of Y

The units of measurement used for the dispersion factor in Part 503 are micrograms per cubic meter per gram per second.

Fluidized Bed Incinerator

Statement of Regulation

§503.41(e) Fluidized bed incinerator is an enclosed device in which organic matter and inorganic matter in sewage sludge are combusted in a bed of particles suspended in the combustion chamber gas.

A fluidized bed incinerator is a unique combustion device in which air, sewage sludge, and inert solid particles (sand) are mixed so that the mixture behaves as a fluid. Fluidizing sewage sludge during combustion provides excellent mixing of combustion air with the sewage sludge and sand particles. The turbulent mixing action provides intimate contact between the sewage sludge, combustion air, and the hot sand particles, resulting in improved heat transfer capabilities, lower excess air and auxiliary fuel requirements, and lower sewage sludge residence times compared to other types of sewage sludge incinerators. The improved mixing capability of fluidized bed incinerators also provides some protection against fluctuations in sewage sludge feed rate and moisture content.

Hourly Average

Statement of Regulation

§503.41(f) Hourly average is the arithmetic mean of all measurements taken during a hour. At least two measurements must be taken during the hour.

The hourly average concentration of total hydrocarbons must be calculated to derive the monthly average concentration for total hydrocarbons. For example, if the THC instrument is operated to collect and analyze the exit gas every 15 seconds, then 240 measurements would be made in one hour. The individual values would be summed and then divided by 240 to obtain the hourly average.

Incineration

Statement of Regulation

§503.41(g) **Incineration is the combustion of organic matter and inorganic matter in sewage sludge by high temperatures in an enclosed device.**

Although sewage sludges contain large amounts of water, the dry solids in the sewage sludges are largely organic and, on a dry basis, very combustible. For the purposes of this regulation, combustion is the thermal oxidation of sewage sludge at relatively high temperatures resulting in ash, water, and carbon dioxide as primary end products. The oxygen required for combustion is normally furnished from ambient air (approximately 21 percent oxygen by volume). The exhaust gases from sewage sludge incinerators are a mixture predominantly composed of nitrogen, carbon dioxide, water vapor, and oxygen. Depending on the composition of the incinerated sewage sludge, the auxiliary fuel that is fired, and the design and operation of the incinerator and any air pollution control device, small quantities of sulfur dioxide, nitrogen oxides, carbon monoxide, organic compounds, and particulate matter may also be present. The particulate matter will, in part, consist of various trace metals in the form of oxides, carbonates, silicates, and/or as elemental metals. Some metals, particularly mercury, will volatilize during incineration and will be emitted from the incinerator largely in gaseous form. A wide variety of organic compounds may exist in incinerator exhaust gases. These organic compound emissions may result from the incomplete combustion of sewage sludge and/or auxiliary fuel. In some cases, these products of incomplete combustion can recombine to form larger organic compounds as they are emitted from the incinerator. Other components of sewage sludge, mostly inorganic materials, will be discharged from the incinerator as a bottom ash.

Monthly Average

Statement of Regulation

§503.41(h) **Monthly average is the arithmetic mean of the hourly averages for the hours a sewage sludge incinerator operates during the month.**

The total hydrocarbons operational standard and carbon monoxide limit of 100 parts per million are expressed as a monthly average concentration. The monthly average concentration is determined by dividing the sum of all hourly averages (see definition of hourly average) obtained during a month by the hours the sewage sludge incinerator operated during that month.

Risk Specific Concentration

Statement of Regulation

§503.41(i) **Risk specific concentration is the allowable increase in the average daily ground level ambient air concentration for a pollutant from the incineration of sewage sludge at or beyond the property line of the site where the sewage sludge incinerator is located.**

The Risk Specific Concentrations (RSCs) are used in the equation provided in § 503.43(d)(1) to calculate the pollutant limits for arsenic, cadmium, chromium, and nickel. The RSCs were derived by EPA during a risk-based assessment during which a risk level of 1 chance in 10,000, a body weight of 70 kg, and an inhalation rate of 20 m^3/day were used. RSC values are provided in § 503.43 for arsenic, cadmium, nickel, and chromium. Part 503 allows the RSC value for chromium to be determined in one of two ways. The chromium RSC value can be selected from four RSC values listed in the regulation depending on the type of sewage sludge incinerator and air pollution control device, or the RSC value for chromium can be calculated using Equation (6) of the regulation.

Sewage Sludge Feed Rate

Statement of Regulation

§503.41(j) **Sewage sludge feed rate is either the average daily amount of sewage sludge fired in all sewage sludge incinerators within the property line of the site where the sewage sludge incinerators are located for the number of days in a 365 day period that each sewage sludge incinerator operates, or the average daily design capacity for all sewage sludge incinerators within the property line of the site where the sewage sludge incinerators are located.**

The sewage sludge feed rate can play a crucial role in optimizing the operation of the sewage sludge incinerator. In general, the sewage sludge feed rate is kept constant as a rapid change in the amount of sewage sludge fed to the incinerator can cause drastic changes in furnace operation. Sewage sludge feed rate changes can affect the quantity and temperature of the incinerator off-gases and therefore may decrease the efficiency of air pollution control devices (EPA 1992a).

The sewage sludge feed rate is used to establish the allowable daily concentration of the metal pollutants in sewage sludge to be incinerated. The average daily amount of sewage sludge that is actually fired in the sewage sludge incinerator or the average daily design capacity of the sludge incinerator can be used as the sewage sludge feed rate. The actual average daily amount is determined by dividing the total amount of sewage sludge fired in a 365-day period by the number of days the sewage sludge incinerator operated in that same 365-day period. A treatment works may contain more than one sewage sludge incinerator within the property lines of the treatment works. The operating capacities and schedules of the individual incinerators may vary considerably. The following is an example of a multi-unit calculation for sewage sludge feed rate:

A site has three incinerators with the following design capacities.

Unit 1: 100 dry metric tons per day (dmt/day)
Unit 2: 100 dmt/day
Unit 3: 200 dmt/day

Part 503 allows the operator to choose one of two methods to calculate the sewage sludge feed rate, which is used in the pollutant limit calculations:

Method 1—Design Capacity for All Incinerators

Calculate the total design capacity for all incinerators at the site:
Total capacity = 100 dmt/day + 100 dmt/day + 200 dmt/day = 400 dmt/day

Method 2—Average Daily Feed Rate for All Incinerators

Case 1.

For the first 20 days of the year, unit 1 operated at 50 dmt/day (and shut down for the remaining 80 days); for the first 100 days of the year, unit 2 operated at 50 dmt/day and unit 3 operated at 100 dmt/day.

Calculate the total amount of sewage sludge fired in a 365-day period:

Unit 1: 50 dmt/day × 20 days = 1,000 dmt
Unit 2: 50 dmt/day × 100 days = 5,000 dmt
Unit 3: 100 dmt/day × 100 days = 10,000 dmt
Total = 1,000 dmt + 5,000 dmt + 10,000 dmt = 16,000 dmt

Calculate the average daily amount of sewage sludge fired during the total number of days the incinerators operated during a 365-day period:

$$Average = \frac{16{,}000\ dmt}{100\ days} = 160\ dmt/day\ (rounded).$$

Case 2.

If the incinerators in the above example did not operate at the same time, but instead operated sequentially, the average would be based on the total number of days any incinerator at the site was operated, which is 220 days. In that case, the average daily feed rate would be:

$$\frac{16{,}000\ dmt}{220\ days} = 73\ dmt/day\ (rounded).$$

For greater flexibility, the person who fires sewage sludge may want to consider using Method 1 to calculate concentration limits for greater latitude in the amount of sewage sludge fed to the incinerator. If the amount of sewage sludge fired in the incinerator significantly exceeds the amount fired during the performance test, a new performance test should be conducted.

Sewage Sludge Incinerator

Statement of Regulation

§503.41(k) **Sewage sludge incinerator is an enclosed device in which only sewage sludge and auxiliary fuel are fired.**

The term "an enclosed device," used in the definition of sewage sludge incinerator, in general refers to some type of furnace. The most common types of furnaces used for sewage sludge incineration are multiple-hearth furnaces and fluidized-bed furnaces (EPA 1990c). Other less commonly used furnaces include electric-infrared furnaces and rotary kilns. Sewage sludge drying and stabilization units are not considered to be sewage sludge incinerators.

Some incinerators are operated under conditions of starved-air combustion in a primary chamber, followed by excess air combustion in a secondary chamber (sometimes referred to as an afterburner).

No Federal regulations specify which type of incinerator must be used to incinerate sewage sludge. However, some States (e.g., Kansas and Rhode Island) or regional authorities may specify certain types of incinerators for firing sewage sludge (EPA 1990b). References listed at the end of this chapter provide more detailed information on the types and operation of sewage sludge incinerators.

Stack Height

Statement of Regulation

§503.41(l) **Stack height is the difference between the elevation of the top of a sewage sludge incinerator stack and the elevation of the ground at the base of the stack when the difference is equal to or less than 65 meters. When the difference is greater than 65 meters, stack height is the creditable stack height determined in accordance with 40 CFR 51.100 (ii).**

Either the actual incinerator stack height or a creditable stack height must be used in an air dispersion model specified by the permitting authority, to determine the dispersion factor. Currently, most sewage sludge incinerators have stacks less than 65 meters. If the difference in elevation is greater than 65 meters, the stack height to be used in the air dispersion model is the creditable stack height obtained in accordance with instructions provided in §51.100(ii). More detailed guidance on determining the stack height is provided in Section 7.4.1 of this manual.

Total Hydrocarbons

Statement of Regulation

§503.41(m) **Total hydrocarbons means the organic compounds in the exit gas from a sewage sludge incinerator stack measured using a flame ionization detection instrument referenced to propane.**

Numerous organic compounds have the potential to be emitted from sewage sludge incinerators. However, identifying and quantifying potential organic compound emissions from incinerators is complicated and expensive. Identification and quantification of organics only can be done by analyzing samples of incinerator exhaust gas obtained over discrete time periods.

EPA has determined that there is a significant correlation between the concentration of several organic compounds in sewage sludge incinerator exhaust gases and the total hydrocarbons (THC) concentration (as measured by a flame ionization detector) in the same gases. Because of this correlation and because THC data can provide incinerator operators with information necessary to make relatively quick adjustments to incinerator operating parameters, EPA uses a THC operational standard to regulate organic compound emissions from sewage sludge incinerators (EPA 1992a).

Wet Electrostatic Precipitator

Statement of Regulation

§503.41(n) **Wet electrostatic precipitator is an air pollution control device that uses both electrical forces and water to remove pollutants in the exit gas from a sewage sludge incinerator stack.**

A wet electrostatic precipitator is a variation of the more widely used dry electrostatic precipitator. Primarily, wet electrostatic precipitators are designed to remove particulate matter (including metals) from exhaust gases. Because wet electrostatic precipitators use water, some absorption of gaseous pollutants can also occur. The use of water also makes the wet electrostatic precipitators more compatible for use with wet scrubbers.

In wet electrostatic precipitator operation, water sprays are used to condition the incoming gas stream. The water sprays cool the gas stream, help maintain more uniform particle size, and ease the application of electrical charge to particulate matter. After particles are charged, they migrate to the charged surfaces of collection plates. Collected particulate matter is removed from the plates by continuous flushing with water.

Wet Scrubber

Statement of Regulation

§503.41(o) **Wet scrubber is an air pollution control device that uses water to remove pollutants in the exit gas from a sewage sludge incinerator stack.**

Wet scrubbers exist in numerous forms, ranging from relatively simple spray chambers and wet cyclones to more complex and more efficient plate and tray and venturi scrubbers. Regardless of whether the scrubber is used to control gaseous pollutants or particulate matter, the removal efficiency of the scrubber depends largely on the scrubber's pressure drop during operation. Generally, the higher the operating pressure drop of the scrubber, the higher the pollutant removal efficiency.

7.3 GENERAL REQUIREMENTS

Statement of Regulation

§503.42 **No person shall fire sewage sludge in a sewage sludge incinerator except in compliance with the requirements in this subpart.**

The general requirement of § 503.42 enhances the direct enforceability of the requirements of Subpart E. The compliance period, established in § 503.2, required compliance to be achieved as expeditiously as practicable, but no later than February 19, 1994. If the person who fires sewage sludge must construct new pollution control facilities to comply with the rule, compliance was to be achieved no later than February 19, 1995. However, as noted below, these dates were suspended for THC pending specification of certain requirements. The permit writer should ensure that construction of new pollution control facilities is indeed necessary for compliance purposes (construction should not be used in lieu of other management practices).

Frequency of monitoring, recordkeeping, and reporting requirements were effective on July 20, 1993. Part 503 states that the compliance date for these requirements for total hydrocarbons in the exit gas from a sewage sludge incinerator is February 19, 1994, or February 19, 1995 if construction of new pollution control facilities is necessary to comply with the operational standard for total hydrocarbons. Section 503.45(a) requires monitoring of THC emissions using an instrument that is installed, calibrated, operated, and maintained "as specified by the permitting authority."

On February 17, 1994, a memo was distributed that states that there is no compliance date for the THC monitoring requirement until the above requirements are specified. The amendments to Part 503 proposed on October 25, 1995, address this issue. Compliance with the incineration requirements that are revised in this proposal will be required no later than 90 days from the publication of the final amendments. If new pollution control facilities must be constructed, compliance is required no later than 12 months from publication. Until these amendments are finalized, there are no enforceable requirements for THC monitoring unless included in a permit with a compliance date. Permit writers can use the EPA document *THC Continuous Emission Monitoring Guidance for Part 503 Sewage Sludge Incinerators* to help them prepare permits containing THC monitoring requirements.

7.4 POLLUTANT LIMITS

Subpart E of Part 503 regulates five pollutants in sewage sludge fired in a sewage sludge incinerator: lead, arsenic, cadmium, chromium, and nickel. Part 503 contains equations for calculating pollutant limits for these five metals based on site-specific conditions. This section provides procedures on how to calculate the pollutant limits for the five metals using equations and site-specific factors. Emissions of beryllium and mercury are regulated by the National Emission Standards for these pollutants in Subpart C and Subpart E of Part 61, respectively. Total hydrocarbons emissions are limited by an operational standard discussed in Section 7.5.

Since publication of Part 503, EPA has realized that the pollutant concentration limits, determined as prescribed in § 503.43, are frequently considerably higher than the actual concentration of metals in the sewage sludge being incinerated. This indicates that the incinerator operating conditions and site conditions will permit safe incineration of sewage sludge with high pollutant concentrations. Given the resulting ample margin of safety between the regulatory values and the actual concentrations of metals in incinerated sewage sludge, EPA proposed to amend the applicability section of the incineration subpart in the October 1995 amendments (60 *FR* 54771). Under the proposed approach, if the permitting authority approves, the sewage sludge does not have to be monitored for a particular pollutant and records of the concentration of a pollutant in sewage sludge do not have to be kept if the calculated pollutant limit exceeds the highest average daily concentration for that pollutant in the sewage sludge for the months of operation in the previous calendar year. EPA will consider all comments on this proposed change when deciding if it should be adopted in the final amendments.

7.4.1 SITE-SPECIFIC LIMITS

The development of pollutant limits for a sewage sludge incinerator requires the use of site-specific information supplied by the person who fires sewage sludge in a sewage sludge incinerator. Before calculating the limits for the five metals, site-specific factors used in the Part 503 equations have to be obtained. These site-specific factors should be reviewed by the permitting authority. They include the dispersion factor, control efficiency, stack height, and sewage sludge feed rate. Each of these factors is discussed in more detail below.

The determination of the appropriate values for these factors requires knowledge of air dispersion modeling, emissions testing, and the design and operation of the incinerator. The permit writer should work with EPA's Air Program to evaluate the information supplied.

Dispersion Factor

The dispersion factor is determined through the use of air dispersion models. Air dispersion models range from simple screening techniques to more sophisticated models. Screening techniques are relatively inexpensive and do not require a great deal of modeling expertise, computer time, or input data. However, screening techniques are conservative in their design and tend to predict higher ambient pollutant concentrations than do more complex models. The use of screening techniques to determine a dispersion factor is acceptable; however, both the permit writer and the permit applicant should recognize and accept that the calculated sewage sludge pollutant limits will be lower (more stringent) than those derived from more refined dispersion models. For this reason, the person who fires sewage sludge may choose to perform more detailed and refined dispersion modeling.

> Dispersion Factor—correlates the emission rate for a pollutant with the resulting increase in ambient ground level pollutant concentrations in the air around the incinerator
>
> Dispersion Factor = increase in ambient ground-level pollutant concentration ($\mu g/m^3$) divided by emission rate (g/sec)

A knowledgeable air quality modeler with adequate computer resources and meteorological and source parameter data for model input is needed to perform a detailed air dispersion modeling analysis. For refined modeling, three air dispersion models are most commonly used (see box below). Selection of the appropriate model depends mainly on two factors:

- <u>Terrain Type</u>—A simple terrain model is used if all terrain in the surrounding area is below the facility's lowest stack elevation; a complex terrain model is used if terrain elevations exist above the lowest stack elevation

- Urban/Rural Classification—Urban plume dispersion coefficients are used if the incinerator is located in an urban area; rural plume coefficients are used if the incinerator is located in a rural area.

AIR DISPERSION MODEL	WHEN USED
Industrial Source Complex Long-Term model [a,b] (ISCLT)	Simple terrain; both rural and urban areas
LONGZ [c]	Complex urban terrain
COMPLEX I [c]	Complex rural terrain

Sources:

[a] *Industrial Source Complex (ISC) Dispersion Model User's Guide - Second Edition*

[b] *Sludge Incineration Modeling (SIM) System User's Guide*

[c] *Guidelines on Air Quality Models (GAQM)*

In addition to terrain and land use classification considerations, source parameters, meteorological data, receptor grids, and model control options need to be provided in most dispersion models. Two parameters that are necessary to perform refined modeling are incinerator design and operation considerations. A list of typical source parameters needed for dispersion modeling appears below.

Source Parameters for Input to the Air Dispersion Models:

- Stack height above ground level
- Inside stack diameter
- Gas velocity at stack exit
- Gas flow rate
- Gas temperature at stack exit
- Stack-base elevation
- Building dimensions
- Stack coordinates (based on distance from grid origin)
- Emission rate

The meteorological data used in the dispersion model should be representative of the incinerator location. The *Guidelines on Air Quality Models* state that, if possible, 1 year or more of on-site meteorological data are preferred for use in the dispersion model. If such data are unavailable, 5 years of meteorological data from the nearest or most representative National Weather Service station should be used. The data needed vary depending on the specific model to be run but, in general, consist of hourly observations of wind speed and direction, mixing heights, stability class, and atmospheric temperatures. Sources of meteorological data are listed below.

Sources of Meteorological Data:

- National Weather Service (NWS)
- Onsite meteorological measurement program
- Federal Aviation Administration (FAA)
- Local universities
- Military stations
- Pollution control agencies
- National Climatic Data Center, Asheville, NC (NWS and military station data)
- Support Center for Regulatory Air Model's (SCRAM) Electronic Bulletin Board System (BBS) (NWS)
- Onsite Meteorological Program Guidance for Regulatory Modeling Applications, GAQM, EPA 1987
- Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD), GAQM, EPA 1987
- *Quality Assurance Handbook for Air Pollution Measurements Systems, Volume IV: Meteorological Measurements*, EPA 1983

Control Efficiency

As discussed earlier, sewage sludge incinerator control efficiencies for the five regulated metals must be determined from a performance test. Control efficiency is crucial in that it indicates the extent to which pollutants remain in the incinerator exhaust and, therefore, the potential ambient air impacts of emissions from the incinerator.

Under Part 503, control efficiency determinations should include three elements:

- Sampling and analysis of sewage sludge for the regulated metals
- Sampling and analysis of incinerator air emissions for the regulated metals
- Monitoring and documentation of incinerator and control equipment operating parameters during sampling. Parameters of interest include sewage sludge feed rate, incinerator exhaust flowrate, incinerator combustion temperature, auxiliary fuel type and feed rate, and specific air pollution control device parameters.

Permitting authorities may refer to the following recommended procedures for guidance in reviewing control efficiency test procedures:

- For Sewage Sludge Sampling and Analysis—*POTW Sludge Sampling and Analysis Guidance Document*.
- For Stack Sampling and Analysis for Metals—"Methodology for the Determination of Metal Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Processes," Appendix 9 of Part 266.
- For Stack Sampling and Analysis for Hexavalent Chromium—"Determination of Hexavalent Chromium Emissions from Stationary Sources," Appendix 9 of Part 266.

The recording of operating parameters during any performance test is important because this information establishes "baseline" operating conditions of the incinerator and its control equipment when control efficiencies were determined. If, at a later time, the monitored operating parameters change significantly from the baseline levels established during the performance test, the control efficiencies for regulated pollutants also may have changed. If this situation were to occur, another performance test may need to be conducted to confirm control efficiencies for each regulated pollutant.

Permit writers should carefully review any performance test results and reports that support control efficiency determinations. The person who fires sewage sludge must submit a test protocol to the permitting authority for review before any testing is conducted. Please refer to Section 7.8, Recordkeeping Requirements, for a more detailed discussion of performance test considerations.

In some instances, data may be available from a performance test conducted to meet the requirements of Part 60, Subpart O. These data, although useful, may not accurately represent the pollutant control efficiencies for the sewage sludge incinerator and may result in higher sewage sludge pollutant limits than would be calculated using more accurate control efficiencies.

Stack Height

Stack height plays an important role in Part 503, Subpart E for calculating pollutant limits in sewage sludge. Stack height is used in the dispersion model to derive the site-specific dispersion factor.

Stack height can generally be obtained from engineering and/or construction drawings or plans specific to each sewage sludge incinerator. If these drawings are unavailable or do not indicate stack height, the permit writer should request that the owner/operator measure or approximate the stack height using methods approved by the permitting authority. One recommended method is the use of transit in land surveying techniques to determine inclination angle and, ultimately, stack height.

To determine stack height for use in the air dispersion model, do the following:

A. If the actual stack height, measured from the ground-level elevation at the base of the stack, is less than or equal to 65 meters, the actual stack height is used in the air dispersion model to determine the dispersion factor (DF).

B. If the actual stack height, measured from the ground-level elevation at the base of the stack, exceeds 65 meters, determine a creditable stack height based on good engineering practice (GEP). The creditable stack height is the largest stack height determined using the following guidelines (in accordance with §51.100 (ii) as referenced in Part 503):

(1) 65 meters, measured from the ground-level elevation at the base of the stack.

(2) For stacks in existence on January 12, 1979, for which the owner/operator has obtained all applicable permits or approvals required under 40 CFR Parts 51 and 52, the creditable stack height should be calculated using the following equation:

$$\textit{Creditable Stack Height} = 2.5 \times H$$

Where:

H is the height of nearby structure(s) measured from the ground-level elevation at the base of the stack.

For example, consider a sewage sludge incinerator that has been in existence since January 1976 and has a stack that measures 66 meters from the ground-level elevation at the base of the stack and where a structure measuring 30 meters high, 20 meters wide and 50 meters long exist within 60 meters of the stack. Using the above equation the creditable stack height is calculated as:

$$\textit{Creditable Stack Height} = 2.5 \times 30 = 75 \textit{ meters}$$

(3) For all other stacks, the stack height should be calculated based on good engineering practice using the following equation:

$$H_g = H + 1.5L$$

Where:

H_g = good engineering practice stack height, measured from the ground-level elevation at the base of the stack.

H = height of nearby structure(s) measured from the ground-level elevation at the base of the stack.

L = lesser dimension, height or projected width, of nearby structure(s).

In this part, "nearby" is defined as that distance up to five times the lesser of the height or the width dimension of a structure, but not greater than 0.8 kilometers (1/2 mile).

Modeling or field studies can be used to determine effective stack heights, but these should first be approved by the EPA, State or local control agency. Specific requirements are identified in §51.100(ii)(3).

For example, consider a sewage sludge incinerator having a stack that measures 66 meters from the ground-level elevation at the base of the stack and is located within 60 meters of a structure measuring 30 meters high, 20 meters wide, and 50 meters long. The GEP stack height for this incinerator is calculated as:

$$H_g = 30 + 1.5 \times 20 = 60 \; meters$$

The creditable stack height for this incinerator is therefore 65 meters because this number is larger than the GEP stack height.

Sewage Sludge Feed Rate

The sewage sludge feed rate is used directly in the pollutant limit equations. Any changes in sewage sludge feed rate will therefore cause a direct, proportional change in pollutant limits. In addition, as mentioned earlier, sewage sludge incinerator operating parameters (including sewage sludge feed rate) can influence pollutant control efficiencies. The specific control efficiency achieved by the sewage sludge incinerator at one sewage sludge feed rate may not be achieved at a different sewage sludge feed rate. In addition, changes in sewage sludge feed rate may not result in proportional changes in control efficiency. Therefore, a significant change in sewage sludge feed rate necessitates a new performance test to determine the control efficiency to be used to calculate sewage sludge pollutant limits. To avoid these additional performance tests and future permit changes, it is important to conduct performance tests and calculate sewage sludge pollutant limits using design capacity sewage sludge feed rates.

A variety of methods can be used to measure sewage sludge feed rate to a sewage sludge incinerator. The most commonly used methods are conveyor weighing systems and volumetric methods. Conveyor weighing systems rely on weight sensors (load cells) mounted beneath conveyor belts or screw augers to measure sewage sludge feed rates. Volumetric methods rely on the measurement of rotational speed on the sewage sludge feeding equipment, generally using a tachometer calibrated to a known feed rate, to measure sewage sludge feed rates. Volumetric methods include calibrated augers, pumps, rotary feeders, and belt conveyors (EPA 1992a). Other methods that have been used successfully include a liquid sewage sludge volumetric mass balance method and a stoichiometric method.

7.4.2 LEAD

The Part 503 regulation controls the emission of lead into the atmosphere by limiting the allowable daily concentration of lead in the sewage sludge fed to the incinerator. Part 503 includes an equation to calculate a site-specific limit for lead.

Statement of Regulation

§503.43(c) **Pollutant limit - lead.**

§503.43(c)(1) **The average daily concentration of lead in sewage sludge fed to a sewage sludge incinerator shall not exceed the concentration calculated using Equation (4).**

$$C = \frac{0.1 \times NAAQS \times 86{,}400}{DF \times (1 - CE) \times SF} \qquad \text{Eq. (4)}$$

Where:

C = Average daily concentration of lead in sewage sludge in milligrams per kilogram of total solids (dry weight basis) for the days in the month that the sewage sludge incinerator operates.

NAAQS = National Ambient Air Quality Standard for lead in micrograms per cubic meter.

DF = Dispersion factor in micrograms per cubic meter per gram per second.

CE = Sewage sludge incinerator control efficiency for lead in hundredths.

SF = Sewage sludge feed rate in metric tons per day (dry weight basis).

(2) The dispersion factor (DF) in equation (4) shall be determined from an air dispersion model.

(i) When the sewage sludge stack height is 65 meters or less, the actual sewage sludge incinerator stack height shall be used in the air dispersion model to determine the dispersion factor (DF) for Equation (4).

(ii) When the sewage sludge incinerator stack height exceeds 65 meters, the creditable stack height shall be determined in accordance with 40 CFR 51.100 (ii) and the creditable stack height shall be used in the air dispersion model to determine the dispersion factor (DF) for Equation (4).

(3) The control efficiency (CE) in Equation (4) shall be determined from a performance test of the sewage sludge incinerator.

The following five-step procedure can be used to determine the appropriate values for each of the variables used in the equation provided in § 503.43(c) and calculate the maximum allowable daily concentration of lead in sewage sludge fed to a sewage sludge incinerator.

Step 1: Determine whether the DF (dispersion factor) has been obtained using the appropriate stack height in an acceptable air dispersion model. Review the dispersion model report to verify that the modeling was done correctly and used appropriate input parameters and assumptions. If the value of DF is not available or was obtained incorrectly, request that a modeling protocol be prepared and submitted for approval. Review the protocol and require that any necessary changes be made before modeling is conducted.

Step 2: Ensure that a numerical value for CE (control efficiency) is provided and that this value is based on a performance test conducted in accordance with Part 503. If the value is not available or has been obtained using inappropriate performance test methods, request that a performance test protocol be prepared and submitted for approval. Review the protocol and make any necessary changes to it. After approval of the protocol, review the performance test report and the value for control efficiency.

Step 3: Verify that the NAAQS for lead provided in the permit application is the current correct number. This information is listed in 50.12. The current NAAQS for lead is 1.5 $\mu g/m^3$.

Step 4: From the information provided in the permit application, obtain the value for sewage sludge feed rate (SF) in metric tons per day (dry weight basis). If this is not provided in the permit application, request this value. The permit writer also should request and carefully review any documentation of how the SF value was determined. Calculations of average sewage sludge feed rates should be verified and compared with historical data and design capacity SF values before being used to set permit limits.

Step 5: Incorporate all necessary variables determined in the previous steps into equation (4) to verify the pollutant limit for lead.

7.4.3 ARSENIC, CADMIUM, CHROMIUM, AND NICKEL

Like lead emissions, Part 503 controls the emission of arsenic, cadmium, chromium, and nickel by limiting the allowable daily concentration of these pollutants in the sewage sludge charged to the incinerator. Part 503 contains an equation to calculate the pollutant limits for the above pollutants. Whereas the NAAQS was used in equation (4) for lead, equation (5), which is used for arsenic, cadmium, chromium, and nickel, employs a risk specific concentration (RSC) factor that reflects the risk associated with incineration of sewage sludge and release of these pollutant into the atmosphere.

<u>Statement of Regulation</u>

§503.43(d) **Pollutant limit - arsenic, cadmium, chromium, and nickel.**

§503.43(d)(1) **The average daily concentration for arsenic, cadmium, chromium, and nickel in sewage sludge fed to a sewage sludge incinerator each shall not exceed the concentration calculated using Equation (5).**

$$C = \frac{RSC \times 86{,}400}{DF \times (1 - CE) \times SF} \qquad \text{Eq. (5)}$$

Where:

C = Average daily concentration of arsenic, cadmium, chromium, or nickel in sewage sludge in milligrams per kilogram of total solids (dry weight basis) for the days in the month that the sewage sludge incinerator operates.

CE = Sewage sludge incinerator control efficiency for arsenic, cadmium, chromium, or nickel in hundredths.

DF = Dispersion factor in micrograms per cubic meter per gram per second.

RSC = Risk specific concentration in micrograms per cubic meter.

SF = Sewage sludge feed rate in metric tons per day (dry weight basis).

(2) **The risk specific concentrations for arsenic, cadmium, and nickel used in equation (5) shall be obtained from Table 1 of §503.43.**

Statement of Regulation

TABLE 1 OF 503.43 - RISK SPECIFIC CONCENTRATION - ARSENIC, CADMIUM, AND NICKEL

Pollutant	Risk Specific Concentration (micrograms per cubic meter)
Arsenic	0.023
Cadmium	0.057
Nickel	2.0

(3) The risk specific concentration for chromium used in equation (5) shall be obtained from Table 2 of §503.43 or shall be calculated using equation (6).

TABLE 2 OF 503.43 - RISK SPECIFIC CONCENTRATION - CHROMIUM

Type of Incinerator	Risk Specific Concentration (micrograms per cubic meter)
Fluidized bed with wet scrubber	0.65
Fluidized bed with wet scrubber and wet electrostatic precipitator	0.23
Other types with wet scrubber	0.064
Other types with wet scrubber and wet electrostatic precipitator	0.016

$$RSC = \frac{0.0085}{r} \qquad \text{Eq. (6)}$$

Where:

RSC = risk specific concentration for chromium in micrograms per cubic meter used in equation (5).

r = decimal fraction of the hexavalent chromium concentration in the total chromium concentration measured in the exit gas from the sewage sludge incinerator stack in hundredths.

(4) The dispersion factor (DF) in equation (5) shall be determined from an air dispersion model.

(i) When the sewage sludge incinerator stack height is equal to or less than 65 meters, the actual sewage sludge incinerator stack height shall be used in the air dispersion model to determine the dispersion factor (DF) for Equation (5).

(ii) When the sewage sludge incinerator stack height is greater than 65 meters, the creditable stack height shall be determined in accordance with 40 CFR 51.100 (ii) and the creditable stack height shall be used in the air dispersion model to determine the dispersion factor (DF) for equation (5).

(5) The control efficiency (CE) in equation (5) shall be determined from a performance test of the sewage sludge incinerator.

The permitting authority can use the following five step procedure to determine the appropriate values for the variables in equation (5) and calculate the allowable daily concentrations of arsenic, cadmium, chromium, and nickel in sewage sludge charged into the sewage sludge incinerator.

Step 1: The DF used in this equation is the same numerical value used in equation (4) to calculate the pollutant limit for lead. Refer to Section 7.4.2 for instructions on how to obtain the value of the dispersion factor.

Step 2: Ensure that numerical values for CE for arsenic, cadmium, chromium, and nickel are based on results of a performance test(s) conducted in accordance with Part 503. If the values are not available or have been obtained using inappropriate performance test methods, request that a performance test protocol be prepared and submitted for approval. Review the protocol and make any necessary changes to it. After approval of the protocol, review the performance test report and the values for control efficiency.

Step 3: The risk specific concentrations (RSC) for the pollutants arsenic, cadmium, and nickel are as follows:

$$\text{RSC(arsenic)} = 0.023\ \mu/\text{m}^3$$

$$\text{RSC(cadmium)} = 0.057\ \mu/\text{m}^3$$

$$\text{RSC(nickel)} = 2.0\ \mu/\text{m}^3$$

The RSC for chromium should be obtained using either of the following two methods:

A. Determine the type of incinerator and the air pollution control devices installed. The numerical value of RSC for chromium for each type of incinerator and air pollution control devices is as follows:

If incinerator is fluidized bed with wet scrubber, RSC(chromium) = 0.65 $\mu g/m^3$

If incinerator is fluidized bed with wet scrubber and wet electrostatic precipitator, RSC(chromium) = 0.23 $\mu g/m^3$

If incinerator is another type with wet scrubber, RSC(chromium) = 0.064 $\mu g/m^3$

If incinerator is another type with wet scrubber and wet electrostatic precipitator, RSC(chromium) = 0.016 $\mu g/m^3$

B. The following equation can also be used to calculate the RSC for chromium:

$$\text{RSC(chromium)} = \frac{0.0085}{r}$$

Where:

RSC = risk specific concentration for chromium in micrograms per cubic meter (also see the definition provided for RSC in Section 7.2).

r = decimal fraction of the hexavalent chromium concentration in the total chromium concentration measured in the exit gas from the sewage sludge incinerator stack in hundredths. Please note that a specific stack test method for the determination of hexavalent chromium in stack gases should be used. The permit writer should use best professional judgment to determine the acceptable number of samples for identifying the hexavalent chromium concentration.

The RSC for chromium can easily be determined by substituting the value of the variable r in this equation.

For example, if 15 percent of the total chromium concentration measured in the exit gas of a sewage sludge incinerator requested by April 6, 1973, and is hexavalent chromium, the decimal fraction of the hexavalent chromium would be 0.15 and the value for RSC is calculated as:

$$\text{RSC(chromium)} = \frac{0.0085}{0.15} = 0.057\ \mu g/m^3$$

If the permittee uses Method B, the permit writer should compare the RSC for chromium with those in Table 2 of §503.43 to ensure that the calculated value is reasonable.

Step 4: From the information provided, obtain the value for sewage sludge feed rate (SF) in metric tons per day (dry weight basis). This is the same value used to calculate the pollutant limit for lead.

Step 5: Incorporate all necessary variables determined in the previous steps into equation (5) to verify the pollutant limits for arsenic, cadmium, chromium, and nickel.

7.4.4 BERYLLIUM

Statement of Regulation

§503.43(a)	**Firing of sewage sludge in a sewage sludge incinerator shall not violate the requirements in the National Emission Standard for Beryllium in subpart C of 40 CFR Part 61.**
§61.32(a)	**Emissions to the atmosphere from stationary sources subject to the provisions of this subpart shall not exceed 10 grams of beryllium over a 24-hour period, except as provided in paragraph (b) of this section.**
§61.32(b)	**Rather than meet the requirement of paragraph (a) of this section, an owner or operator may request approval from the Administrator to meet an ambient concentration limit on beryllium in the vicinity of the stationary source of 0.01 $\mu g/m^3$, averaged over a 30-day period.**

Beryllium emissions from a sewage sludge incinerator are regulated by the National Emission Standards for Hazardous Air Pollutants (NESHAPs) in Subpart C of Part 61. Part 503 requires that the NESHAP for beryllium be met when sewage sludge is fired in a sewage sludge incinerator. The NESHAP for beryllium is applicable to sewage sludge incinerators that process beryllium-containing waste. If a sewage sludge incinerator demonstrates that it does not burn any beryllium-containing waste, it is in compliance with §503.43(a). If a sewage sludge incinerator does burn beryllium-containing waste, the emission of beryllium can be regulated in one of two ways:

- In the exit gas from the sewage sludge incinerator stack
- In the ambient air around the incinerator.

The conditions placed in the permit will depend on the method chosen by the applicant to demonstrate compliance with the beryllium requirements.

The NESHAP for beryllium that applies to all sewage sludge incinerators covered under Part 503 is <u>10 grams of beryllium over a 24-hour period.</u> This standard applies to all regulated incinerators, except when the owner/operator of a sewage sludge incinerator requested by April 6, 1973, and has been granted a written approval from the Administrator to meet an ambient concentration limit for beryllium in the vicinity of the sewage sludge incinerator of <u>0.01 $\mu g/m^3$, averaged over a 30-day period</u>. The first limit stated above requires that, when sewage sludge is fired in a sewage sludge incinerator, the total quantity of beryllium emitted must not exceed 10 grams during any 24-hour period. This limit is for each site (e.g., if three incinerators are on site, the total quantity of beryllium that is emitted from all incinerators must not exceed 10 grams per 24-hour period). The alternative limit requires that

The NESHAP for beryllium in Subpart C of Part 61 includes a provision that allows an owner or operator to request approval from the Administrator to meet an ambient concentration limit on beryllium in the vicinity of the stationary source of 0.01 $\mu g/m^3$ (averaged over a 30-day period) to replace the limit of 10 grams of beryllium over a 24-hour period. Because the deadline for seeking such request was April 6, 1973, a sewage sludge incinerator covered under the Part 503 rule can only be subject to this alternative ambient concentration limit if the owner/operator of the incinerator has already been granted a written approval to comply with this provision.

The term "in the vicinity of the stationary source" refers to the distance from the sewage sludge incinerator stack to the point of maximum impact or concentration of the beryllium emissions, as determined by use of a proper air dispersion model.

the ambient concentration of beryllium in the proximity of the sewage sludge incinerator not exceed 0.01 $\mu g/m^3$ when averaged over any 30-day period. The radius of the area that is considered within proximity or vicinity of the plant is generally described in the written approval from the Administrator for this alternative limit.

The permit writer can utilize the following two step procedure to determine and incorporate the appropriate emission standard for beryllium:

Step 1: From the information provided, determine whether a written approval has been granted to the owner/operator by the Administrator to meet the alternative ambient concentration limit of 0.01 $\mu g/m^3$, averaged over a 30-day period in the vicinity of the incinerator facility. If written approval was granted, first obtain a copy of the original written approval, then include this alternative limit in the permit. If written approval was not granted, go to Step 2.

Step 2: If there is not a written approval from the Administrator granting the alternative ambient concentration limit, incorporate the NESHAP of 10 grams of beryllium over a 24-hour period into the permit.

7.4.5 MERCURY

Statement of Regulation

§503.43(b) **Firing of sewage sludge in a sewage sludge incinerator shall not violate the requirements in the National Emission Standard for Mercury in subpart E of 40 CFR Part 61.**

§61.52(b) **Emissions to the atmosphere from sludge incineration plants, sludge drying plants, or a combination of these that process wastewater treatment plant sludge shall not exceed 3200 grams of mercury per 24-hour period.**

The air emissions of mercury from a sewage sludge incinerator are regulated by the National Emission Standards for Hazardous Air Pollutants (NESHAPs) in Subpart E of Part 61. Part 503 requires that the NESHAP for mercury be met when sewage sludge is fired in a sewage sludge incinerator. The emission of mercury can be regulated in one of two ways:

- In the exit gas from the sewage sludge incinerator stack
- In the sewage sludge fed to the incinerator.

The conditions placed in the permit will depend on the method chosen by the applicant to demonstrate compliance with the mercury requirements.

The NESHAP for mercury that applies to all sewage sludge incinerators covered under Part 503 is 3200 grams of mercury over a 24-hour period. This means the total quantity of mercury that is emitted into the atmosphere from all incinerators at a given site must not exceed 3200 grams during any 24-hour period (e.g., if three incinerators are on site, the three incinerators could emit a total of 3200 grams per 24-hour period). The permit writer can incorporate this pollutant limit requirement verbatim from the regulations.

7.5 MANAGEMENT PRACTICES

Part 503 contains several management practices related to the firing of sewage sludge in a sewage sludge incinerator. These management practices require that certain instruments be installed, calibrated, operated, and maintained for each sewage sludge incinerator. They also require that requirements be established for incinerator combustion temperature and air pollution control device operating parameters, based on values obtained during performance testing. The following technical guidance provides a more detailed discussion of the purpose and need of such instrumentation. These management practices apply to all incinerators subject to Part 503.

7.5.1 TOTAL HYDROCARBONS MONITOR

<u>Statement of Regulation</u>

§503.45(a)(1) An instrument that continuously measures and records the total hydrocarbons concentration in the sewage sludge incinerator stack exit gas shall be installed, calibrated, operated, and maintained for each sewage sludge incinerator.

(2) The total hydrocarbons instrument shall employ a flame ionization detector; shall have a heated sampling line maintained at a temperature of 150 degrees Celsius or higher at all times; and shall be calibrated at least once every 24-hour operating period using propane.

Part 503 requires installation of an instrument that continuously measures and records the total hydrocarbons concentration in the sewage sludge incinerator stack exit gas, unless CO is continuously monitored, as described in the February 25, 1994, amendments to Part 503. The THC instrument must have a flame ionization detector and a heated sampling line that can maintain a temperature of 150°C or higher at all times. The flame ionization detector (FID) measures hydrocarbon emissions in the stack of an incinerator. The instrument reports the stack monitoring results as a concentration of hydrocarbons (in parts per million of THC by volume). The FID is a hydrogen-oxygen flame into which a small sample of incinerator exhaust gases is introduced. The flame burns any gases present in the sample.

The Part 503 regulation also requires that this instrument be calibrated at least once every 24-hour period using propane gas. When carbon-carbon (C-C) or carbon-hydrogen (C-H) bonds are broken and oxidized in the flame, an ion is released and an electrical detector senses the release of the ion. Thus, the number of C-C and C-H bonds being oxidized in the flame can be measured directly by the strength of the electrical signal produced. The direct readout of this electrical signal can be calibrated to indicate the concentration of hydrocarbons in the sample stream. Calibration is achieved by periodically introducing a series of calibration gases of known hydrocarbon concentration into the sample flame and marking or adjusting the readout to the actual concentration of calibration gases. EPA has selected propane as the reference gas for calibration of THC instruments. The Agency also believes that 24 hours is the maximum amount of time that this type of instrument can maintain its accuracy without calibration.

In addition to daily calibration, other issues related to THC monitor installation and performance need to be addressed. To ensure that the THC standard can be enforced continuously, the permit writer needs to establish specific criteria for judging whether THC continuous emission monitoring (CEM) data are accurate. Section 7.7 of this document presents a more detailed discussion of criteria for continuing emission monitors. A permit writer, however, will need to specify these criteria and acceptable mechanisms that operators can use to achieve them as permit conditions. Because of the potential complexity in outlining CEM performance criteria and test procedures, the permit writer may want to refer to EPA's guidance document called *THC Continuous Emission Monitoring Guidance for Part 503 Sewage Sludge Incinerators* (EPA 1994).

7.5.2 OXYGEN MONITOR

Statement of Regulation

§503.45(b) **An instrument that continuously measures and records the oxygen concentration in the sewage sludge incinerator stack exit gas shall be installed, calibrated, operated, and maintained for each sewage sludge incinerator.**

Part 503 requires installation of an instrument that continuously measures and records the oxygen concentration in the sewage sludge incinerator stack exit gas. As discussed in Section 7.5, this management practice is needed to obtain information to correct the THC concentration to 7 percent oxygen.

Oxygen monitors use one of several possible analytical techniques and sampling mechanisms to measure oxygen concentrations. Oxygen monitors can be either in situ or extractive. In situ monitors are in direct contact with the gas stream and measure the oxygen concentration at that specific location. Extractive monitors use a sampling system that continuously withdraws gas samples from the gas stream and directs it to an analyzer that may be up to several hundred feet away. Extractive systems are almost always equipped with sample conditioning systems that remove dust and moisture from the gas stream. The most important difference to note is that in situ monitors measure oxygen on a wet basis and extractive monitors generally measure oxygen on a dry basis. This difference is important because an oxygen concentration on a wet basis can differ significantly from one measured on a dry basis, depending on the moisture content of the gas sample. Wet and dry oxygen CEM measurements also can be used to calculate stack gas moisture content continuously.

Three types of analytical techniques are generally used with oxygen monitors. These techniques include electrocatalytic, polarographic, and paramagnetic. Detailed descriptions of each type of analyzer can be found in EPA's *Handbook of Continuous Air Pollution Source Monitoring Systems* (June 1979). As with the THC CEM, permit writers need to specify performance criteria and test procedures to ensure accurate data that can be used to enforce the THC operational standard. The permit writer can refer to the CEM specification established in Appendix B of Part 60, Subpart O for continuous oxygen monitors for sewage sludge incinerators.

7.5.3 MOISTURE CONTENT

Statement of Regulation

§503.45(c) **An instrument that continuously measures and records information used to determine the moisture content in the sewage sludge incinerator stack exit gas shall be installed, calibrated, operated, and maintained for each sewage sludge incinerator.**

Part 503 requires installation of an instrument that continuously measures and records information that can be used to determine the moisture content in the sewage sludge incinerator stack exit gas. As discussed in Section 7.5, this information is necessary to correct the THC concentration for 0 percent moisture. As mentioned earlier, one method used to measure the moisture content of a stack gas sample is to measure wet and dry oxygen concentrations simultaneously and calculate moisture content from the differences in these measurements. Another method involves determining the moisture from a psychometric chart based on the temperature and pressure at 100 percent saturation of wet scrubber exhaust gases. If proprietary monitors that measure stack gas moisture content directly are available, they can also be used. Because moisture content is essential to the calculation of THC, the instruments used to measure moisture content need to meet performance specifications as described for THC and oxygen monitors.

7.5.4 COMBUSTION TEMPERATURE

Statement of Regulation

§503.45(d) **An instrument that continuously measures and records combustion temperatures shall be installed, calibrated, operated and maintained for each sewage sludge incinerator.**

§503.45(e) **Operation of the sewage sludge incinerator shall not cause a significant exceedence of the maximum combustion temperature for the sewage sludge incinerator. The maximum combustion temperature for the sewage sludge incinerator shall be based on information obtained during the performance test of the sewage sludge incinerator to determine pollutant control efficiencies.**

Part 503 requires the installation, maintenance, operation and calibration of a device that continuously measures and records incinerator combustion temperatures. The regulation also requires that the maximum combustion temperature be established for each incinerator based on information obtained during the control efficiency performance test of the incinerator. The permit writer should consider the performance test conditions when setting the maximum temperature. The maximum temperature should be set at no more than 100-150°F higher than the maximum temperature recorded during the test. The maximum temperature should be established as a daily average unless the permit writer believes a different averaging period is more appropriate. Combustion temperature can affect both organic and inorganic emissions. Low combustion temperatures can result in poor combustion of sewage sludge and increased organic emission rates. High combustion temperatures can increase the volatilization of metals in the sewage sludge being incinerated and the potential for higher metal emission rates. High combustion temperatures can also result in high flue gas temperatures that could possibly damage air pollution control devices.

Because of the THC operational standard, a minimum combustion temperature is not needed. To achieve the THC operational standard, the incinerator will have to be operated at a certain temperature. By relating the combustion temperature limit to the temperature observed during performance testing, the potential rate of metals volatilization is theoretically maintained at the same level achieved during the performance test. This condition, therefore, limits the metals loading applied to the incinerator's air pollution control device.

Combustion temperatures are typically measured using thermocouples. They offer a relatively inexpensive, reliable and accurate means of measuring fairly high temperatures. Thermocouples are almost always enclosed in a thermowell that protects the thermocouple from the hostile environment of the incinerator combustion areas. Because of the potential for frequent damage, thermocouples are located downstream of the combustion zone near the exit of the combustion chamber. Thermowells that extend away from the incinerator wall improve the accuracy and response of the thermocouple, but are subject to slag buildup or abrasion (EPA 1990a). Periodic inspection and replacement of thermocouples is recommended; periodic calibration of thermocouples that are in place is impractical. If possible, the use of two thermocouples in separate wells is recommended to provide a cross-check of the operation of each thermocouple.

7.5.5 AIR POLLUTION CONTROL DEVICE OPERATING PARAMETERS

Statement of Regulation

§503.45(f) **Appropriate air pollution control devices shall be installed for the sewage sludge incinerator. Operating parameters for the air pollution control devices shall be selected that indicate adequate performance of the device. The values for the operating parameters for the air pollution control devices shall be based on information obtained during the performance test of the sewage sludge incinerator to determine pollutant control efficiencies. Operation of the sewage sludge incinerator shall not cause a significant exceedence of the values for the selected operating parameters for the air pollution control device.**

Part 503 requires the values for the operating parameters for an incinerator's air pollution control device (APCD) be based on information obtained during the incinerator's performance test. By recording key APCD operating parameters during control efficiency performance testing, one can establish baseline values for these parameters at known control efficiencies. By operating the incinerator and its control equipment at these baseline values in the future, the control efficiencies can be expected to remain relatively unchanged from performance test values. Continuously monitoring these operating parameters is theoretically an indirect means of monitoring pollutant control efficiencies.

As for the maximum temperature determination, it is important to know how the performance test conditions relate to normal operating conditions. Permit limits should be set based on the manufacturer's recommendations and the operating conditions during the performance test. To allow for operating flexibility, the values for the APCD operating parameters should be a range around the values demonstrated during the performance test.

Because each incinerator and APCD combination is site-specific, APCD operating parameter values also will be site-specific. Table 7-1 presents several APCD operating parameters that can be indicators of performance. Section 7.7 of this chapter discusses the establishment of incinerator and APCD operating parameters in permit conditions in greater detail.

TABLE 7-1 PERFORMANCE INDICATOR PARAMETERS FOR AIR POLLUTION CONTROL DEVICES

APCD	Parameters	Example Measuring Devices
Venturi scrubber	Pressure drop	Differential pressure (ΔP) gauge/ transmitter
	Liquid flow rate	Orifice plate with ΔP gauge/transmitter
	Gas temperature (inlet and/or outlet)	Thermocouple/transmitter
	Gas flow rate	Annubar or induced (ID) fan parameters
Impingement scrubber	Pressure drop	ΔP gauge/transmitter
	Liquid flow rate	Orifice plate with ΔP gauge/transmitter
	Gas temperature (inlet and/or outlet)	Thermocouple/transmitter
	Gas flow rate	Annubar or ID fan parameters
Mist eliminator (types include a wet cyclone, vane demister, chevron demister, mesh pad, etc.)	Pressure drop	Differential pressure gauge/transmitter
	Liquid flow	Orifice plate with ΔP gauge/transmitter
Dry scrubber (spray dryer absorber)	Liquid/reagent flow rate to atomizer	Magnetic flowmeter
	pH of liquid/reagent to atomizer	pH meter/transmitter
	For rotary atomizer: Atomizer motor power	Wattmeter
	For dual fluid flow: Compressed air pressure	Pressure gauge
	Compressed airflow rate	Orifice plate with ΔP gauge/transmitter
	Gas temperature (inlet and/or outlet)	Thermocouple/transmitter
Fabric filter	Pressure drop (for each compartment)	ΔP gauges/transmitters
	Broken bags	Proprietary monitors
	Opacity	Transmissometer
	Gas temperature (inlet and/or outlet)	Thermocouple(s)
	Gas flow rate	Annubar or ID fan parameters
Wet electrostatic precipitator	Secondary voltage (for each transformer/rectifier)	Kilovolt meters/transmitter
	Secondary currents (for each transformer/rectifier)	Milliammeters/transmitter
	Liquid flow(s) (for separate liquid feeds)	Orifice plate(s) with ΔP gauge/ transmitter
	Gas temperature (inlet and/or outlet)	Thermocouple(s)
	Gas flow rate	Annubar or ID fan parameters

Source: EPA 1990a

7.5.6 ENDANGERED SPECIES ACT

Statement of Regulation

§503.45(g) **Sewage sludge shall not be fired in a sewage sludge incinerator if it is likely to adversely affect a threatened or endangered species listed under Section 4 of the Endangered Species Act or its designated critical habitat.**

In addition to meeting the requirements of Subpart E of the Part 503 regulations, additional management practices that would prevent likely adverse effects on threatened or endangered species or their critical habitats may need to be developed on a site-specific basis. First, a determination should be made as to whether there are any threatened or endangered species or their critical habitats present in the areas affected by the air emissions from the sewage sludge incinerator. In general, this determination should be done by the person who fires sewage sludge. Results of the air dispersion modeling will help in delineating the area of impact.

This provision is not of concern if no threatened or endangered species or critical habitats are present. However, the permit writer may want to include this provision in the permit as it appears in Part 503.

If threatened or endangered species or their designated critical habitats are present, the permit writer will need to determine whether the firing of sewage sludge will be likely to cause an adverse effect upon the species or their habitats. Again, this determination may need to be done by the person who fires sewage sludge. An assessment of potential adverse impacts may be expensive and the causal link between the air emissions from the sewage sludge incinerator and the degree of impact to the species or habitat may be difficult to substantiate. The field office of the U.S. Department of Interior, Fish and Wildlife Service (FWS) may have information on any studies of the area's threatened and endangered species or critical habitats. If there is any available information indicating potential adverse impacts due to the firing of sewage sludge, then a site-specific assessment may be needed. The permit writer should document in the fact sheet the presence of threatened or endangered species or their critical habitats and any information indicating adverse impacts. The permit writer should include a permit condition that incorporates the management practice that firing of sewage sludge shall not cause adverse effects upon the species or habitats present in the area.

If adverse effects are likely, the permit writer will need to follow EPA policies or use best professional judgment in constructing site-specific management practices to prevent these likely adverse impacts. It will be necessary for the permit writer to work with the owner/operator in identifying these specific management practices.

7.6 OPERATIONAL STANDARDS

Subpart E does not contain numerical limits for specific toxic organic compounds in sewage sludge or in the exit gases from sewage sludge incinerators. However, to protect human health and the environment from organic pollutants when sewage sludge is incinerated, the regulation contains an operational standard for total hydrocarbons (THC). This operational standard applies to all incinerators subject to Part 503 except where CO is monitored in accordance with §503.40(c). The following guidance provides the necessary information and direction to incorporate this operational standard into the permit.

Statement of Regulation

§503.44(a) **The total hydrocarbons concentration in the exit gas from a sewage sludge incinerator shall be corrected for zero percent moisture by multiplying the measured total hydrocarbons concentration by the correction factor calculated using equation (7).**

$$\text{Correction factor (percent moisture)} = \frac{1}{(1 - X)} \qquad \text{Eq. (7)}$$

Where:

X = Decimal fraction of the percent moisture in the sewage sludge incinerator exit gas in hundredths.

§503.44(b) **The total hydrocarbons concentration in the exit gas from a sewage sludge incinerator shall be corrected to seven percent oxygen by multiplying the measured total hydrocarbons concentration by the correction factor calculated using Equation (8).**

$$\text{Correction factor (oxygen)} = \frac{14}{(21 - Y)} \qquad \text{Eq. (8)}$$

Where:

Y = Percent oxygen concentration in the sewage sludge incinerator stack exit gas (dry volume/dry volume).

(c) **The monthly average concentration for total hydrocarbons in the exit gas from a sewage sludge incinerator stack, corrected for zero percent moisture using the correction factor from equation (7) and to seven percent oxygen using the correction factor from equation (8), shall not exceed 100 parts per million on a volumetric basis when measured using the instrument required by §503.45(a).**

7.6.1 TOTAL HYDROCARBON (THC)

THC is a measure of the carbon-carbon (C-C) or carbon-hydrogen (C-H) bonds of the organic material present in the exhaust gas of an incinerator. THC provides an indirect measurement of the total organic pollutants in the exit gases of an incinerator. Therefore, limiting the THC levels in the exhaust gas of an incinerator provides an indirect control over the total quantities of organic pollutants released from that incinerator. Part 503 contains an operational standard for THC in the stack emissions to ensure that excessive amounts of organic pollutants are not released into the atmosphere. This requirement is a technology-based operational standard based on operating data from a study of four sewage sludge incinerators (EPA 1992a).

The corrected THC level in the exhaust gases must not exceed a monthly average of 100 parts per million on a volumetric basis. This operational standard requires that the THC concentration in the stack exit gas be measured continuously and corrected to 7 percent oxygen (from 21 percent oxygen in air) and for 0 percent moisture using an equation provided in the regulation. The THC concentration is corrected to 7 percent oxygen to account for the excess air used in the combustion of sewage sludge.

Excess air refers to the amount of air that is present in the combustion chamber of the incinerator in excess of the minimum amount required for the combustion process to take place. The presence of excess air in the combustion chamber enhances the combustion process and provides a safety measure against variations in the system, such as changes in sewage sludge feed rate and sewage sludge moisture content, that could lead to incomplete combustion of the organic matter. A sewage sludge incinerator operated with very little excess air could easily exceed the operational standard of 100 ppm THC. On the other hand, the THC concentration could be lowered without reducing the actual emission rate simply by adding higher rates of air to the incinerator. High excess air rates "dilute" the THC concentration detected by the flame ionization detector (FID). This could allow an incinerator to appear to be meeting the THC standard, when the actual THC emissions are in excess of those set by the regulations taking dilution into account (EPA 1989, 1992b). This is why the measured THC concentration has to be corrected to seven percent oxygen.

The presence of moisture in the exit gas can dilute the THC measurement and create artificially low readings. Because most sewage sludges contain substantial amounts of water, the exit gas contains moisture and the THC must be corrected for this moisture content. Conventionally, the THC is measured in terms of dry-volumetric basis (0 percent moisture) and therefore correction for moisture is based on 0 percent moisture content. The THC concentration in the exit gas must be corrected for 0 percent moisture by multiplying the measured THC concentration by the following correction factor:

$$\text{Correction factor (percent moisture)} = \frac{1}{(1 - X)}$$

Where:

X = decimal fraction of the percent moisture in the exit gas in hundredths.

Further correction of the measured THC concentration to 7 percent oxygen must be performed by multiplying the measured THC concentration by a dimensionless correction factor specified in the regulation [§ 503.44(b)]. That correction factor is as follows:

$$\text{Correction factor (oxygen)} = \frac{14}{(21 - Y)}$$

Where:

Y = percent oxygen concentration in the exit gas (dry volume/dry volume).

For example, if the measured THC is 30 ppm, the measured oxygen content is 9 percent, and the measured moisture content is 30 percent, the THC value corrected to 7 percent oxygen and no moisture is calculated as the following:

$$\text{THC (dry, 7 percent oxygen)} = \frac{30\text{ ppm}}{(1 - .3)} \times \frac{14}{(21 - 9)}$$

$$= 42.9\text{ ppm} \times 1.1667$$

$$= 50\text{ ppm}$$

The monthly average THC limit of 100 ppm is based on continuous measurements while sewage sludge is being incinerated. Thus, the regulation requires installation of instruments for continuous monitoring of THC, oxygen, and information needed to determine the moisture content in the exit gas of a sewage sludge incinerator (detailed discussion of these continuous monitoring requirements are provided in Section 7.6 of this chapter).

The permit should clarify that the THC operational standard is based on continuous measurement with the specified instrumentation, oxygen concentration, and moisture content in the sewage sludge incinerator stack exit gas (see Section 7.6 for the monitoring instruments required). Furthermore, the permit writer should include in the permit the specific equations that must be used to correct for excess air and moisture content. The permit should also specify that the limit of 100 ppm must be on a volumetric basis and that hourly averages of THC measurements after correction to 7 percent oxygen and for 0 percent moisture should be recorded continuously. The raw monitoring data used to derive the values of corrected, dry THC also should be collected, maintained, and made available to the permitting authority on request.

7.6.2 CARBON MONOXIDE (CO)

Statement of Regulation

§503.40(c) **The management practice in §503.45(a), the frequency of monitoring requirement for total hydrocarbon concentration in §503.46(b) and the recordkeeping requirements for total hydrocarbon concentration in §503.47(c) and (n) do not apply if the following conditions are met:**

(1) **The exit gas from a sewage sludge incinerator stack is monitored continuously for carbon monoxide.**

(2) **The monthly average concentration of carbon monoxide in the exit gas from a sewage sludge incinerator stack, corrected for zero percent moisture and to seven percent oxygen, does not exceed 100 parts per million on a volumetric basis.**

(3) **The person who fires sewage sludge in a sewage sludge incinerator retains the following information for five years:**

(i) **The carbon monoxide concentrations in the exit gas; and**

(ii) **A calibration and maintenance log for the instrument used to measure the carbon monoxide concentration.**

(4) **Class I sludge management facilities, POTWs (as defined in 40 CFR 501.2) with a design flow rate equal to or greater than one million gallons per day, and POTWs that serve a population of 10,000 people or greater submit the monthly average carbon monoxide concentrations in the exit gas to the permitting authority on February 19 of each year.**

As mentioned earlier, on February 25, 1994, Part 503 was amended to allow carbon monoxide to be monitored instead of THC if the following conditions are met. The exit gas from a sewage sludge incinerator must be monitored continuously and the monthly average concentration of CO, corrected for zero percent moisture and to seven percent oxygen, must not exceed 100 parts per million on a volumetric basis.

7.7 FREQUENCY OF MONITORING REQUIREMENTS

The monitoring requirements presented in §503.46 apply to sewage sludge fired in a sewage sludge incinerator, to the exit gas from a sewage sludge incinerator while sewage sludge is being fired, and to air pollution control device operating parameters.

7.7.1 SEWAGE SLUDGE

Statement of Regulation

§503.46(a) **Sewage sludge**

§503.46(a)(1) **The frequency of monitoring for beryllium shall be as required under subpart C of 40 CFR Part 61 and for mercury as required under subpart E of 40 CFR Part 61.**

(2) **The frequency of monitoring for arsenic, cadmium, chromium, lead, and nickel in sewage sludge fed to a sewage sludge incinerator shall be the frequency in Table 1 of §503.46.**

Part 61 requires only a one-time start-up stack sampling or, alternatively, continuous air sampling, for beryllium. For mercury, Part 61 requires a one-time start-up stack or sludge sampling, with annual monitoring for those sources for which mercury emissions exceed 1600 grams per 24-hour period, as specified in §§61.53-.55. Permit writers may want to require periodic monitoring to ensure that the NESHAPs are being met. The preamble to the October 25, 1995, amendments to Part 503 (60 *FR* 54781) suggests various monitoring alternatives that may be appropriate for sewage sludge incinerators.

Section 503.46 requires that sewage sludge fired in a sewage sludge incinerator be monitored for arsenic, cadmium, chromium, lead, and nickel at the frequencies presented in Table 1 of §503.46. The frequency of monitoring for these pollutants depends on the amount of sewage sludge fired in an incinerator in a 365-day period.

TABLE 1 OF 503.46 - FREQUENCY OF MONITORING - INCINERATION

Amount of Sewage Sludge* (metric tons per 365 day period)	Frequency
Greater than zero but less than 290	once per year
Equal to or greater than 290 but less than 1,500	once per quarter (4 times per year)
Equal to or greater than 1,500 but less than 15,000	once per 60 days (6 times per year)
Equal to or greater than 15,000	once per month (12 times per year)

* Amount of sewage sludge fired in a sewage sludge incinerator (dry weight basis).

§503.46(a)(3)	**After the sewage sludge has been monitored for 2 years at the frequency in Table 1 of §503.46, the permitting authority may reduce the frequency of monitoring for arsenic, cadmium, chromium, lead, and nickel.**

The regulation allows the permitting authority to modify the frequency of monitoring after sewage sludge has been monitored at the frequencies in Table 1 of §503.46 for 2 years. Some important factors that a permit writer should consider in establishing permit conditions for sewage sludge monitoring frequencies include:

- History of compliance with the pollutant limits
- Variability of pollutant concentrations in the sewage sludge
- Trends in pollutant concentrations in the sewage sludge
- Magnitude of typical pollutant concentrations
- Magnitude of the pollutant limits.

Permit writers also may wish to specify either by permit or by referencing appropriate guidance documents how sewage sludge monitoring is to be conducted. Specifically:

- <u>Sewage Sludge Sampling Methods</u>—Discussions should include the entity responsible for sampling; sample splitting; equipment to be used; sample techniques, locations, times, amounts, and types (grab or composite); sample handling and preservation; sampling records to be kept; and conditions when sampling should occur.

- <u>Analytical Methods</u>—Discussions should include the numbers of analyses, acceptable techniques, quality assurance and quality control procedures, analytical records to be kept, and calculations to be made.

<u>Grab</u>—A single grab sample can be a representative sample if every part of the sewage sludge has an equal chance to be sampled and the sewage sludge is fairly homogenous in pollutants and solids content. Because the sample collection point is fixed and cannot be randomly selected, the time at which a sample is collected should be randomly chosen. For example, a number from 1 to 24 can be randomly selected to determine the time at which a grab sample should be collected from an incinerator sewage sludge feed line during a 24-hour continuous operation period.

<u>Composite</u>—Another method of obtaining a representative sample is to collect single grab samples at predetermined intervals during a continuous operation period and combine them into a single composite sample. A composite sample is more representative of the sewage sludge than a single grab sample.

The frequency of monitoring in Table 1 of §503.46 assumes that sewage sludge is fired in a sewage sludge incinerator throughout the 365 day period. The frequency of monitoring could be affected if the sewage sludge is stored before it is fired in the incinerator.

Two approaches that can be used when sewage sludge is stored before it is used or disposed to show compliance with pollutant concentration limits are discussed in section 4.7.2. An important aspect of both approaches is that representative samples of the sewage sludge must be collected and analyzed.

7.7.2 STACK GAS

Statement of Regulation

§503.46(b) Total hydrocarbons, oxygen concentration, information to determine moisture content, and combustion temperatures.

The total hydrocarbons concentration and oxygen concentration in the exit gas from a sewage sludge incinerator stack, the information used to measure moisture content in the exit gas, and the combustion temperatures for the sewage sludge incinerator shall be monitored continuously unless otherwise specified by the permitting authority.

Section 503.46 requires that the exit stack gas from a sewage sludge incinerator be monitored continuously for total hydrocarbons, oxygen, and moisture concentrations unless otherwise specified by the permitting authority. The primary purpose of the CEM is to provide data to verify an incinerator's compliance with the operational standard of §503.44. To ensure that the monitoring data can be used to show compliance with Part 503, the permit writer should address the following important issues in each permit. Guidance on addressing these issues is available in EPA's *THC Continuous Emission Monitoring Guidance for Part 503 Sewage Sludge Incinerators* (EPA 1994).

- CEM quality assurance and quality control procedures should be required and the criteria used to judge these procedures should be specified. Besides the daily calibration and maintenance requirements of §503.45, quarterly calibration error checks of the CEMs are recommended. Written calibration, testing, and maintenance procedures for CEMs should also be required from incinerator operators.

- CEMs should be required to meet certain performance specifications. These performance specifications should establish the criteria used to judge the acceptability of the CEMs at the time of installation. Important elements of performance specifications include performance test procedures, monitor range and resolution, calibration gas requirements, response time, and conditioning and operational test period requirements.

- Data availability requirements should be required and defined. Is monitor downtime allowed for monitor calibration, maintenance, and malfunctions? If so, how much and how frequently?

- Data reduction and averaging procedures and calculations should be detailed. Specific procedures for the calculation of THC exceedence incidents, for the percentage of THC exceedence time and for correction of total hydrocarbons for oxygen and moisture should be defined.

- Acceptable locations of CEM sample points and calibration gas injection points should be specified. The chief consideration in CEM sample point location is that the measurement obtained is representative of incinerator exit gases. The CEM sampling point should be located such that the potential for gas stratification and air in-leakage are minimized and that manual stack sampling and maintenance accessibility is provided. The quality and concentrations of calibration gases also need to be specified.

- Criteria should be defined for judging the validity of CEM data and determining when corrective actions need to be taken.

If an incinerator monitors CO instead of THC, the permit writer should specify the CO CEM requirements in the same manner as she would specify THC CEM requirements.

The Agency has received requests for a variance from the CEM requirement from incinerators that operate infrequently. In the proposed amendments to Part 503 (60 *FR* 54771, October 1995), EPA proposed to amend §503.46(b) to allow the permitting authority to specify an alternative to continuous monitoring of the exit gas from a sewage sludge incinerator. EPA requested comments on whether small incinerators should be allowed to monitor less than continuously, how the monitoring should be performed, and how to decide which incinerators should be allowed to monitor less than continuously. The Agency will consider all comments received on the proposed amendments when deciding if the permitting authority should be able to exempt certain small incinerators from continuous THC or CO monitoring.

7.7.3 INCINERATOR AND AIR POLLUTION CONTROL DEVICE

Statement of Regulation

§503.46(c) Air pollution control device operating parameters.

The frequency of monitoring for the sewage sludge incinerator air pollution control device operating parameters shall be at least daily.

The requirements at §503.46 require the incinerator combustion temperature to be monitored continuously. Air pollution control device operating parameters are to be monitored at least daily. The values of these parameters should be consistent with the values observed during the performance test to determine pollutant control efficiencies.

The regulations at Part 61, Subparts C and E do not specify operating parameters to be monitored. They do require that no change in the operation be made which would potentially increase beryllium or mercury emission rates above those estimated by the most recent stack test, until new emission rates are calculated and the results are reported to the Administrator. To satisfy this requirement, operating parameters that impact beryllium and mercury emission rates should be established and monitored.

Part 503 provides flexibility in establishing permit conditions for incinerator and APCD operating parameters. This flexibility is necessary so that appropriate conditions can be applied, based on incinerator and APCD designs and operating procedures; it also burdens the permit writer with the responsibility of identifying important operating parameters and establishing limits for them. When writing permits, the permit writer should consider the following:

- Specific averaging times ensure enforceability
- Ranges allow for some operational flexibility.
- Pollutant limits must be tied to the values of the operating parameters observed during any performance tests. It is important to understand that the conditions that exist during a performance test can restrict the future operations of the incinerator and its APCD.

Some key parameters for which permit writers should consider establishing permit conditions include:

- Auxiliary fuel type and feed rates—in some cases, an increase in auxiliary fuel(s) feed rate may increase pollutant emission rates. Permit writers should consider limiting the type(s) and feed rates of auxiliary fuels.

- Incinerator combustion temperature—low combustion temperatures for even short time periods can result in poor combustion efficiencies, and short-term increases in organic and odor-causing emissions. Higher combustion temperatures can result in increased metals volatilization and metals loading on the APCD. Because it may be difficult to reliably measure the combustion zone temperature in many incinerators, another sampling location within or near the combustion chamber can be used as an indicator of combustion zone temperature. The location should be away from any quench water or air injection points.

- Temperature of flue gas entering the APCD—increased temperature at the inlet to the APCD increases the volatility of metals that may be present. Metals that remain in the vapor form in the APCD will be less efficiently captured.

- Venturi scrubber pressure drop—particulate and metals removals decrease with reduced pressure drop.

- Fabric filter pressure drop—a low pressure drop can be indicative of torn or missing filters that can lead to increased particulate and metals emissions. A high pressure drop can be indicative of plugged or "blinded" filters that could potentially fail.

- Electrical power applied to an electrostatic precipitator or ionizing wet scrubber—reduced electrical power or the number of fields in operation decreases the rate of particle charging thus decreasing collection efficiencies. The unit of power applied and where the applied power is measured also should be specified.

Permit writers should also remember that sewage sludge incinerators and their control equipment are complex systems and that many of the parameters outlined earlier are related. Permit writers should be aware of operating parameters and potential permit conditions that may conflict. Conflict also may occur when parameters used to gauge compliance cannot be simultaneously operated at their worst-case conditions. One example might be incinerator combustion temperature conditions established to maximize organic destruction and to minimize metal volatilization. Permit writers should also be alert to parameter limits that could violate permit conditions for reasons that may not be related to emissions. For example, a low APCD pressure drop may result from reduced air flow rate or lower sewage sludge charging rates and not from APCD problems.

7.8 RECORDKEEPING REQUIREMENTS

The permit should contain requirements for maintaining records that demonstrate compliance with the operational standard, pollutant limits, and management practices. Specific records that must be maintained by the person who fires sewage sludge in a sewage sludge incinerator are listed in §503.47. In general, the recordkeeping requirements in §503.47 pertain to the monitoring requirements in §503.46. The records are required to be developed and retained for at least 5 years by any person who fires sewage sludge in a sewage sludge incinerator. These records will be largely based on other pieces of information and documents such as air dispersion models, testing procedures, calculations, and incinerator design and operating manuals. Without this documentation, the incinerator operator will not be able to support reports made to the permitting authority. Similarly, the permitting authority will not have enough information to make complete evaluations of compliance or to judge the adequacy of the information used to show compliance.

Because the Part 503 rule does not detail documentation requirements, the permit writer needs to be specific enough so that the person who fires sewage sludge knows what is expected. Depending on the specific requirement, the permit writer may require documentation to be submitted in the permit application, during the review of the application, and after the permit has been issued (as an ongoing permit condition). Some of the recordkeeping requirements in §503.47 are very specific and some must be developed by the permit writer based on site-specific conditions. This document provides general recommendations for recordkeeping and documentation. The recordkeeping requirements and recommended documentation to be discussed in this section has been divided into the following four categories, each to be discussed individually in greater detail:

- Incinerator information
- Dispersion modeling
- Stack gas data
- Sewage sludge monitoring information.

7.8.1 INCINERATOR INFORMATION

Statement of Regulation

§503.47(a)	**The person who fires sewage sludge in a sewage sludge incinerator shall develop the information in §503.47(b) through §503.47(n) and shall retain that information for five years.**
§503.47(g)	**Values for the air pollution control device operating parameters.**

Detailed information about each sewage sludge incinerator and its air pollution control device is necessary in order to establish proper sewage sludge pollutant limits and sewage sludge monitoring frequencies. This information should include:

- The number of sewage sludge incinerators.
- The type of each sewage sludge incinerator (e.g., multiple hearth or fluidized bed).
- The design and typical operating capacities of each incinerator in dry pounds of sewage sludge fired per hour.
- The operating schedule for each incinerator.
- The type and firing rate of auxiliary fuel(s).
- The type of air pollution control device used for each sewage sludge incinerator. Permit writers may also request specific design and operating parameters for the air pollution control system in order to evaluate the adequacy of emissions control.

Certain incinerator exhaust stack parameters also need to be determined and documented so that a dispersion factor can be obtained. Important stack parameters to document are:

- Stack height (the distance from ground level to the top of the stack discharge point)
- Stack diameter (if round) or stack opening length and width (if rectangular or square)
- Stack gas discharge velocity at or near the top of the stack
- Stack gas discharge temperature at or near the top of the stack.

Because this information is unlikely to change very often, if at all, it would be appropriate for this general information to be submitted as part of the permit application. The permit writer should include a permit condition requiring the notification of the permitting authority of any changes in the information submitted in the application as soon as the person who fires the sewage sludge is aware of the change (preferably before the change occurs).

7.8.2 DISPERSION MODELING

<u>**Statement of Regulation**</u>

§503.47(a)	**The person who fires sewage sludge in a sewage sludge incinerator shall develop the information in §503.47(b) through §503.47(n) and shall retain that information for five years.**
§503.47(j)	**The stack height for the sewage sludge incinerator.**
§503.47(k)	**The dispersion factor for the site where the sewage sludge incinerator is located.**

Part 503 requires the use of a Dispersion Factor (DF) to calculate limits for lead, arsenic, cadmium, chromium, and nickel in sewage sludge fed to a sewage sludge incinerator. Because the pollutants subject to dispersion modeling requirements can be assumed to behave similarly (all act as particles and do not undergo atmospheric reactions), one DF can be used to calculate pollutant limits for all five regulated metals.

The increase in the ground level ambient air pollutant concentration at or beyond the property line can be determined by using an air dispersion model. Models provide differing levels of sophistication and suitability depending on the modeling application. Because of the variety of models available and the potential complexities in their use, a modeling protocol should be reviewed by the permitting authority prior to conducting any sophisticated dispersion modeling. A modeling protocol establishes procedures, data requirements and acceptable assumptions. A protocol can help to avoid misunderstandings and the need to conduct additional modeling runs.

The regulations do not specify acceptable methods of dispersion modeling to be applied to development of a DF; methodologies acceptable to both the person who fires the sewage sludge and the permitting authority should be developed on an individual basis. Many technical issues need to be considered when discussing the application of air dispersion models, such as:

- The mathematical algorithm of the model
- Meteorological data requirements
- Averaging times for emission rates and predicted ambient air impacts
- Topographic and land use considerations

- Receptor site locations
- Downwash considerations.

The permit writer and incinerator operator may wish to refer to *Guidelines on Air Quality Models (Revised)* and *Screening Procedures for Estimating the Air Quality Impact of Stationary Sources* (both published by EPA) for more detailed discussions on the application of dispersion models. The permit writer and incinerator operator should also get help from personnel trained and experienced in dispersion modeling whenever possible, to conduct and review dispersion modeling runs.

Regardless of the model chosen, the permit writer should require complete modeling documentation and should thoroughly review this documentation after modeling is conducted. Sewage sludge incinerators should be required to maintain the following documentation:

- Modeling protocols.

- Complete modeling reports that follow the approved protocols and include the model used, who performed the modeling, all model input data, and the output of the model.

- The pollutant emission rates used.

- A scale diagram that shows the location of the incinerator stack(s), property lines, buildings and other significant structures. The diagram should indicate building dimensions and distances between buildings, property lines and the incinerator stack(s).

- A map of the area that shows its topography and land use.

- The value of the dispersion factor used to calculated pollutant limits and how it was calculated.

7.8.3 STACK GAS DATA

Statement of Regulation

§503.47(a)	**The person who fires sewage sludge in a sewage sludge incinerator shall develop the information in §503.47(b) through §503.47(n) and shall retain that information for five years.**
§503.47(d)	**Information that indicates the requirements in the National Emission Standard for beryllium in Subpart C of 40 CFR Part 61 are met.**
§503.47(e)	**Information that indicates the requirements in the National Emission Standard for mercury in Subpart E of 40 CFR Part 61 are met.**
§503.47(l)	**The control efficiency for lead, arsenic, cadmium, chromium, and nickel for each sewage sludge incinerator.**
§503.47(m)	**The risk specific concentration for chromium calculated using equation (6), if applicable.**

Stack gas data required to be obtained and retained by sewage sludge incinerator operators can be divided into two categories: stack test data and continuous emissions monitoring (CEM) data.

Stack Test Data

The sewage sludge incinerator operator is required to conduct incinerator emissions stack testing by the following regulations:

- Part 503, Subpart E—Determine control efficiencies for lead, arsenic, cadmium, chromium, and nickel
- Part 61, Subpart C—Determine beryllium emission rate
- Part 61, Subpart E—Determine mercury emission rate.

Before discussing the specific documentation requirements of the testing outlined above, it may be helpful to discuss some general stack testing documentation needs. As with dispersion modeling, a protocol must be prepared for review by the permitting authority before any stack testing is performed. A stack test protocol can prevent misunderstandings and the need for frustrating and costly re-tests. A stack test protocol should establish approved sampling and analytical methods, sample point location(s), and incinerator and air pollution control device operating conditions. The final stack test report should follow the established protocol and should explain deviations from agreed-upon procedures and operating conditions. The test report should document the following:

- Sampling methods including the amount of sample, the duration of sampling, the number of samples, time and date of samples, person who conducted sampling, and sample point locations.
- Analytical methods including the number, time, date, and analyst for each analysis.
- Raw sampling and laboratory sheets.
- Calculation sheets.
- Quality assurance and quality control procedures such as sample train leak tests and sampling and laboratory equipment calibrations and checks.
- Chain-of-custody sheets.
- Incinerator operating parameters during testing such as sewage sludge feed rate, auxiliary fuel feed rate, oxygen concentrations, and incinerator temperatures. The locations of oxygen and temperature monitors should be specified.
- Applicable air pollution control device parameters during testing, such as stack gas opacity, pressure drop across the pollution control device, scrubber liquid flow rates and solids concentrations, stack gas flow rates, temperatures and pressures, and electrostatic precipitator field power, voltage, and amperage being applied during testing.

Part 503, Subpart E requires that both the mass of a pollutant in the sewage sludge fed to a incinerator and the mass of that pollutant in the incinerator exhaust stack gas be determined in a performance test. The mass of pollutants in the incinerator exhaust can be determined by stack testing and documented as described in the earlier paragraph. The mass of pollutants in the sewage sludge fed to the incinerator can be determined by sewage sludge sampling and analysis. Sewage sludge sampling should precede stack sampling by the time it takes a metal molecule to move through the incinerator so that the same sludge is compared at both ends. Sewage sludge sampling documentation that should be maintained from the performance test includes:

- Sampling and analytical methods
- Sample point(s)
- Sample times, amounts, and frequencies
- Sample compositing techniques
- Raw sampling and laboratory sheets
- Calculation sheets used in sampling and analysis
- Chain-of-custody sheets
- Quality assurance and quality control data.

Part 61, Subpart C and Subpart E require initial performance testing to verify compliance with beryllium and mercury emission standards. The documentation requirements for stack gas and sewage sludge sampling described earlier also would apply to these emission standards. Because both the beryllium and mercury emission standards are expressed as grams emitted in a 24-hour period, documentation is needed to show that incinerator operating conditions do not deviate from those conditions used to demonstrate worst-case beryllium and mercury emissions in a 24-hour period. Subpart E also requires that incinerators with mercury emissions greater than 1,600 grams per 24-hour period must monitor and document mercury emissions by either stack testing or sewage sludge sampling and analysis annually.

Recommendations for stack gas sampling methods to be used are as follows:

- Beryllium—EPA Method 104 found in Part 61, Appendix B

- Mercury—EPA Method 101A found in Part 61, Appendix B

- Other metals—EPA protocol entitled "Methodology for the Determination of Metal Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Processes."

Continuous Emissions Monitoring Data

Statement of Regulation

§503.47(a)	**The person who fires sewage sludge in a sewage sludge incinerator shall develop the information in §503.47(b) through §503.47(n) and shall retain that information for five years.**
§503.47(c)	**The total hydrocarbons concentration in the exit gas from the sewage sludge incinerator stack.**
§503.47(f)	**The combustion temperatures, including the maximum combustion temperature, for the sewage sludge incinerator.**
§503.47(h)	**The oxygen concentration and information used to measure moisture content in the exit gas from the sewage sludge incinerator stack.**
§503.47(n)	**A calibration and maintenance log for the instruments used to measure the total hydrocarbons concentration and oxygen concentration in the exit gas from the sewage sludge incinerator stack, the information needed to determine moisture content in the exit gas, and the combustion temperatures.**

Statement of Regulation

§503.40 Applicability

(c) The management practice in §503.45(a), the frequency of monitoring requirement for total hydrocarbon concentration in §503.46(b) and the recordkeeping requirements for total hydrocarbon concentration in §503.47(c) and (n) do not apply if the following conditions are met:

(1) The exit gas from a sewage sludge incinerator stack is monitored continuously for carbon monoxide.

(2) The monthly average concentration of carbon monoxide in the exit gas from a sewage sludge incinerator stack, corrected for zero percent moisture and to seven percent oxygen, does not exceed 100 parts per million on a volumetric basis.

(3) The person who fires sewage sludge in a sewage sludge incinerator retains the following information for five years:
(i) The carbon monoxide concentrations in the exit gas; and
(ii) A calibration and maintenance log for the instrument used to measure the carbon monoxide concentration.

(4) Class I sludge management facilities, POTWs (as defined in 40 CFR 501.2) with a design flow rate equal to or greater than one million gallons per day, and POTWs that serve a population of 10,000 people or greater submit the monthly average carbon monoxide concentrations in the exit gas to the permitting authority on February 19 of each year.

The use of continuous emissions monitors at sewage sludge incinerators is required by Part 503, Subpart E. This subpart requires the use, calibration, and maintenance of CEMs to determine total hydrocarbon, oxygen, and moisture concentrations in the incinerator stack gases. A CEM for CO can be used as an alternative to a CEM for THC.

As indicated earlier in Section 7.7, the Part 503 regulation does not specify CEM performance and recordkeeping requirements. The CEM data issues identified in this section also need to be considered and resolved before establishing recordkeeping requirements. Generic recommendations for CEM documentation that should be maintained by the sewage sludge incinerator operator include:

- Daily calibration records, including a description of calibration procedures, the time and date of each calibration, the calibration gas values, the CEM calibration results, any automatic calibration correction factors used, and any corrective actions taken.
- Daily maintenance records, including a description of any maintenance and corrective actions and the amount of monitor downtime.
- Other records of quality assurance and quality control procedures, including quarterly calibration error determinations.
- The criteria used to specify invalid CEM data. The operator should be required to document what CEM data are excluded and why they were excluded from the calculation of the monthly

average for total hydrocarbons or for carbon monoxide. The operator should be required to calculate monitor downtime on a monthly basis.

- A description of data reduction and averaging procedures and calculations approved by the permitting authority.

- The criteria used to specify when corrective actions must be taken and preventative maintenance schedules and procedures.

- The locations of the CEM sample points, stack gas sample ports, and calibration gas injection points.

- The initial certification plan and final test report for the CEM system.

As previously indicated, the permit writer may want to refer to EPA's *THC Continuous Emission Monitoring Guidance for Part 503 Sewage Sludge Incinerators* (EPA 1994).

The permit writer also may require calibration and maintenance records for sewage sludge feed monitors, auxiliary fuel feed monitors, monitors for pressure drop across wet scrubbers, incinerator combustion temperature monitors, and any monitors for other operating parameters specific to a particular incinerator be kept. The permit writer may consider requiring that records of any deviations of operating parameter values be kept.

7.8.4 SEWAGE SLUDGE MONITORING INFORMATION

Statement of Regulation

§503.47(a)	**The person who fires sewage sludge in a sewage sludge incinerator shall develop the information in §503.47(b) through §503.47(n) and shall retain that information for 5 years.**
§503.47(b)	**The concentration of lead, arsenic, cadmium, chromium, and nickel in the sewage sludge fed to the sewage sludge incinerator.**
§503.47(i)	**The sewage sludge feed rate.**

Sewage sludge incinerator operators are required by Part 503, Subpart E to record the sewage sludge feed rate for a sewage sludge incinerator and the concentrations of lead, arsenic, cadmium, chromium, and nickel in the sewage sludge that is incinerated. The frequency of monitoring of metals concentrations in the sewage sludge to be burned depends on the amount of sewage sludge fired in an incinerator. Table 1 of §503.46 outlines the monitoring frequency requirements.

Sewage sludge incinerators are generally designed and built to operate continuously, but a sudden change in the quantity of sewage sludge fed to the incinerator can develop dramatic changes in operation. As a result, the combustion process can be upset and THC concentrations can increase. Feed rate changes also affect air pollution control devices, which operate within specific design parameters. When the sewage sludge feed rate varies, the incinerator off-gases also will vary in quantity and temperature. This variability can decrease the efficiency of the air pollution control devices and result in excess emissions for particulate matter and metals.

Under steady-state conditions, the firing of sewage sludge provides enough heat both to evaporate the large quantities of water that enter with the sewage sludge and to initiate combustion of the new sewage sludge. Keeping constant the volume of the sewage sludge incinerated optimizes the required rate of excess air and therefore reduces heat lost in excess air. In the case of multiple-hearth incinerators, ash is not removed from the incinerator until it has cooled and given up its heat to entering combustion air. It is almost impossible to achieve these optimum conditions unless the sewage sludge feed is consistent (Perking 1974; EPA 1981, 1979/1987; WPCF 1988).

The sewage sludge feed rate should be monitored to provide information to the operator on the amount of sewage sludge fed to the incinerator(s). Monitoring the sewage sludge feed rate ensures that it does not exceed the feed rate used to establish the concentration limits for the metal pollutants.

The most widely used instruments to measure the incinerator sewage sludge feed rate are load cell conveyor belt scales. The weight of sewage sludge on the belt is measured by strain gauges. As the weight on the belt increases, the stress on the load cell increases, which causes a corresponding change in the electrical resistance of the strain gauge. The electrical resistance, combined with the speed of the belt, is fed to a microprocessor that calculates the mass per unit time of sewage sludge on the belt. These scales, like any other instrument, often need calibration, require maintenance, and must be replaced when beyond repair (EPA 1992a). Based on the requirements of Part 60, Subpart O, the sewage sludge feed rate monitor should be certified by the manufacturer to have an accuracy of plus or minus 5 percent over its operating range. The monitor should be calibrated and adjusted at a frequency necessary to maintain this accuracy. The recommended frequency of sewage sludge feed rate monitor calibration should be based on the manufacturer's recommendation. The calibration frequency can be adjusted by the permitting authority, if warranted by a review of calibration records obtained from the incinerator operator.

Important sewage sludge monitoring documentation and records that should be maintained by sewage sludge incinerator operators include:

- Sewage sludge feed rates (on a dry basis) expressed as hourly, daily, and annual averages
- The operating range of the sewage sludge feed rate monitor and a certification of the monitor's accuracy over that range
- Calibration and maintenance records of the sewage sludge feed rate monitor
- Records of sewage sludge feed rate monitor malfunctions, corrective actions, and downtime
- Sewage sludge sampling records including the methods used, sample amounts, compositing techniques, times and dates, sample point locations, person(s) who obtained samples, and chain of custody sheets
- Sewage sludge analytical results including the methods used, times and dates of analysis, laboratory data and calculation sheets, person(s) performing the analysis, and laboratory quality assurance and quality control procedures that were followed.

Permit writers need to stipulate the acceptable sewage sludge sampling and analytical methods to be used. Permit writers can refer to the following EPA documents for detailed guidance on sewage sludge sampling and analysis:

- *SW-846, Test Methods for Evaluating Solid Wastes*
- *POTW Sludge Sampling and Analysis Guidance Document*
- *Hazardous Waste Incineration Measurement Guidance Manual*
- *Handbook on Quality Assurance/Quality Control Procedures for Hazardous Waste Incineration.*

7.9 REPORTING REQUIREMENTS

Statement of Regulation

§503.48(a) **Class I sludge management facilities, POTWs (as defined in 40 CFR 501.2) with a design flow rate equal to or greater than one million gallons per day, and POTWs that serve a population of 10,000 people or greater shall submit the information in §503.47(b) through §503.47(h) to the permitting authority on February 19 of each year.**

The reporting requirements of Part 503 provide a regulatory mechanism that allows permitting authorities to gather information from sewage sludge incinerators to assess compliance. Because all sewage sludge incinerators are classified as Class I sludge management facilities, all sewage sludge incinerators as *defined in* §503.41 *are subject to the reporting requirements of* §503.48.

These reporting requirements establish a minimum for reporting sewage sludge incinerator emission and operating records. The person who fires the sewage sludge is required to submit the information in §§503.47(b)-(h) to the permitting authority each year, provided sewage sludge was fired to the incinerator in that particular year.

The information specified in §§503.47(b)-(h) is more complex than it may appear to be. As discussed in Sections 7.7 and 7.8, the information required in §503.47 is largely based on other pieces of information. Without detailed information, the permitting authority may not be able to verify the validity of the §503.47 information and draw accurate and complete conclusions on the compliance status of the sewage sludge incinerators. Therefore, the imposition of more detailed recordkeeping and reporting permit conditions may be necessary.

The permit writer may want to establish reporting formats so that the information is meaningful and useful for evaluating compliance and enforcing standards and limits. Examples include specifying averaging times for CEM and APCD operating parameter data, and combustion temperature. The permit writer also may want to specify the more frequent reporting of certain data. For example, by reviewing CEM data submitted by an incinerator operator every quarter, the permitting authority can identify patterns of noncompliance earlier than would be possible using the §503.48 requirements. Once these emission exceedences are identified, actions can be taken to correct these violations and prevent future ones.

When permit writers specify permit conditions that require the detailed record keeping and monitoring described earlier, they may also want to include requirements to report or make available to the permitting authority these records and data.

7.10 SCENARIO FOR THE INCINERATION STANDARD

This section discusses a scenario for a sewage sludge incineration standard. The scenario contains the requirements for the seven elements of a Part 503 standard (i.e., general requirements, pollutant limits, management practices, operational standards, and frequency of monitoring, recordkeeping, and reporting requirements).

The standard in this scenario protects public health from reasonably anticipated adverse effects of pollutants in sewage sludge. This is the only scenario for a sewage sludge incineration standard under Part 503.

7.10.1 SCENARIO 1 - FIRING OF SEWAGE SLUDGE IN A SEWAGE SLUDGE INCINERATOR

In this scenario, the National Emission Standard for beryllium and mercury and site-specific pollutant limits for arsenic, cadmium, chromium, lead, and nickel have to be met. In addition, requirements for the concentration of total hydrocarbons (THC) in the stack exit gas have to be met.

Note that §503.40(c) indicates that the management practice in §503.45(a) concerning a continuous emissions monitor for THC and the frequency of monitoring requirement for THC in §§503.47(c) and (n) do not apply if the following conditions are met:

(1) The exit gas from a sewage sludge incinerator stack is monitored continuously for carbon monoxide (CO).

(2) The monthly average concentrating of CO in the exit gas, corrected for zero percent moisture and to seven percent oxygen, does not exceed 100 parts per million on a volumetric basis.

(3) The person who fires sewage sludge in a sewage sludge incinerator retains the following information for 5 years:

(i) The CO concentrations in the exit gas; and

(ii) A calibration and maintenance log for the instrument used to measure the CO concentration.

(4) Class I sludge management facilities, POTWs (as defined in §501.2) with a design flow rate equal to or greater than one million gallons per day, and POTWs that serve a population of 10,000 people or greater submit the monthly average CO concentration in the exit gas to the permitting authority on February 19 of each year.

The elements of a Part 503 standard for this scenario are presented below.

ELEMENTS OF A PART 503 STANDARD - SCENARIO 1

General requirements:	Requirements in §503.42
Pollutant limits:	NESHAPS for beryllium and mercury (see §§503.43(a) and (b))
	Site-specific for arsenic, cadmium, chromium, lead and nickel (see §§503.43(c) and (d))
Management practices:	Requirements in §503.45
Operational standard (total hydrocarbons):	Requirements in §503.44
Frequency of monitoring:	Requirements in §503.46
Recordkeeping:	Requirements in §503.47
Reporting:	Requirements in §503.48

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8. PATHOGEN AND VECTOR ATTRACTION REDUCTION - PART 503 SUBPART D

QUICK REFERENCE INDEX

8.1 INTRODUCTION

This chapter provides guidance on the requirements for pathogen and vector attraction reduction in Part 503, Subpart D. The requirements in this Subpart apply to sewage sludge that is land applied or placed on a surface disposal site and to a land application site or surface disposal site under certain situations. This chapter assumes that the sewage sludge is regulated under Part 503 (see Chapter 2) and the use or disposal practice is either land application or surface disposal (see Chapters 4 and 5).

8.2 WHAT ARE PATHOGENS AND VECTOR ATTRACTION?

8.2.1 PATHOGENS

Pathogens are organisms capable of causing diseases. These include certain bacteria, fungi, viruses, protozoa (and their cysts) and intestinal parasites (and their ova). These organisms produce disease by entering the body, and then interfering with one or more metabolic functions. The diseases produced are communicable because the organisms are transferred from infected hosts to potential hosts through either direct or indirect physical contact.

For the purpose of this regulation, "pathogens" and "vector attraction" are defined as follows:

Pathogenic organisms are disease-causing organisms. These include, but are not limited to, certain bacteria, protozoa, viruses, and viable helminth ova. §503.31(f).

Vector attraction is the characteristic of sewage sludge that attracts rodents, flies, mosquitos, or other organisms capable of transporting infectious agents. §503.31(k).

Pathogens are found in the following wastewater:

- Residential wastewater, including that related to personal hygiene, toilet use, clothes washing and food preparations
- Commercial food processing and preparation wastewater
- Street run-off (in systems with combined sewers).

These organisms enter the treatment works in both active and inactive states (see the discussion below of individual organism types). Regardless of type, pathogenic organisms are removed by sedimentation and entrainment in biological flocs in secondary treatment. Their removal rates in a treatment works can be well in excess of 90 percent. Nevertheless, this still leaves sufficient levels of organisms in the treatment works effluent to pose a health threat - hence the inclusion of disinfection requirements in most permits to treatment works that treat domestic sewage. Pathogens removed from the wastewater can concentrate in the sewage sludge.

The different types of pathogens include:

- Bacteria—Bacteria are single celled organisms. In general, bacteria are the only pathogens that can carry out their entire life cycle outside of a "host," or infected organism. Pathogenic bacteria are heterotrophic; that is, they use organic materials as both carbon and energy sources. Because pathogenic bacteria can complete their life cycles outside man (or another host), sewage sludge that has been treated to reduce pathogens can be reinfected, or may exhibit an increase in bacterial concentration under conditions favorable to the bacteria.

- Viruses—Viruses are wholly parasitic in nature. They are capable of reproducing only through the invasion of the host organism's own cells. Viruses that cause disease in man are typically present in the gut, and thus are routinely present in domestic sewage. Viruses have been found to be removed effectively by sedimentation (presumably through entrainment in sewage sludge floc particles) and are thereby concentrated in sewage sludge.

- Parasites—Parasites include protozoa, and a variety of multi-cellular animals, all of which utilize the resources of their host's body to complete their life cycle. Protozoa are single-celled organisms that form cysts. Cysts remain dormant until ingested by a host. In the host's gut the cyst is changed into an active protozoan, which in turn releases cysts to be expelled with the feces.

  Most of the multicellular parasites are worms of various types. These infect their host through the ingestion of parasite ova. The ova changes to an active worm in the gut. Some types then remain in the gut, while others invade other body tissues. For example, helminth are flatworms associated with meat-animals (such as cattle and sheep) and with rodents. Disease is caused by the development of one or more worms in the gut. In the case of some helminths, the worm will migrate to other tissues, such as the heart or nervous system. This results in conditions potentially fatal to the infected host.

- Fungi—Fungi are non-photosynthetic plants that reproduce by generating spores. The pathogenic nature of certain fungi is exhibited when the spores are inhaled by humans. In general, the pathogenic effect exhibited is the result of the growth of the fungi in the nasal passages, throat, mouth or lungs of the individual.

The pathogens for which requirements are established in Part 503 are *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova. In some cases, fecal coliform density is used as an indicator of the density of these microorganisms. EPA concluded that if the requirements for these three microorganisms are met, other pathogens in sewage sludge also are reduced.

8.2.2 VECTOR ATTRACTION

Vector attraction is any characteristic that attracts disease vectors. Disease vectors are animals that, as a result of some aspect of their life cycle, are capable of transporting and transmitting infectious agents. Their interaction with humans provides a pathway for the transmission of disease. Vectors are themselves not pathogenic. Vectors fall into two broad categories:

> Insects—These include fleas, flies and mosquitos. They typically transmit disease through their feeding habits; in the case of mosquitos and fleas, pathogens are picked up and spread by biting and feeding on infected animals or humans, and subsequently feeding on an uninfected animal or human. Flies and certain other insects typically transmit disease through the contamination of exposed food on which they are feeding.
>
> Mammals—Rodents are the most well known mammalian vectors but other mammals, including feral domestic animals, can act as disease vectors. In general, mammals act as disease vectors by acting as hosts for infected insects (such as fleas) and transporting the infected insects to places where they may come into contact with humans.

In general, unprocessed sewage sludge contains an organic component that is an attractive food source to certain vectors. Specific components of raw sewage sludge that act as attractants include feces and food wastes.

The Part 503 requirements for vector attraction reduction are designed either to reduce the food source in sewage sludge or to place a barrier between the sewage sludge and the vector. The barrier prevents access to the food source in the sewage sludge.

8.3 WHEN DOES PATHOGEN AND VECTOR ATTRACTION REDUCTION HAVE TO OCCUR?

8.3.1 PATHOGEN REDUCTION

The reduction of the pathogen content of any sewage sludge requires the following:

- Exposure of the sewage sludge to conditions that are disadvantageous physiologically for the pathogenic organisms
- Alteration of the characteristics of the sewage sludge such that if any exposure to pathogenic organisms occurs after sewage sludge processing, the likelihood of re-infection is minimized
- Handling of the sewage sludge in a manner so as to minimize the chance for reintroduction of pathogenic organisms.

The reduction of pathogenic organism is not the primary goal of most of the sewage sludge stabilization processes even though those processes generally are effective at reducing pathogens. Commonly used sewage sludge stabilization processes that also reduce pathogens include:

- Anaerobic digestion
- Aerobic digestion
- Chemical stabilization
- Heat treatment.

Because of the potential for certain pathogens to regrow after they have been reduced, several of the Part 503 pathogen requirements are time-related (i.e., they have to be met either at the time the sewage sludge is used or disposed or at the time control over the sewage sludge is lost). The Part 503 pathogen requirements subject to this time-related requirement include:

(1) Measurement of either fecal coliform or *Salmonella*, sp. bacteria for all of the Class A pathogen alternatives; and

(2) Measurement of enteric viruses and viable helminth ova densities in Class A Alternative 4.

The purpose of the time-related pathogen requirements is to ensure that the requirements for the density of certain pathogens are met as close as possible to when the sewage sludge is either used or disposed or when control over the sewage sludge is lost. The three situations for which the time-related pathogen requirements apply are discussed below.

The first situation is "at the time of use or disposal." This means as close as possible to when the sewage sludge is used or disposed. This may be, for example, 3 days before it is used or disposed depending on the time to collect and analyze a sample of sewage sludge and receive the results.

If the sewage sludge is used or disposed before the analytical results are received, the sample should be collected when the sewage sludge is actually used or disposed (e.g., when the sewage sludge is applied to the land). Of course, the risk with this approach is that the analytical results may indicate that a Part 503 pathogen requirement is not met. In this case, there would be a violation of that requirement because the sewage sludge already has been used or disposed.

The last two situations for the time-related pathogen requirements are situations where control over the sewage sludge is lost. In the case of sewage sludge sold or given away in a bag or other container, the sewage sludge is first treated to meet the Part 503 requirements for pollutants, pathogens, and vector attraction reduction. After those requirements are met, the sewage sludge usually is placed in a bag or other container for sale or give away for application to the land. When and where the sewage sludge is land applied is unknown in this case. The last opportunity for the time-related pathogen requirements to be met is when the sewage sludge is prepared for sale or give away in a bag or other container for application to the land.

The other situation is when sewage sludge is prepared to meet the EQ requirements. Because there is no control over the actual application of an EQ sewage sludge (i.e., an EQ sewage sludge is not subject to the land application general requirements and management practices), the last opportunity that the time-related pathogen requirements can be met in this situation is when the sewage sludge is prepared to meet the three quality requirements for an EQ sewage sludge.

The Part 503 requirements that are not time-related can be met any time before the sewage sludge is used or disposed. For example, the time-temperature requirements for Class A, Alternative 1 can be met any time. The sewage sludge then could be stored before it is used or disposed and the enteric viruses and viable helminth ova, which are the two organisms the time-temperature requirements are designed to reduce, will not regrow during the storage period.

The Part 503 pathogen requirements that are not subject to the above time-related requirements include:

(1) The time-temperature requirements in Class A Alternative 1;

(2) The pH-temperature-percent solids requirements in Class A Alternative 2;

(3) The demonstration requirements for the reduction of enteric viruses and viable helminth ova in Class A Alternative 3;

(4) Treatment of the sewage sludge in a Process to Further Reduce Pathogens (PFRP) or an equivalent PFRP in Class A Alternative 5 and 6, respectively;

(5) Measurement of fecal coliform in Class B Alternative 1; and

(6) Treatment of the sewage sludge in a Process to Significantly Reduce Pathogens (PSRP) or an equivalent PSRP in Class B Alternatives 2 and 3, respectively.

8.3.2 VECTOR ATTRACTION REDUCTION

One of the goals of most sewage sludge stabilization processes is to reduce putrescibility, which directly affects the tendency for sewage sludge to attract disease vectors. In general, efforts to reduce the attraction of disease vectors to sewage sludge require some or all of the following:

- Reduction in the sewage sludge's organic content
- Modification of the sewage sludge's chemical characteristics to make it unattractive to vectors
- Placement of a barrier between the sewage sludge and vectors (e.g., inject sewage sludge beneath the surface of the soil).

Three of the treatment-related vector attraction reduction options (Options 6, 7, and 8) and the options that require that a barrier be placed between the sewage sludge and vectors (i.e., Options 9 through 11) must be met when the sewage sludge is used or disposed.

The treatment-related option that has a limited storage period is pH adjustment (i.e., Option 6). The technical support document for the Part 503 pathogen and vector attraction reduction requirements indicates pH adjustment "does not significantly change the nature of the substances in the sewage sludge, but instead causes stasis in biological activity." If the pH of the sewage sludge drops, the organic material in the sewage sludge could begin to decompose, which could cause vectors to be attracted to the sewage sludge.

The pH target conditions in Option 6 are designed to ensure that the sewage sludge can be stored for several days before it is actually used or disposed. When quicklime or slaked lime is used to adjust the pH, the storage period is from 12 to 25 days. After that period, vectors could be attracted to the sewage sludge as the pH falls. If a different material (e.g., cement kiln dust or wood ash) is used to adjust the pH, the period before which the pH drops may be different because other alkali materials are more soluble than lime. Thus, less undissolved material is available to maintain the pH as it starts to drop.

In cases where sewage sludge is stored for longer than 15 days, the pH of the sewage sludge should be monitored just prior to when the sewage sludge is used or disposed (e.g., within one or 2 days). If the pH of a representative sample of the stored sewage sludge is 11.5 or higher, the vector attraction reduction requirement is met. If the pH is below 11.5, the pH has to be adjusted again to reach the target conditions or another vector attraction reduction option has to be met.

Vector attraction reduction options 7 and 8 require that the percent solids in the sewage sludge be above a certain value. If the moisture content of the sewage sludge increases after the percent solids requirement is met, the sewage sludge could attract vectors. For this reason, options 7 and 8 must be met at the time the sewage sludge is used or disposed.

Vector attraction reduction option 10 requires incorporation of sewage sludge into the soil within six hours after it is land applied or surfaced disposed, unless otherwise specified by the permitting authority. This reduces the attraction of vectors to the sewage sludge by placing a barrier between the sewage sludge and the vectors. In some cases, it may not be feasible to incorporate the sewage sludge into the soil within six hours after it is land applied or surface disposed. Site-specific conditions (e.g., the remoteness of a land application site) that may affect the time period during which sewage sludge can be incorporated into the soil, should be considered by the permitting authority when deciding if a different time period is appropriate.

8.4 FREQUENCY OF MONITORING

For those requirements that establish pathogen performance levels and vector attraction reduction performance levels, the monitoring frequency is the frequency in Table 8-1.

TABLE 8-1 MONITORING FREQUENCY FOR PATHOGEN DENSITY LEVELS AND VECTOR ATTRACTION REDUCTION OPTIONS 1-4, 6-8

Amount of sewage sludge* (metric tons per 365-day period)	Frequency
Greater than zero but less than 290	once per year
Equal to or greater than 290 but less than 1,500	once per quarter (four times per year)
Equal to or greater than 1,500 but less than 15,000	once per 60 days (six times per year)
Equal to or greater than 15,000	once per month (12 times per year)

* Either the amount of bulk sewage sludge applied to the land, the amount of sewage sludge received by a person who prepares the sewage sludge for sale or give away in a bag or other container for application to the land, or the amount of sewage sludge placed on an active sewage sludge unit (on a dry weight basis).

The permit writer has the authority and discretion to specify more frequent monitoring. Reasons for doing so may include:

- Very high potential for contact by the public with the use or disposal site
- A history of poor sewage sludge management on the part of the permittee.

In specifying monitoring frequency, the permit writer should:

- Make clear the minimum frequency required for <u>each</u> parameter
- Include language noting the need to submit all data if monitoring is carried out more frequently than specified.

When specifying monitoring frequency for operational parameters, the permit writer should consider:

- Good practice in the operation of sewage sludge treatment processes
- The size and complexity of the treatment works and the sewage sludge treatment processes involved.

For more insight into what constitutes appropriate operational monitoring, the permit writer is referred to:

- *Operation of Wastewater Treatment Plants*, MOP11, WEF
- *Sludge Handling and Conditioning*, EPA 430/9-78-002
- *Control of Pathogens and Vector Attraction in Sewage Sludge*, EPA 625/R-92/013.

Specific monitoring parameters, their required or suggested monitoring frequency, and suggested documentation are discussed after each specific pathogen or vector attraction reduction alternative.

When sewage sludge is stored for several months before being land applied or placed on an active sewage sludge unit, the approach to frequency of monitoring for pathogen densities and vector attraction reduction depends on which requirements are met. For the purpose of the following discussion, assume that sewage sludge is generated continuously during a 365-day period and stored for 11 months before it is used or disposed. Also assume that the frequency of monitoring required by Part 503 is once per month. Note that the frequency of monitoring requirements do not apply for pathogen alternatives or parts of pathogen alternatives that require that "operational conditions" be met (e.g., raise the temperature of the sewage sludge for a specific time). Those conditions should be met at all times.

The different approaches for sewage sludge that has been stored may result in a different number of samples that are analyzed. The important thing to remember is that the samples that are analyzed have to be representative of the sewage sludge that is used or disposed, which is the objective of the Part 503 frequency of monitoring requirements.

The only pathogen density requirement that could be affected by storing the sewage sludge before use or disposal is the "regrowth requirement" for the Class A alternatives. (See Section 8.6.2 for a discussion of regrowth.) To meet this requirement, either the density of fecal coliform or the density of *Salmonella* sp. bacteria in the sewage sludge has to be below a specific value at the time the sewage sludge is used or disposed. In the above example, a representative sample of the sewage sludge that is stored for 11 months would have to be analyzed at the time the sewage sludge is land applied to show compliance with the "regrowth requirement." It is not appropriate to collect and analyze a sample of the sewage sludge that is placed on the storage pile each month and use the analytical results for those samples to show compliance with the "regrowth requirement."

The approach in the above example for frequency of monitoring for vector attraction reduction also varies depending on which vector attraction reduction option is met. The frequency of monitoring requirements do not apply to vector attraction reduction options §§503.33(b)(5), (b)(9), and (b)(10). The conditions in those options should be met at all times.

Two approaches can be used in the above example for the frequency of monitoring for vector attraction reduction option in §503.33(b)(1). In the first approach, the required percent volatile solids reductions can be demonstrated each month prior to when the sewage sludge is placed on the storage pile.

In the second approach, the volatile solids in the influent to the pathogen reduction process could be measured each month. The volatile solids in a representative sample of the stored sewage sludge could be measured at the time the sewage sludge is land applied. Those two measurements could then be used to calculate the percent volatile solids reduction in the sewage sludge. Note that other parameters (e.g., fixed solids) also may have to be measured in the sewage sludge depending on which equation is used to calculate percent volatile solids reduction.

There also are two approaches for the frequency of monitoring for the vector attraction reduction option in §503.33(b)(2). In the first approach, compliance with this option could be demonstrated each month by anaerobically digesting a sample of the sewage sludge in the laboratory prior to when it is dewatered and placed on the storage pile.

The second approach only is applicable when the sewage sludge is stored in an environment that is clearly anaerobic. In this case, a representative sample of the stored sewage sludge could be digested anaerobically in the laboratory to demonstrate compliance with the percent volatile solids reduction requirement in this option. This approach does not appear to be appropriate for sewage sludge that is dewatered and stored in windrows or piles because these are not totally anaerobic conditions.

There also are two approaches for the frequency of monitoring for the vector reduction option in §503.33(b)(3). In the first approach, a representative sample of the sewage sludge would be collected and digested aerobically in the laboratory each month prior to when the sewage sludge is placed on the storage pile.

In the second approach, a representative sample of the stored sewage sludge could be digested in the laboratory to shown compliance with the percent volatile solids reduction requirement in this option. This approach only is appropriate if the sewage sludge is stored under aerobic conditions, which is highly unlikely in most cases.

The vector attraction reduction option in §503.33(b)(4) only is applicable to liquid sewage sludges with a percent solids content of two percent or less that have not been deprived of oxygen for more than two hours. For this reason, there is only one approach for the frequency of monitoring for this option.

To comply with this option, a representative sample of the sewage sludge has to be collected each month (assuming the sewage sludge is treated in an aerobic process) and the specific oxygen update rate (SOUR) for the sewage sludge has to be determined. Of course, the results of the test have to meet the requirements for this option. The sewage sludge could then be dewatered and stored for 11 months or the liquid sewage sludge could be stored in a lagoon for the 11 months.

As mentioned above, the operating conditions in the vector attraction reduction option in §503.33(b)(5) should be met at all times. The reduction in the characteristics of the sewage sludge that attract vectors achieved during the option (5) process should not be affected if the sewage sludge is stored before it is used or disposed.

Option (6) could be affected if the sewage sludge is stored after the pH adjustment requirements are met. When lime is used to adjust the pH, the sewage sludge can be stored for up to 25 days before the pH starts to drop. When other materials are used to adjust the pH, the storage time before the pH starts to drop is shorter. Thus, the pH of the sewage sludge (all of the sewage sludge, not just a representative sample) should be adjusted at the time the stored sewage sludge is land applied (up to 25 days prior to land application if lime is used for pH adjustment) to prevent the pH from dropping before the sewage sludge is land applied. If the pH does drop, vectors could be attracted to the sewage sludge as it putrefies.

There are two approaches for the frequency of monitoring for the vector attraction reduction options in §§503.33(b)(7) and (b)(8). In the first approach, the percent solids requirement in the appropriate option could be met each month in a representative sample of the sewage sludge. The option continues to be met when the sewage sludge is stored as long as the percent solids does not decrease during the storage period. If the moisture content of the sewage sludge increases (i.e., the percent solids decreases) before the sewage sludge is used or disposed, vectors could be attracted to the sewage sludge. Thus, this approach is applicable to the above example if the percent solids of the sewage sludge does not decrease during the 11-month storage period.

The other approach for this option is to determine the percent solids of a representative sample of the stored sewage sludge just prior to when it is land applied. If the percent solids meets the requirement in the appropriate option, vector attraction reduction is achieved.

8.5 SPECIAL DEFINITIONS

Statement of Regulation

§503.31(a) **Aerobic digestion is the biochemical decomposition of organic matter in sewage sludge into carbon dioxide and water by microorganisms in the presence of air.**

§503.31(b) **Anaerobic digestion is the biochemical decomposition of organic matter in sewage sludge into methane gas and carbon dioxide by microorganisms in the absence of air.**

§503.31(c) **Density of microorganisms is the number of microorganisms per unit mass of total solids (dry weight) in the sewage sludge.**

§503.31(d) **Land with a high potential for public exposure is land that the public uses frequently. This includes, but is not limited to, a public contact site and a reclamation site located in a populated area (e.g., a construction site located in a city).**

§503.31(e) **Land with a low potential for public exposure is land that the public uses infrequently. This includes, but is not limited to, agricultural land, forest, and a reclamation site located in an unpopulated area (e.g., a strip mine located in a rural area).**

§503.31(f) **Pathogenic organisms are disease-causing organisms. These include, but are not limited to, certain bacteria, protozoa, viruses, and viable helminth ova.**

§503.31(g) **pH means the logarithm of the reciprocal of the hydrogen ion concentration measured at 25°C or measured at another temperature and then converted to an equivalent value at 25°C.**

§503.31(h) **Specific oxygen uptake rate (SOUR) is the mass of oxygen consumed per unit time per unit mass of total solids (dry weight basis) in the sewage sludge.**

§503.31(i) **Total solids are the materials in sewage sludge that remain as residue when the sewage sludge is dried at 103 to 105 degrees Celsius.**

§503.31(j) **Unstabilized solids are organic materials in sewage sludge that have not been treated in either an aerobic or anaerobic treatment process.**

§503.31(k) **Vector attraction is the characteristic of sewage sludge that attracts rodents, flies, mosquitos, or other organisms capable of transporting infectious agents.**

§503.31(l) **Volatile solids is the amount of the total solids in sewage sludge lost when the sewage sludge is combusted at 550 degrees Celsius in the presence of excess air.**

Colony Forming Unit - The density of microorganisms expressed as a count of colonies on an agar plate or filter disk. Because a colony might have originated from a clump of bacteria (instead of an individual), the count is not a count of individual bacteria. This unit of measurement can not be used when the Class A pathogen requirements are met because of the inaccuracy of the method at low microorganism densities.

Indicator Organism - is an organism that is itself not pathogenic, but whose presence or absence is indicative of the respective presence or absence of pathogenic organisms.

Most Probable Number (MPN) - is determined using a test based on the fermentation of a fixed number of replicates of a number of dilutions of the test sample. The number of replicable tubes in each dilution exhibiting a certain behavior (e.g., gas production for coliform) is used to probablistically estimate the organism density in the original sample.

Plaque-forming Units - Virus densities are determined by inoculation of several standard types of host cells. The inoculated host cells are placed in a growth medium; after an incubation period, zones of no growth (i.e., plaques) will form as a result of the viral action on the host cells. Counting of these zones provides the numerical value expressed as Plaque-forming Units.

Mean Cell Residence Time (MCRT) - is defined as:

$$\Theta_c = \frac{\text{mass of solids in the digester}}{\text{mass of solids removed per day}}$$

The resulting number, in days, is related to the average time a cell remains in the digester. Exact determination of an actual average cell residence time is complicated by the fact that due to digestion, mass of cells into a digester does not equal mass of cells out. For more information, see Appendix E in *Control of Pathogens and Vector Attraction in Sewage Sludge*. (EPA, 1992)

Wet Bulb Temperature - is measured using a thermometer that has its bulb encased in a water-saturated wick; the thermometer and wick are allowed to reach evaporative equilibrium with the gas whose temperature is being measured.

The megarad - is a measure of the energy dose received per unit mass of the material being irradiated. One megarad is equivalent to 10 joules of energy per grain (a joule is about 1/100 btu).

8.6 CLASS A PATHOGEN ALTERNATIVES

8.6.1 ORDER IN WHICH PATHOGEN AND VECTOR ATTRACTION REDUCTION IS ACHIEVED

The order in which pathogen and vector attraction reduction occurs is important when the Class A pathogen requirements and certain vector attraction reduction options are met. Section 503.32(a)(2) requires that Class A pathogen reduction be accomplished before or at the same time as vector attraction reduction except when vector attraction reduction is achieved by alkali addition (Option 6) or drying (Options 7 and 8). This requirement does not apply when the Class B pathogen requirements are met.

The need to specify the order in which pathogen and vector attraction occurs is based on evidence that regrowth of pathogens can occur, in some cases, if pathogen reduction follows vector attraction reduction. In the early 1980s, both Germany and Switzerland required disinfection of digested sewage sludge before it could be applied to pasture in the summer. After receiving reports of the presence of *Salmonella* sp. bacteria in disinfected sewage sludge (usually disinfection was achieved through pasteurization), an investigation was conducted that revealed that the pasteurized sewage sludges were contaminated with pathogenic bacteria. This was attributed to the absence of competitive bacteria in the sewage sludge due to disinfection. Pathogenic bacteria regrew rapidly to dangerous levels even though the sewage sludge had been well digested.

The discovery that pathogenic bacteria can regrow to high levels when competitive bacteria (i.e., vegetative bacteria) are absent demonstrated that it is unwise to have pathogen reduction as the final processing step before the sewage sludge is used or disposed unless there is some kind of a deterrent to regrowth of pathogenic bacteria in the sewage sludge. Such deterrents include the nonpathogenic bacterial population that remains in the sewage sludge when pathogen reduction occurs either prior to or at the same time as vector attraction reduction; the presence of a chemical that causes stasis in biological activity, such as would occur when vector attraction reduction option 6 is met; a high percent solids in the sewage sludge, such as would occur when either vector attraction reduction option 7 or 8 is met; and the nonpathogenic bacterial population in a sewage sludge that meets the Part 503 Class B pathogen requirements.

Results of several studies indicated that a much lower rate of regrowth of pathogenic bacteria occurs in sewage sludge in which the bacteria have been reduced to low levels (e.g., when the Class A pathogen requirements are met) if vector attraction reduction follows pathogen reduction. This is the reason why Part 503 requires that pathogen reduction occur prior to or at the same time as vector attraction reduction, except when the Class B pathogen requirements are met or when the requirements in vector attraction options 6, 7, or 8 are met. As mentioned above, when the Class B pathogen requirements are met or when the requirements in vector attraction reduction options 6, 7, or 8 are met, the sewage sludge contains deterrents that limit the regrowth of pathogenic bacteria.

8.6.2 REGROWTH REQUIREMENT

The objective of the Class A pathogen alternatives is to reduce the density of *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova in the sewage sludge to below detectable levels. After the density of enteric viruses and viable helminth ova are reduced, they will not regrow over time. *Salmonella* sp. bacteria may regrow, however. This is the reason for the regrowth requirement discussed below.

Each of the six Class A pathogen alternatives requires that the sewage sludge meet either the following fecal coliform density level or *Salmonella* sp. bacteria density level at the time the sewage sludge is used or disposed, at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land, or at the time the sewage sludge is prepared to meet the EQ requirements (see section 8.3 for discussion of at the time of use or disposal):

- Fecal Coliform—Less than 1,000 Most Probable Number (MPN) per gram total dry solids, or;

- *Salmonella* sp.—Less than 3 MPN per 4 grams total dry solids.

The purpose of the above requirement is to ensure that *Salmonella* sp. bacteria do not regrow between the time pathogen reduction occurs and the time that the sewage sludge is used or disposed. For example, the temperature of the sewage sludge may be raised to the required level and kept at that level for the required time and then the sewage sludge may be stored for 6 months prior to use or disposal. To ensure that *Salmonella* sp. bacteria do not regrow during the 6-month storage period, a sample of the sewage sludge has to be tested for either fecal coliform or *Salmonella* sp. bacteria at the time of use or disposal. If either the fecal coliform density or *Salmonella* sp. bacteria density in the sample is equal to or less than the above values, regrowth has not occurred and the sewage sludge remains Class A with respect to pathogens.

Fecal coliform density is used to demonstrate that the sewage sludge contains a low level of pathogenic bacteria (i.e., it is an indicator organism). In some cases, the fecal coliform density in the sewage sludge may exceed the allowable density even though the density of pathogenic bacteria in the sewage sludge is low. In this case, the level of *Salmonella*, sp. bacteria can be measured in the sewage sludge in lieu of measuring the fecal coliform. The Part 503 regrowth requirement for Class A sewage sludge is met if the density of *Salmonella* sp. bacteria is below the allowable density in Part 503 even if the fecal coliform density in the sewage sludge exceeds the allowable Part 503 fecal coliform density.

8.6.3 CLASS A ALTERNATIVE 1

Statement of Regulation

§503.32(a)(3) Class A - Alternative 1 (Not applicable for composting)

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella* sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 503.10(c), 503.10(e), or 503.10(f).

(ii) The temperature of the sewage sludge that is used or disposed shall be maintained at a specific value for a period of time.

(A) When the percent solids of the sewage sludge is seven percent or higher, the temperature of the sewage sludge shall be 50 degrees Celsius or higher; the time period shall be 20 minutes or longer; and the temperature and time period shall be determined using equation (2), except when small particles of sewage sludge are heated by either warmed gases or an immiscible liquid.

$$D = \frac{131,700,000}{10^{0.1400t}} \qquad \text{Eq. (2)}$$

Where,

D = time in days.

t = temperature in degrees Celsius.

(B) When the percent solids of the sewage sludge is seven percent or higher and small particles of sewage sludge are heated by either warmed gases or an immiscible liquid, the temperature of the sewage sludge shall be 50 degrees Celsius or higher; the time period shall be 15 seconds or longer; and the temperature and time period shall be determined using equation (2).

(C) When the percent solids of the sewage sludge is less than seven percent and the time period is at least 15 seconds, but less than 30 minutes, the temperature and time period shall be determined using equation (2).

Statement of Regulation

(D) When the percent solids of the sewage sludge is less than seven percent; the temperature of the sewage sludge is 50 degrees Celsius or higher; and the time period is 30 minutes or longer, the temperature and time period shall be determined using equation (3).

$$D = \frac{50,070,000}{10^{0.1400t}} \qquad \text{Eq. (3)}$$

Where,

D = time in days.

t = temperature in degrees Celsius.

Alternative 1 applies to processes that reduce pathogens by thermal means (elevated temperatures) such as heat treatment, thermophilic digestion, pasteurization, and heat drying. This alternative requires both the demonstration that certain pathogen density levels are not exceeded and adherence to specified operating parameters. There is an inverse relationship between the temperature and the time of contact needed to reduce pathogenic organisms to below detectable levels. The above equations are mathematical expressions of the relationship between temperature and time. The time that sewage sludge must be held at a given temperature is determined using the equations.

When the time/temperature conditions are met, *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova in the sewage sludge are reduced to below detectable levels. Enteric viruses and viable helminth ova do not regrow after they are reduced. Thus, there is no need to test the sewage sludge for those microorganisms at the time of use or disposal. Because *Salmonella* sp. bacteria may regrow, the above regrowth requirement has to be met when the sewage sludge is used or disposed.

Appropriate parameters to be monitored and a monitoring frequency are presented below. The permit writer also may want to specify the records or documentation that should be kept. Suggested documentation to demonstrate compliance with this alternative is provided below.

FREQUENCY OF MONITORING	
Pathogen Parameters	**Frequency**
***Salmonella* or fecal coliform**	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
Operating Parameters	**Frequency**
Sewage sludge temperature/time maintained	**At least 1 reading per shift, preferably continuous**
Percent solids	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**

RECORDS OR DOCUMENTATION

Records of Sampling and Analysis for *Salmonella* or Fecal Coliform and Percent Solids

- **Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling**
- **Date and time of sample analysis, name of analyst, and analytical methods used**
- **Laboratory bench sheets indicating all raw data used in analyses and calculation of results (unless a contract lab performed the analyses for the preparer)**
- **Sampling and analytical QA/QC procedures**
- **Analytical results expressed as dry weight.**

Records of Operating Parameters

- **Date and time temperature checked**
- **Record or documentation of detention time of the sewage sludge in the treatment unit**
  - **Daily volumes of sewage sludge to the treatment unit(s) and daily volume of supernatant and processed sewage sludge withdrawn**
  - **Size (gallons) of the treatment unit(s).**

8.6.4 CLASS A ALTERNATIVE 2

Statement of Regulation

§503.32(a)(4) Class A - Alternative 2

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella* sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 50310(c), 503.10(e), or 503.10(f).

(ii) (A) The pH of the sewage sludge that is used or disposed shall be raised to above 12 and shall remain above 12 for 72 hours.

(B) The temperature of the sewage sludge shall be above 52 degrees Celsius for 12 hours or longer during the period that the pH of the sewage sludge is above 12.

(C) At the end of the 72 hour period during which the pH of the sewage sludge is above 12, the sewage sludge shall be air dried to achieve a percent solids in the sewage sludge greater than 50 percent.

Alternative 2 applies to processes that reduce pathogens by means of high pH, high temperature, and air drying to achieve a high percent solids. This alternative, which is a generic description of a process that was classified a Process to Further Reduce Pathogens prior to Part 503, requires that the sewage sludge be treated in the following sequence:

- The pH of the sewage sludge must be raised to over 12, and maintained above 12 for at least 72 continuous hours;
- For at least one 12-hour period during the 72 hours, the temperature of the sewage sludge must be raised (and maintained) to over 52°C; and
- Following the 72 hours, the sewage sludge must be air dried to over 50 percent solids.

The pH should be measured at 25°C (77°F) or at the existing temperature and corrected to 25°C by use of the following:

$$pH\ correction = \frac{-0.03\ pH\ units}{1.0^\circ C}\ x\ (25^\circ C - T_{meas}{}^\circ C)$$

For example, sewage sludge measured at 15°C would have to be above 12.3 so that it would be above 12 after the .3 pH correction (Smith and Farrell 1994).

When the above conditions are met, *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova in the sewage sludge are reduced to below detectable levels. The enteric viruses and viable helminth ova will not regrow after being reduced. Because *Salmonella* sp. bacteria may regrow, the sewage sludge has to be tested for either fecal coliform or *Salmonella* sp. bacteria at the time of use or disposal.

Parameters to be monitored, a suggested frequency of monitoring, and records to be kept are provided below.

FREQUENCY OF MONITORING	
<u>Pathogen parameters</u>	**<u>Frequency</u>**
***Salmonella* or fecal coliform**	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
<u>Operating parameters</u>	**<u>Frequency</u>**
pH of sewage sludge/time maintained	**Beginning, middle, and end of treatment**
Temperature of sewage sludge/time maintained	**Beginning, middle, and end of treatment**
Percent solids	**Once at end of air drying (batch mode)**

RECORDS OR DOCUMENTATION
<u>Records of Sampling and Analysis for *Salmonella* or Fecal Coliform</u>
• **Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling**
• **Date and time of sample analysis, name of analyst, and analytical methods used**
• **Laboratory bench sheets indicating all raw data used in analyses and calculation of results (unless a contract lab performed the analyses for the preparer)**
• **Sampling and analytical QA/QC procedures**
• **Analytical results expressed as dry weight.**
<u>Records of Operating Parameters</u>
• **Time (hours) pH maintained above 12**
• **Time (hours) temperature maintained greater than 52°C**
• **Percent solids of sewage sludge after air drying**

8.6.5 CLASS A ALTERNATIVE 3

Statement of Regulation

§503.32(a)(5) Class A - Alternative 3

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella* sp. bacteria in sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 503.10(c), 503.10(e), or 503.10(f).

(ii) (A) The sewage sludge shall be analyzed prior to pathogen treatment to determine whether the sewage sludge contains enteric viruses.

(B) When the density of enteric viruses in the sewage sludge prior to pathogen treatment is less than one Plaque-forming Unit per four grams of total solids (dry weight basis), the sewage sludge is Class A with respect to enteric viruses until the next monitoring episode for the sewage sludge.

(C) When the density of enteric viruses in the sewage sludge prior to pathogen treatment is equal to or greater than one Plaque-forming Unit per four grams of total solids (dry weight basis), the sewage sludge is Class A with respect to enteric viruses when the density of enteric viruses in the sewage sludge after pathogen treatment is less than one Plaque-forming Unit per four grams of total solids (dry weight basis) and when the values or ranges of values for the operating parameters for the pathogen treatment process that produces the sewage sludge that meets the enteric virus density requirements are documented.

(D) After the enteric virus reduction in (ii)(C) of this subsection is demonstrated for the pathogen treatment process, the sewage sludge continues to be Class A with respect to enteric viruses when the values for the pathogen treatment process operating parameters are consistent with the values or ranges of values documented in (ii)(C) of this subsection.

(iii) (A) The sewage sludge shall be analyzed prior to pathogen treatment to determine whether the sewage sludge contains viable helminth ova.

(B) When the density of viable helminth ova in the sewage sludge prior to pathogen treatment is less than one per four grams of total solids (dry weight basis), the sewage sludge is Class A with respect to viable helminth ova until the next monitoring episode for the sewage sludge.

(C) When the density of viable helminth ova in the sewage sludge prior to pathogen treatment is equal to or greater than one per four grams of total solids (dry weigh basis), the sewage sludge is Class A with respect to viable helminth ova when the density of viable helminth ova in the sewage sludge after pathogen treatment is less than one per four grams of total solids (dry weight basis) and when the values or ranges of values for the operating parameters for the pathogen treatment process that produces the sewage sludge that meets the viable helminth ova density requirement are documented.

(D) After the viable helminth ova reduction in (iii)(C) of this subsection is demonstrated for the pathogen treatment process, the sewage sludge continues to be Class A with respect to viable helminth ova when the values for the pathogen treatment process operating parameters are consistent with the values or ranges of values documented in (iii)(C) of this subsection.

The purpose of this alternative is to demonstrate that the sewage sludge treatment processes reduce enteric viruses and viable helminth ova in the sewage sludge to below detectable levels. After that demonstration is made, the sewage sludge does not have to be monitored for enteric viruses and viable helminth ova. Instead, values for the process operating parameters have to be consistent at all times with the values for the parameters determined during the demonstration. The values for enteric viruses and viable helminth ova that have to be achieved during the demonstration are:

- Enteric Viruses—Less than 1 Plaque-forming Unit per 4 grams total solids (dry weight basis)
- Helminth Ova—Less than 1 viable ovum per 4 grams total solids (dry weight basis).

If the sewage sludge meets these values before treatment, it is Class A with respect to either enteric virus, viable helminth ova, or both until the next sampling episode at which time another sample of the sewage sludge has to be tested for those microorganisms. When either the enteric virus density, viable helminth ova density, or both are above the level of detection, the above demonstration has to be made.

Once enteric viruses and viable helminth ova are reduced in the sewage sludge they will not regrow. Thus, there is no requirement to test the sewage sludge for those microorganisms at the time of use or disposal. The sewage sludge does have to be tested for either fecal coliform or *Salmonella* sp. bacteria at the time of use or disposal because *Salmonella* sp. bacteria may regrow after being reduced if the sewage sludge is stored before it is used or disposed.

FREQUENCY OF MONITORING	
Parameters	**Frequency**
***Salmonella* or fecal coliform**	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
Enteric viruses	**Once per year, quarterly, bimonthly, or monthly until demonstration is made**
viable Helminth ova	**Once per year, quarterly, bimonthly, or monthly until demonstration is made**
Operating parameters	**Specific to process after the reduction for either enteric viruses or viable helminth ova is shown**

RECORDS OR DOCUMENTATION

Records of Sampling and Analysis for *Salmonella* or Fecal Coliform

- **Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling**
- **Date and time of sample analysis, name of analyst, and analytical methods used**
- **Laboratory bench sheets indicating all raw data used in calculation of results (unless a contract lab performed analysis for the permittee)**
- **Sampling and analytical QA/QC procedures.**

Records of Operating Parameters

- **Specific to the process.**

8.6.6 CLASS A ALTERNATIVE 4

Statement of Regulation

§503.32(a)(6) Class A - Alternative 4

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram to total solids (dry weight basis), or the density of *Salmonella* sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 503.10(c), 503.10(e), or 503.10(f).

(ii) The density of enteric viruses in the sewage sludge shall be less than one Plaque-forming Unit per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 503.10(c), 503.10(e), or 503.10(f), unless otherwise specified by the permitting authority.

(iii) The density of viable helminth ova in the sewage sludge shall be less than one per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 503.10(c), 503.10(e), or 503.10(f), unless otherwise specified by the permitting authority.

Alternative 4 is ideally suited for the following situations:

- Sewage sludge has been treated using a newly developed or innovative treatment process(es) that has process operating parameters different from those specified for the other Class A alternatives.
- Sewage sludge has been treated using a treatment process(es) for which a correlation between values for operating parameters and pathogen reduction has not been derived.
- There is no history of treatment of the sewage sludge for pathogen reduction.
- Sewage sludge is stored for long periods of time.

This alternative requires demonstration that the sewage sludge meets the following pathogen density levels at the time of use or disposal:

- Fecal Coliform—Less than 1,000 MPN per gram total dry solids, or
- *Salmonella* sp.—Less than 3 MPN per 4 grams total dry solids, and
- Enteric Viruses—Less than 1 Plaque-forming Unit per 4 grams total solids (dry weight basis), and
- Viable Helminth Ova—Less than 1 viable ovum per 4 grams total solids (dry weight basis).

If the sewage sludge meets the above requirements at the time of use or disposal, it is Class A with respect to pathogens. To continue to be Class A, the above requirements have to be met in every sample of sewage sludge that is collected and analyzed.

FREQUENCY OF MONITORING	
Parameters	**Frequency**
Salmonella or fecal coliform	Once per year, quarterly, bimonthly, or monthly (see Table 8-1)
Enteric viruses	Once per year, quarterly, bimonthly, or monthly
Viable Helminth ova	Once per year, quarterly, bimonthly, or monthly

RECORDS OR DOCUMENTATION

- Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling
- Date and time of sample analysis, name of analyst, and analytical methods used
- Laboratory bench sheets indicating all raw data used in calculation of results (unless a contract lab performed analysis for the permittee)
- Sampling and analytical QA/QC procedures.

8.6.7 CLASS A ALTERNATIVE 5

Statement of Regulation

§503.32(a)(7) Class A - Alternative 5

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella*, sp. bacteria in the sewage sludge shall be less than three Most Probable number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposal; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 503.10(c), 503.10(e), or 503.10(f).

(ii) Sewage sludge that is used or disposed shall be treated in one of the Processes to Further Reduce Pathogens described in Appendix B of this part.

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APPENDIX B - PATHOGEN TREATMENT PROCESSES

B. Processes to Further Reduce Pathogens (PFRP)

1. Composting

Using either the within-vessel composting method or the static aerated pile composting method, the temperature of the sewage sludge is maintained at 55 degrees Celsius or higher for three days.

Using the windrow composting method, the temperature of the sewage sludge is maintained at 55 degrees Celsius or higher for 15 days or longer. During the period when the compost is maintained at 55 degrees Celsius or higher, there must be a minimum of five turnings of the windrow.

2. Heat drying

Sewage sludge is dried by direct or indirect contact with hot gases to reduce the moisture content of the sewage sludge to 10 percent or lower. Either the temperature of the sewage sludge particles exceeds 80 degrees Celsius or the wet bulb temperature of the gas in contact with the sewage sludge as the sewage sludge leaves the dryer exceeds 80 degrees Celsius.

3. Heat treatment

Liquid sewage sludge is heated to a temperature of 180 degrees Celsius or greater for 30 minutes.

4. Thermophilic aerobic digestion

Liquid sewage sludge is agitated with air or oxygen to maintain aerobic conditions and the mean cell residence time of the sewage sludge is 10 days at 55 to 60 degrees Celsius.

5. Beta ray irradiation

Sewage sludge is irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20 degrees Celsius).

6. Gamma ray irradiation

Sewage sludge is irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at dosages of at least 1.0 megarad at room temperature (ca. 20 degrees Celsius).

7. Pasteurization

The temperature of the sewage sludge is maintained at 70 degrees Celsius or higher for 30 minutes or longer.

This alternative requires the sewage sludge be treated in one of the PFRPs and that the PFRP be operated in accordance with the above description at all times. These processes are those originally defined in Part 257 as Processes to Further Reduce Pathogens (PFRPs) with the vector attraction reduction requirements (e.g., volatile solids reduction) deleted from the description. In addition to being treated in a PFRP, the density of either fecal coliform or *Salmonella* sp. bacteria has to be equal to or less than the value presented above at the time the sewage is used or disposed. Suggested monitoring and record-keeping requirements are provided below.

FREQUENCY OF MONITORING	
Pathogen Parameters	**Frequency**
Salmonella or fecal coliform	Once per year, quarterly, bimonthly, or monthly (see Table 8-1)
Operating Parameters	**Frequency**
• Composting	
- Temperature of sewage sludge during composting process	Continuous or periodic during treatment
• Heat drying	
- Moisture content of dried sewage sludge	Once at end of treatment
- Temperature of sewage sludge particles or wet bulb temperature of exit gas	Continuous or periodic during treatment
• Heat treatment	
- Temperature of sewage sludge during treatment	Continuous or periodic during treatment
• Thermophilic aerobic digestion	
- Temperature of sewage sludge in digester	Continuous or periodic during treatment
• Beta ray irradiation	
- Dosage	Continuous or periodic during treatment
• Gamma ray irradiation	
- Dosage	Continuous or periodic during treatment
• Pasteurization	
- Temperature of sewage sludge during treatment	Continuous or periodic during treatment

RECORDS OR DOCUMENTATION
Records of Sampling and Analysis for *Salmonella* or Fecal Coliform
• Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling
• Date and time of sample analysis, name of analyst, and analytical methods used
• Laboratory bench sheets indicating all raw data used in analyses and calculation of results (unless a contract lab performed the analyses for the preparer)
• Sampling and analytical QA/QC procedures

RECORDS OR DOCUMENTATION

Records of Operating Parameters

- **Composting**
  - Description of composting method
  - Logs documenting time temperature maintained above 55°C (at least 2 readings per day 7 or more hours apart)
  - Logs documenting compost pile turned at least 5 times during period temperature remains above 55°C, if windrow compost method
- **Heat drying**
  - Moisture content of dried sewage sludge <10%
  - Logs documenting temperature of sewage sludge particles, or wet bulb temperature of exit gas exceeds 80°C (either continuous chart or a minimum of 2 readings per day 7 or more hours apart)
- **Heat treatment**
  - Logs documenting sewage sludge heated to temperatures greater than 180°C for 30 minutes (either continuous chart or 3 readings at 10 minute intervals)
- **Thermophilic aerobic digestion**
  - Logs documenting temperature maintained at 55-60°C for 10 days (at least 2 readings per day 7 or more hours apart)
- **Beta ray irradiation**
  - Beta ray dosage
  - Ambient room temperature log (either continuous chart or a minimum of 2 readings per day 7 or more hours apart)
- **Gamma ray irradiation**
  - Gamma ray isotope used
  - Ambient room temperature log (either continuous chart or a minimum of 2 readings per day 7 or more hours apart)
- **Pasteurization**
  - Time temperature maintained above 70°C
    (either continuous chart or a minimum of 2 readings per day 7 or more hours apart)

8.6.8 CLASS A ALTERNATIVE 6

State of Regulation

§503.32(a)(8) Class A - Alternative 6

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of *Salmonella*, sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in 503.10(b), 503.10(c), 503.10(e), or 503.10(f).

(ii) Sewage sludge that is used or disposed shall be treated in a process that is equivalent to a Process to Further Reduce Pathogens, as determined by the permitting authority.

This alternative requires that the sewage sludge be treated in a process that is equivalent to a PFRP. The permitting authority will determine whether a process is equivalent to a PFRP based on information submitted by the person requesting such a designation. In deciding whether a process is a PFRP, the permitting authority may request assistance from EPA's Pathogen Equivalency Committee (PEC). The PEC, which includes representatives from the Office of Research and Development and the Office of Water, was established in 1985 to provide technical assistance on pathogen and vector attraction reduction issues.

PFRP equivalency determinations only will be made with respect to the reduction of enteric viruses and viable helminth ova in the sewage sludge. Equivalency determinations will not be made for the reduction of *Salmonella* sp. bacteria because of the regrowth requirement for a Class A sewage sludge. To prevent regrowth, the density of fecal coliform or *Salmonella* sp. bacteria in the sewage sludge has to be 1000 MPN per gram of total solids or three MPN per four grams of total solids, respectively, at the time the sewage sludge is used or disposed.

For additional information on PFRP equivalency, see *Environmental Regulations and Technology, Control of Pathogens and Vector Attraction in Sewage Sludge*, (EPA, 1992).

FREQUENCY OF MONITORING	
Parameters	**Frequency**
***Salmonella* or fecal coliform**	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
Operating parameters	**Specific to process**
RECORDS OR DOCUMENTATION	
Records of Operating Procedures	
• Specific to the process	

RECORDS OR DOCUMENTATION
Records of Sampling and Analysis for *Salmonella* or Fecal Coliform
• **Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling**
• **Date and time of sample analysis, name of analyst, and analytical methods used**
• **Laboratory bench sheets indicating all raw data used in analyses and calculation of results (unless a contract lab performed the analyses for the preparer)**
• **Sampling and analytical QA/QC procedures**

8.7 CLASS B PATHOGEN ALTERNATIVES

For sewage sludge to be classified Class B with respect to pathogens, the requirements in one of the following three alternatives must be met. The objective of these alternatives is to reduce *Salmonella* bacteria, enteric viruses, and viable helminth ova in the sewage sludge.

Table 8-2 summarizes the Class B alternatives applicable to land application and surface disposal of sewage sludge.

TABLE 8-2 CLASS B PATHOGEN ALTERNATIVES

Use or Disposal Practice	Class B Alternatives			
	1	2	3	Site Restriction Met
Bulk sewage sludge applied to agricultural land/forest/ public contact sites/reclamation sites	X	X	X	X*
Bulk sewage sludge applied to lawns and home gardens	**	**	**	-
Sewage sludge sold or given away in a bag or other container for application to the land	**	**	**	-
Surface disposal	X***	X***	X***	-

*The site restrictions in §503.32(b)(5) have to be met if one of the Class B pathogen alternatives is met.
**Not allowable for these types of land; the Class A pathogen alternatives must be met when bulk sewage sludge is applied to lawns or home gardens or sewage sludge is sold or given away in a bag or other container for application to the land.
***Either the Class A or Class B pathogen requirements have to be met when sewage sludge is placed on an active sewage sludge unit unless the vector attraction requirement in §503.33(b)(11) (i.e., the sewage sludge is covered with soil or other material at the end of each operating day) is met.

The Class B alternatives rely on a combination of treatment of the sewage sludge and prevention of exposure to the sewage sludge after it is use or disposed to protect public health and the environment from pathogens in the sewage sludge. In the case of land application, exposure is prevented through restrictions on the land application site (e.g., do not harvest root crops for 38 months after application of the sewage sludge). For surface disposal, exposure is prevented through the Part 503 surface disposal management practices (e.g., do not graze animals).

A summary of each Class B pathogen alternative is presented below.

8.7.1 ORDER OF PATHOGEN AND VECTOR ATTRACTION REDUCTION

There is no requirement that pathogen reduction occur either prior to or at the same time as vector attraction reduction for a Class B sewage sludge. When the Class B requirements are met, there are enough competitive bacteria remaining in the sewage sludge to prevent rapid regrowth of *Salmonella* sp. bacteria. In addition, both the site restrictions that have to be met when a Class B sewage sludge is land applied and the management practices for surface disposal of sewage sludge prevent exposure to the sewage sludge after it is used or disposed. This provides time for the environment to further reduce pathogens remaining in the sewage sludge.

8.7.2 CLASS B ALTERNATIVE 1

Statement of Regulation

§503.32(b)(2) Class B - Alternative 1

(i) Seven representative samples of the sewage sludge that is used or disposed shall be collected.

(ii) The geometric mean of the density of fecal coliform in the samples collected in paragraph (b)(2)(i) of this section shall be less than either 2,000,000 Most Probable Number per gram of total solids (dry weight basis) or 2,000,000 Colony Forming Units per gram of total solids (dry weight basis).

This alternative requires that the geometric mean of the fecal coliform densities of seven samples be less than:

- 2,000,000 MPN per gram total solids (dry weight basis), or
- 2,000,000 Colony Forming Units per gram of total solids (dry weight basis).

Geometric Mean - the n^{th} root of the product of n numbers. In this case:

Geo. Mean

$$= \sqrt[7]{S_1 \times S_2 \times S_3 \times S_4 \times S_5 \times S_6 \times S_7}$$

Where S_n = fecal density for sample n.

For this alternative, seven samples of the sewage sludge have to be taken during each monitoring episode and each sample has to be tested for fecal coliform. The geometric mean of the fecal coliform densities for those seven samples has to be below the above values for the sewage sludge to be Class B with respect to pathogens.

The geometric mean of seven samples is used in this alternative to reduce the standard error of the mean fecal coliform density. This accounts for variability in the fecal coliform density in the sewage sludge.

The above fecal coliform density is the value that typically is achieved when sewage sludge is treated in an anaerobic digester. Pathogens in a Class B sewage sludge are further reduced by the environment when the sewage sludge is used or disposed.

FREQUENCY OF MONITORING	
Pathogen Parameters	**Frequency**
Fecal coliform	**Once per year, twice per year, quarterly, or monthly (see Table 8-1)**
RECORDS OR DOCUMENTATION	
Records of Sampling and Analysis for Fecal Coliform	

- **Date and time of sample collection, sampling location, sample type, sample volume, name of sampler, type of sample container, and methods of preservation, including cooling**
- **Date and time of sample analysis, name of analyst, and analytical methods used**
- **Laboratory bench sheets indicating all raw data used in analyses and calculation of results (unless a contract lab performed the analyses for the preparer)**
- **Sampling and analytical QA/QC procedures**

8.7.3 CLASS B ALTERNATIVE 2

Statement of Regulation

§503.32(b)(3) Class B - Alternative 2

Sewage sludge that is used or disposed shall be treated in one of the Processes to Significantly Reduce Pathogens described in Appendix B of this part.

APPENDIX B - PATHOGEN TREATMENT PROCESSES

A. Processes to Significantly Reduce Pathogens (PSRP)

1. Aerobic digestion

Sewage sludge is agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 40 days at 20 degrees Celsius and 60 days at 15 degrees Celsius.

2. Air drying

Sewage sludge is dried on sand beds or on paved or unpaved basins. The sewage sludge drys for a minimum of three months. During two of the three months, the ambient average daily temperature is above zero degrees Celsius.

Statement of Regulation

3. **Anaerobic digestion**

   Sewage sludge is treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and temperature shall be between 15 days at 35 degrees Celsius and 55 degrees Celsius and 60 days at 20 degrees Celsius.

4. **Composting**

   Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the sewage sludge is raised to 40 degrees Celsius or higher and remains at 40 degrees Celsius or higher for five days. For four hours during the five days, the temperature in the compost pile exceeds 55 degrees Celsius.

5. **Lime stabilization**

   Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 after two hours of contact.

This alternative requires that the sewage sludge be treated in one of the PSRPs and that the PSRP be operated in accordance with the above description at all times. These processes are those originally defined in Part 257 as Processes to Significantly Reduce Pathogens with the vector attraction reduction requirements (e.g., reduce volatile solids) deleted from the description. Treatment can occur any time prior to use or disposal.

FREQUENCY OF MONITORING	
Operating Parameters	**Frequency**
• Aerobic digestion	
- Temperature of sewage sludge during treatment	Continuous or periodic during treatment
• Air drying	
- Daily average ambient temperature	At least once per day during drying period
• Anaerobic digestion	
- Temperature of sewage sludge during treatment	Continuous or periodic during treatment
• Composting	
- Temperature of sewage sludge during treatment	Continuous or periodic during treatment
• Lime stabilization	
- pH of sewage sludge	At least twice, once upon addition of lime and once 2 hours after addition

RECORDS OR DOCUMENTATION	
Records of Operating Parameters	
• Aerobic digestion - Mean residence time of sewage sludge in digester - Logs showing temperature was maintained for sufficient period of time (ranging from 60 days at 15°C to 40 days at 20°C) (continuous charts or 2 readings per day at least 7 hours apart)	• Composting - Description of composting method - Daily temperature logs documenting sewage sludge maintained at 40°C for 5 days (at least 2 readings per day 7 or more hours apart) - Hourly readings showing temperature exceeded 55°C for 4 consecutive hours
• Air drying - Description of drying bed design - Depth of sewage sludge on drying bed - Drying time in days - Daily average ambient temperature	• Lime stabilization - pH of sewage sludge immediately and then 2 hours after lime addition
• Anaerobic digestion - Mean residence time of sewage sludge in digester - Logs showing temperature was maintained for sufficient period of time (ranging from 60 days at 20°C to 15 days at 35°C) (continuous charts or 2 readings per day at least 7 hours apart)	

8.7.4 CLASS B ALTERNATIVE 3

Statement of Regulation

§503.32(b)(4) Class B - Alternative 3

Sewage sludge that is used or disposed shall be treated in a process that is equivalent to a Process to Significantly Reduce Pathogens, as determined by the permitting authority.

This alternative requires that the sewage sludge be treated in a process that is equivalent to a PSRP. The permitting authority will determine whether a process is equivalent to a PSRP based on information submitted by the person requesting such a designation. In deciding whether a process is a PSRP, the permitting authority may request assistance from EPA's Pathogen Equivalency Committee. For more information on PSRP equivalency, see *Environmental Regulations and Technology, Control of Pathogens and Vector Attraction in Sewage Sludge*, (EPA, 1992).

FREQUENCY OF MONITORING/RECORDS OR DOCUMENTATION
Frequency of Monitoring Records of Operating Parameters
• Specific to the process.

8.7.5 CLASS B SITE RESTRICTIONS

Statement of Regulation

§503.32(b)(5) Site Restrictions

(i) Food crops with harvested parts that touch the sewage sludge/soil mixture and are totally above the land surface shall not be harvested for 14 months after application of sewage sludge.

(ii) Food crops with harvested parts below the surface of the land shall not be harvested for 20 months after application of sewage sludge when the sewage sludge remains on the land surface for 4 months or longer prior to incorporation into the soil.

(iii) Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of sewage sludge when the sewage sludge remains on the land surface for less than 4 months prior to incorporation into the soil.

(iv) Food crops, feed crops, and fiber crops shall not be harvested for 30 days after application of sewage sludge.

(v) Animals shall not be grazed on the land for 30 days after application of sewage sludge.

(vi) Turf grown on land where sewage sludge is applied shall not be harvested for 1 year after application of the sewage sludge when the harvested turf is placed on either land with a high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.

(vii) Public access to land with a high potential for public exposure shall be restricted for 1 year after application of sewage sludge.

(viii) Public access to land with a low potential for public exposure shall be restricted for 30 days after application of sewage sludge.

Because of the likelihood that pathogenic organism remain in a Class B sewage sludge, the site restriction presented above have to be met when a Class B sewage sludge is applied to the land. These restrictions prevent exposure to the sewage sludge and provide time for the environment to reduce the pathogens in the sewage sludge to below detectable levels.

The site restrictions for crops require that crops not be harvested for a period after application of the sewage sludge. These restrictions assume a 2-month growing period before a crop is harvested. For example, the 14-month restriction on harvesting a food crop whose harvested parts touch the sewage sludge/soil mixture assume a crop will not be grown for 12 months and a 2-month growing period before harvest.

The site restriction for crops with harvested parts below the land surface addresses die-off of viable helminth ova. There is evidence that viable helminth ova can survive below the land surface for 36 months if the sewage sludge is incorporated into the soil within 4 months after being land applied. For this reason, the site restriction requires that a crop such as potatoes, radishes, or carrots not be harvested within 38 months (36-month restriction plus 2-month growing period) after the sewage sludge is applied to the land.

If the sewage sludge remains on the surface of the land for 4 months or longer before it is incorporated into the soil, the period before harvest of crop with harvested parts below the land surface is reduced to 20 months (18-month restriction plus 2-month growing period). During the 4-month period, environmental conditions reduce the viable helminth ova in the sewage sludge.

Table 8-3 lists examples of food crops subject to the Class B harvesting restrictions.

TABLE 8-3 EXAMPLES OF CROPS AFFECTED BY THE CLASS B HARVESTING RESTRICTIONS

Crops with Harvested Parts That Touch the Ground	Crops with Harvested Parts Below the Ground
Melons	Potatoes
Eggplant	Yams
Squash	Sweet Potatoes
Tomatoes	Mushrooms
Cucumbers	Onions
Celery	Leeks
Strawberries	Radishes
Cabbage	Turnips
Lettuce	Rutabaga
	Beets

The Class B site restrictions also require that no crop, whether it has harvested parts that touch the sewage sludge/soil mixture, are below the ground, or are above the ground, be harvested within 30 days after application of the sewage sludge. This 30-day period is part of the above periods before crops that touch the sewage sludge/soil mixture and crops that are below the land surface can be harvested. The 30-day period allows the environment to reduce pathogens in the Class B sewage sludge before crops with parts above the ground are harvested.

There also is a 30-day restriction on grazing of animals after a Class B sewage sludge is land applied because sewage sludge can adhere to animals that walk on the application site and then contact humans. Thus, this is a potential pathway of exposure for humans to pathogens in the sewage sludge. Note that the intent of this site restriction is to not allow managed grazing of animals (e.g., milk cows and riding horses) on the application site. This is different from transient grazing of the application site by wildlife.

The other site restrictions for a Class B sewage sludge restrict access to the sewage sludge by the public. When turf grown on the application site is harvested for placement on land with high potential for public exposure or a lawn, the harvesting restriction is 1 year after application of the sewage sludge. This is the same as the restriction for land with a high potential for public exposure on which a Class B sewage sludge is applied. In both cases, there is a high potential that the public could contact the sewage sludge after it is land applied and be exposed to the pathogens in the sewage sludge.

In the case where a Class B sewage sludge is applied to turf that is placed on land with a high potential for public exposure or a lawn, the permitting authority may reduce the 1 year restriction on harvesting of the turf. An example when this may be appropriate is where turf is placed on land around a building that will not be ready for occupancy within a year after sewage sludge is applied to the land on which the turf is grown. In this situation, public access to both the land on which the turf is grown and to the land on which the turf is placed could be restricted for 1 year. This would prevent exposure to the sewage sludge and allow the environment to reduce pathogens in the sewage sludge.

The public access restriction for land with a low potential for public exposure (e.g., a farm) is 30 days. Thirty days is the minimum period needed for the environment to reduce pathogens in a Class B sewage sludge. The 1-year access restriction is not needed in this case because it is unlikely that the public will be exposed to the sewage sludge.

8.8 VECTOR ATTRACTION REDUCTION OPTIONS

One of 11 vector attraction reduction options in Part 503 has to be met when sewage sludge is land applied or placed on a surface disposal site. Vector attraction reduction is achieved in the first eight options through treatment of the sewage sludge. For the last three options, vector attraction reduction is achieved by placing a barrier between the sewage sludge and the vector (e.g., injecting the sewage sludge below the land surface). The applicability of the vector attraction reduction options is presented in Table 8-4.

TABLE 8-4 VECTOR ATTRACTION REDUCTION OPTIONS FOR EACH USE OR DISPOSAL PRACTICE

	Vector Attraction Reduction Option										
Use or Disposal Practice	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Bulk sewage sludge applied to agricultural land/forest/public contact sites/reclamation sites	X	X	X	X	X	X	X	X	X	X	
Bulk sewage sludge applied to lawns or home gardens	X	X	X	X	X	X	X	X			
Sewage sludge sold or given away in a bag or other container for application to the land	X	X	X	X	X	X	X	X			
Surface disposal	X	X	X	X	X	X	X	X	X	X	X

Each of the vector attraction reduction options is discussed below.

8.8.1 VECTOR ATTRACTION REDUCTION OPTION 1

> **<u>Statement of Regulation</u>**
>
> §503.33(b)(1) **The mass of volatile solids in the sewage sludge shall be reduced by a minimum of 38 percent.**

Option 1 requires that the mass of volatile solids in the sewage sludge be reduced by a minimum of 38 percent. This is achieved typically by treating the sewage sludge in an aerobic or anaerobic digester. During treatment, most of the biodegradable material in the sewage sludge is degraded, thus reducing the attractiveness of the sewage sludge to vectors.

To calculate percent volatile solids reduction, the mass of volatile solids in the sewage sludge prior to entering the stabilization process and the mass of volatile solids in the sewage sludge that is used or disposed is determined. Percent volatile solids reduction is then calculated using those data and other appropriate data in an equation. The equations that can be used include the full mass balance equation, the approximate mass balance equation, the constant ash equation, and the Van Kleeck equation. For more information on these equations, see Appendix C in *Environmental Regulations and Technology, Control of Pathogens and Vector Attraction Reduction*, (EPA, 1992).

In calculating percent volatile solids reduction, credit can be given for any volatile solids reduction that occurs from the influent to the sewage sludge stabilization process through other treatment processes before the sewage sludge leaves the treatment works. For example, if the sewage sludge is treated in an anaerobic digester and then dewatered in sand drying beds, percent volatile solids reduction can be calculated from the influent to the digester to the dewatered sewage sludge that leaves the treatment works. Credit can not be given, however, for volatile solids reduction achieved in any wastewater treatment process.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
Volatile solids	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
RECORDKEEPING	
• Volatile solids concentration of in influent sewage sludge and in sewage sludge that is used or disposed • Information on method used to determine volatile solids	

8.8.2 VECTOR ATTRACTION REDUCTION OPTION 2

Statement of Regulation

§503.33(b)(2) **When the 38 percent volatile solids reduction requirement in 503.33(b)(1) cannot be met for an anaerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge anaerobically in the laboratory in a bench-scale unit for 40 additional days at a temperature between 30 and 37 degrees Celsius. When at the end of the 40 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 17 percent, vector attraction reduction is achieved.**

Often, a sewage sludge is well-stabilized (i.e., has a low mass of volatile solids) when it enters either an aerobic or anaerobic digester. As a result, the volatile solids content of the sewage sludge can not be reduced an additional 38 percent through digestion. In cases like this, vector attraction reduction can be demonstrated by showing that the percent volatile solids is reduced by less than a certain percentage after further treatment in a bench-scale unit. This is the approach taken in this option and in Option 3.

Option 2 applies to a sewage sludge that has been treated in an anaerobic process. If a sample of the sewage sludge is treated further in an anaerobic bench-scale unit and if the percent volatile solids reduction during this period is less than 17 percent, vector attraction reduction is achieved. The following conditions have to be met during the bench-scale test:

1. A sample of the anaerobically digested sewage sludge has to be digested anaerobically in the laboratory in a bench-scale unit at a temperature between 30°C and 37°C for 40 days.

2. After 40 days, the mass of volatile solids in the sewage sludge at the beginning of the test has to be reduced by less than 17 percent.

In developing this option, EPA relied on percent volatile solids reduction calculated using the Van Kleeck equation. A sewage sludge that meets this option when the Van Kleeck equation in used to calculate percent volatile solids reduction may fail this option if a different equation is used (e.g., the mass balance equation). Therefore, EPA recommends that the Van Kleeck equation be used if this option is met.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
Volatile solids	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
RECORDKEEPING	
• One-time description of bench-scale digestion • Time (days) that sewage sludge was further digested in bench-scale digester • Temperature (degrees Celsius) maintained while sewage sludge was in digester (at least 2 readings per day)	

8.8.3 VECTOR ATTRACTION REDUCTION OPTION 3

Statement of Regulation

§503.33(b)(3) When the 38 percent volatile solids reduction requirement in 503.33(b)(1) cannot be met for an aerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge that has a percent solids of two percent or less aerobically in the laboratory in a bench-scale unit for 30 additional days at 20 degrees Celsius. When at the end of the 30 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 15 percent, vector attracting reduction is achieved.

This option is similar to Option 2 except in this case the sewage sludge has been digested aerobically. If a sample of the aerobically digested sewage sludge that has a percent solids of two percent or less is treated further in an aerobic bench-scale unit for 30 days and if the mass of volatile solids in the sewage sludge at the beginning of the test is reduced by less than 15 percent, vector attraction reduction is achieved. The following conditions have to be met during the bench-scale test:

1. A sample of aerobically digested sewage sludge having less than two percent solids has to be digested aerobically in a bench-scale unit for 30 days at a temperature of 20°C.

2. After 30 days, the mass of volatile solids in the sewage sludge at the beginning of the test has to be reduced by less than 15 percent.

The 15 percent volatile solids reduction requirement in this option also is based on information obtained using the Van Kleeck equation. For the reasons mention above in Option 2, EPA recommends that the Van Kleeck equation be used to calculate volatile solids reduction when this option is met.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
Volatile solids	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**

RECORDKEEPING

- **One-time description of bench-scale digestion**
- **Time (days) that sewage sludge was further digested in bench-scale digester**
- **Temperature (degrees Celsius) maintained while sewage sludge was in digester (at least 2 readings per day)**

8.8.4 VECTOR ATTRACTION REDUCTION OPTION 4

Statement of Regulation

§503.33(b)(4) The specific oxygen uptake rate (SOUR) for sewage sludge treated in an aerobic process shall be equal to or less than 1.5 milligrams of oxygen per hour per gram of total solids (dry weight basis) at a temperature of 20 degrees Celsius.

Option 4 provides another way to demonstrate vector attraction reduction for sewage sludge treated in an aerobic process. As indicated above, 38 percent volatile solid reduction may not be achieved because the sewage sludge entering an aerobic digester already is partially stabilized. This is frequently the case for sewage sludges held or circulated in wastewater treatment processes for longer than 30 days.

Vector attraction reduction is achieved for an aerobically digested sewage sludge if the specific oxygen uptake rate (SOUR) for the sewage sludge is equal to or less than 1.5 milligrams of oxygen per hour per gram of total solids (dry weight basis) at 20°C. Note that the unit of measurement for the sewage sludge is total solids on a dry weight basis, not volatile solids.

The SOUR test is applicable only to aerobic liquid sewage sludges with two percent solids or less that have not been deprived of oxygen for more than two hours. Thus, this test is not appropriate for dewatered sewage sludge, compost, and liquid anaerobic sewage sludge (e.g., sewage sludge in an anaerobic lagoon).

Specific Oxygen Uptake Rate (SOUR) - SOUR is a measure of the rate of oxygen utilization of a wastewater mixed liquor or sludge. In general, SOUR is the oxygen uptake rate, in milligrams of dissolved oxygen per hour per gram of volatile solids. Oxygen uptake rate is measured using a device known as a respirometer.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
SOUR	Once per year, quarterly, bimonthly, or monthly (see Table 8-1)

RECORDKEEPING
• Dissolved oxygen readings for sewage sludge sample over 15-minute period (mg/L)
• Calibration records for the DO meter
• Temperature (degrees Celsius) at beginning and end of DO readings
• Total solids for sewage sludge sample (g/L)
• SOUR calculations (mg/h/g)

8.8.5 VECTOR ATTRACTION REDUCTION OPTION 5

Statement of Regulation

§503.33(b)(5) **Sewage sludge shall be treated in an aerobic process for 14 days or longer. During that time, the temperature of the sewage sludge shall be higher than 40 degrees Celsius and the average temperature of the sewage sludge shall be higher than 45 degrees Celsius.**

For some sewage sludge aerobic processes, such as composting, it is not possible to determine the percent of volatile solids reduction. This option provides a way to demonstrate vector attraction reduction for those processes.

For this option, specific process operating parameters have to be met. They are:

- The sewage sludge has to be treated aerobically for a minimum of 14 days; and
- The temperature of the sewage sludge has to remain above 40°C at all times during the 14 day-period; and
- The average temperature of the sewage sludge over the 14-day period has to be higher than 45°C.

The most common sewage sludge process for which Option 5 applies is composting. This option also could be used, however, to demonstrate vector attraction reduction for other sewage sludge aerobic processes such as aerobic digestion.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
Sewage sludge temperature/time maintained	Continuous or periodic during treatment

RECORDKEEPING
• Description of treatment process
• Log documenting time temperature was above 40°C (at least 2 readings per day 7 or more hours apart)
• Log documenting average temperature of sewage sludge

8.8.6 VECTOR ATTRACTION REDUCTION OPTION 6

Statement of Regulation

§503.33(b)(6) **The pH of sewage sludge shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for two hours and then at 11.5 or higher for an additional 22 hours at the time the sewage sludge is used or disposed, at the time the sewage sludge is prepared for sale or given away in a bag or other container for application to the land, or at the time the sewage sludge is prepared to meet the requirements in §503.10(b), (c), (e), or (f).**

In this option, vector attraction reduction is achieved by adding alkali to the sewage sludge. Alkali does not change the composition of the sewage sludge, but instead causes a stasis in biological activity. When this occurs, vectors are not attracted to the sewage sludge because it no longer contains putrefying material. Vector attraction reduction is achieved in this option by:

- Raising the pH of the sewage sludge to 12 or higher by adding alkali to the sewage sludge; and
- Maintaining the pH of the sewage sludge at 12 or higher for at least two hours without the addition of more alkali; and
- Maintaining the pH of the sewage sludge at 11.5 or higher for another 22 hours without the addition of more alkali.

As mentioned above, alkali addition only causes a stasis in the biological activity in the sewage sludge. If the pH should drop, the surviving bacterial spores could become active biologically, which could cause the sewage sludge to putrefy and attract vectors. This could happen, for example, if the sewage sludge is stored for long periods after the pH of the sewage sludge is adjusted (see discussion in section 8.3).

Information used to develop this option is based on pH measured at 25°C, thus, the pH either should be measured at 25°C or the measured pH value should be corrected to 25°C. See Section 8.6.4 for the correction equation.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
pH of sewage sludge/time maintained	**Beginning, middle, and end of treatment**

RECORDKEEPING

- **pH of sewage sludge/alkali mixture measured at 25° C**
- **Hours pH was maintained**
- **Amount of alkali added to sewage sludge (lbs or gal)**
- **Amount of sewage sludge treated**

8.8.7 VECTOR ATTRACTION REDUCTION OPTION 7

Statement of Regulation

§503.33(b)(7) **The percent solids of sewage sludge that does not contain unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 75 percent based on the moisture content and total solids prior to mixing with other materials at the time the sewage sludge is used or disposed, at the time the sewage sludge is prepared for sale or given away in a bag or other container for application to the land, or at the time the sewage sludge is prepared to meet the requirements in §503.10(b), (c), (e), or (f).**

This option applies to sewage sludge that does not contain unstabilized solids generated in a primary wastewater treatment process. Sewage sludge included in this category include secondary, tertiary, stabilized primary, and other stabilized sewage sludges. The sewage sludge cannot contain unstabilized solids because organic material, such as partially degraded food scraps, in the sewage sludge can attract vectors even though the solids content is 75 percent or higher.

Under this option, sewage sludge must be dried to a percent solids of 75 percent or higher before mixing with other materials. Thus, the percent solids requirement must be met by removing water from the sewage sludge rather than by adding inert material to the sewage sludge. Materials that reduce moisture by reaction (e.g., lime), by adsorption, or as water of crystallization can be used to raise the percent solids content of the sewage sludge.

When this option is used to reduce the attractiveness of the sewage sludge to vectors, the dried sewage sludge should be handled in such a way to ensure that the moisture content of the sewage sludge does not increase before use or disposal. If the dried sewage sludge becomes wet before it used or disposed, vectors could be attracted to the sewage sludge.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
Percent solids	Once per year, quarterly, bimonthly, or monthly (see Table 8-1)
RECORDKEEPING	
• Percent solids • Absence of unstabilized solids generated during primary treatment	

8.8.8 VECTOR ATTRACTION REDUCTION OPTION 8

Statement of Regulation

§503.33(b)(8) **The percent solids of sewage sludge that contains unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 90 percent based on the moisture content and total solids prior to mixing with other materials at the time the sewage sludge is used or disposed, at the time the sewage sludge is prepared for sale or given away in a bag or other container for application to the land, or at the time the sewage sludge is prepared to meet the requirements in §503.10(b), (c), (e), or (f).**

This option is applicable to sewage sludge that contains unstabilized solids generated in a primary wastewater process. Even though the sewage sludge contains unstabilized solids, a solids content of 90 percent or greater is sufficient to reduce the attractiveness of the sewage sludge to vectors. As with Option 7, the percent solids must be achieved by removing water, not by adding inert materials.

In addition, the percent solids of the sewage sludge should not be reduced prior to when the sewage sludge is used or disposed. If the sewage sludge becomes wet, vectors could be attracted to the sewage sludge. For this reason, the sewage sludge should be handled in a such a way to ensure that the moisture content of the sewage sludge is not increased after the percent solids requirement in this option is met and before the sewage sludge is used or disposed.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
Percent solids	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
RECORDKEEPING	
• **Percent solids** • **Absence of unstabilized solids generated during primary treatment**	

8.8.9 VECTOR ATTRACTION REDUCTION OPTION 9

Statement of Regulation

§503.33(b)(9) (i) Sewage sludge shall be injected below the surface of the land.

(ii) No significant amount of the sewage sludge shall be present on the land surface within one hour after the sewage sludge is injected.

(iii) When the sewage sludge that is injected below the surface of the land is Class A with respect to pathogens, the sewage sludge shall be injected below the land surface within eight hours after being discharged from the pathogen treatment process.

This is the first of the barrier options for vector attraction reduction. In this case, exposure to the sewage sludge is prevented by placing a barrier between the sewage sludge and the vector.

This option applies to bulk sewage sludge that is applied to agricultural land, forest, a public contact site, or a reclamation site and to sewage sludge placed on a surface disposal site. It does not apply to bulk sewage sludge applied to a lawn or home garden or to sewage sludge sold or given away in a bag or other container.

Vector attraction reduction is achieved when the sewage sludge is injected below the land surface:

- If no significant amount of sewage sludge remains on the land surface one hour after injection of the sewage sludge; and
- If the sewage sludge is Class A with respect to pathogens, it is injected below the land surface within 8 hours after it is discharged from the pathogen reduction process.

Special restrictions are included in this option for a Class A sewage sludge because of the concern for regrowth of *Salmonella* sp. bacteria. During the first eight hours after the sewage sludge is discharged from the pathogen reduction process, levels of pathogenic bacteria in a Class A sewage sludge remain low. After eight hours, pathogenic bacteria may regrow rapidly.

FREQUENCY OF MONITORING	
Parameter	Frequency
Time between end of Class A pathogen treatment process and injection	Each time sewage sludge is injected below the land surface
RECORDKEEPING	
• Description of application site • Log indicating sewage sludge was injected below the land surface • Log indicating no significant amount of sewage sludge remains on the land surface within one hour after application	

8.8.10 VECTOR ATTRACTION REDUCTION OPTION 10

Statement of Regulation

§503.33(b)(10) (i) Sewage sludge applied to the land surface or placed on a surface disposal site shall be incorporated into the soil within six hours after application to or placement on the land, unless otherwise specified by the permitting authority.

(ii) When sewage sludge that is incorporated into the soil is Class A with respect to pathogens, the sewage sludge shall be applied to or placed on the land within eight hours after being discharged from the pathogen treatment process.

This is the second of the barrier options for vector attraction reduction. It only applies to bulk sewage sludge applied to agricultural land, forest, a public contact site, or a reclamation site and to sewage sludge placed on a surface disposal site.

Vector attraction reduction is achieved in this option by incorporating sewage sludge that is applied to the land surface into the soil within 6 hours after it is land applied. Incorporation is done by "turning over" or plowing the land on which the sewage sludge is applied. This results in the mixing of the sewage sludge with the upper 6-12 inches of the soil. The 6 hours provide a reasonable time for the sewage sludge to be incorporated into the soil. In certain situations it may not be feasible to incorporate the sewage sludge within 6 hours. The permitting authority can allow a longer time period if necessary.

When the sewage sludge that is incorporated into the soil is Class A with respect to pathogens, it has to be applied to the land within 8 hours after discharge from the pathogen reduction to prevent regrowth of *Salmonella* sp. bacteria. The Class A sewage sludge then has to be incorporated into the soil within 6 hours after it is land applied. These additional 6 hours are not expected to result in regrowth of *Salmonella* sp. bacteria because:

- Regrowth is inhibited by the desiccation that starts when the sewage sludge is applied to the land surface

- The soil bacteria that invade the sewage sludge when it is surface applied inhibit rapid regrowth of *Salmonella* sp. bacteria.

FREQUENCY OF MONITORING	
Parameter	**Frequency**
Time between application/placement and incorporation into soils **Time between end of Class A pathogen treatment process and application/placement on the land**	**Each time sewage sludge is applied to the land surface**
RECORDKEEPING	
• **Description of application site** • **Log indicating sewage sludge was incorporated into the soil**	

8.8.11 VECTOR ATTRACTION REDUCTION OPTION 11

Statement of Regulation

§503.33(b)(11) Sewage sludge placed on an active sewage sludge unit shall be covered with soil or other material at the end of each operating day.

Option 11, which is the third option that achieves vector attraction reduction by placing a barrier between the sewage sludge and vectors, applies to sewage sludge placed on active sewage sludge units at a surface disposal site. When sewage sludge placed on an active sewage sludge unit is covered daily, vectors can not contact the sewage sludge. For this reason, they are not attracted to the sewage sludge.

FREQUENCY OF MONITORING
• **Daily**
RECORDKEEPING
• **Log indicating cover was placed on the active sewage sludge unit daily**

REFERENCES

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U.S. EPA. 1992. *Control of Pathogens and Vector Attraction in Sewage Sludge*. December 1992. EPA/675/R-92/013.

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APPENDIX A

CONVERSION FACTORS - ENGLISH SYSTEM UNITS TO METRIC SYSTEM UNITS

TABLE A-1. CONVERSION FACTORS - ENGLISH SYSTEM UNITS TO METRIC SYSTEM UNITS

English System			International System of Units (SI)	
Name	**Abbreviation**	**Multiplier**	**Symbol**	**Name**
Length				
Inch	in	2.54	cm	Centimeter
Foot	ft	0.3048	m	Meter
Mile	mi	1.609	km	Kilometer
Area				
Square Inch	in^2	6.4516	cm^2	Square Centimeter
Square Foot	ft^2	9.29×10^{-2}	m^2	Square Meter
Square Mile	mi^2	2.59	km^2	Square Kilometer
Square Mile	mi^2	259	ha	Hectare
Acre	acre	0.4047	ha	Hectare
Volume				
Cubic Foot	ft^3	28.32	L	Liter
Cubic Foot	ft^3	2.832×10^{-2}	m^3	Cubic Meter
Gallon	gal	3.785	L	Liter
Million Gallons	Mgal	3.7854×10^3	m^3	Cubic Meter
Acre Foot	acre-ft	1233	m^3	Cubic Meter
Pressure				
Pounds per Square Inch	lbs/in^2	7.031×10^{-2}	kg/cm^2	Kilograms per Square Centimeter
Mass				
Pound	lb	4.539×10^2	gm	Gram
Pound	lb	0.4536	kg	Kilogram
Ton (short)	T	0.9072	mt	Metric Tonne
Density				
Pounds per Cubic Foot	lbs/ft^3	16.02	kg/m^3	Kilograms per Cubic Meter
Tons per Acre	T/acre	2242.15	kg/ha	Kilograms per Hectare
Tons per Acre	T/acre	2.2421	mt/ha	Metric Tonnes per Hectare

TABLE A-1. CONVERSION FACTORS - ENGLISH SYSTEM UNITS TO METRIC SYSTEM UNITS (Continued)

English System			International System of Units (SI)	
Name	**Abbreviation**	**Multiplier**	**Symbol**	**Name**
Discharge (flow rate, volume/time)				
Cubic Feet per Second	ft^3/sec	28.32	L/sec	Liters per Second
Gallons per Minute	gal/min	6.39×10^{-2}	L/sec	Liters per Second
Gallons per Day	gal/day	4.3813×10^{-5}	L/sec	Liters per Second
Million Gallons per Day	Mgal/day	43.8126	L/sec	Liters per Second
Million Gallons per Day	Mgal/day	3.7854×10^{3}	m^3/day	Cubic Meters per Day
Power				
Horsepower	hp	0.7457	kW	Kilowatt
Temperature				
Degrees Fahrenheit	°F	0.555(°F-32)	°C	Degrees Celsius
Miscellaneous				
Parts per Million	ppm	1.0	mg/L	Milligrams per Liter
Parts per Billion	ppb	1.0	ug/L	Micrograms per Liter
Million Gallons per Acre	Mgal/acre	9354.537	m^3/ha	Cubic Meters per Hectare

TABLE A-2. CONVERSION FACTORS - METRIC SYSTEM UNITS TO ENGLISH SYSTEM UNITS

International System of Units (SI)			English System	
Name	**Abbreviation**	**Multiplier**	**Symbol**	**Name**
		Length		
Centimeter	cm	0.3937	in	Inch
Meter	m	3.2808	ft	Foot
Kilometer	km	0.6214	mi	Mile
		Area		
Square Centimeter	cm^2	0.155	in^2	Square Inch
Square Meter	m^2	10.763	ft^2	Square Foot
Square Kilometer	km^2	.3861	mi^2	Square Mile
Hectare	ha	3.861×10^{-3}	mi^2	Square Mile
Hectare	ha	2.471	ac	Acre
		Volume		
Liter	L	3.531×10^{-2}	ft^3	Cubic Foot
Liter	L	0.2642	gal	Gallon
Cubic Meter	m^3	35.3147	ft^3	Cubic Foot
Cubic Meter	m^3	2.641×10^{-4}	Mgal	Million Gallons
Cubic Meter	m^3	8.1071×10^{-4}	acre-ft	Acre-foot
		Pressure		
Kilograms per Square Centimeter	kg/cm^2	14.22	lbs/in^2	Pounds per Square Inch
		Mass		
Gram	gm	2.20×10^{-3}	lb	Pound
Kilogram	kg	2.205	lb	Pound
Metric Tonne	mt	1.103	T	Ton (short)
		Density		
Kilograms per Cubic Meter	kg/m^3	0.0624	lbs/ft^3	Pounds per Cubic Foot
Kilograms per Hectare	kg/ha	4.46×10^{-4}	T/acre	Tons per Acre

TABLE A-2. CONVERSION FACTORS - METRIC SYSTEM UNITS TO ENGLISH SYSTEM UNITS (Continued)

International System of Units (SI)			English System	
Name	Abbreviation	Multiplier	Symbol	Name
Metric Tonnes per Hectare	mt/ha	0.446	T/acre	Tons per Acre
Discharge (flow rate, volume/time)				
Liters per Second	L/sec	3.531×10^{-2}	ft^3/sec	Cubic Feet per Second
Liters per Second	L/sec	15.85	gal/min	Gallons per Minute
Liters per Second	L/sec	22,824.5	gal/day	Gallons per Day
Liters per Second	L/sec	2.28×10^{-2}	Mgal/day	Million Gallons per Day
Cubic Meters per Day	m^3/day	2.6417×10^{-4}	Mgal/day	Million Gallons per Day
Power				
Kilowatt	kW	1.341	hp	Horsepower
Temperature				
Degrees Celsius	°C	1.8°C + 32	°F	Degrees Fahrenheit
Miscellaneous				
Milligrams per Liter	mg/L	1.0	ppm	Parts per Million
Micrograms per Liter	ug/L	1.0	ppb	Parts per Billion
Cubic Meters per Hectare	m^3/ha	1.069×10^{-4}	Mgal/acre	Million Gallons per Acre

APPENDIX B

SURFACE DISPOSAL SITE LINERS

SURFACE DISPOSAL SITE LINERS

A liner is defined in §503.21(j) as soil or synthetic material that has a hydraulic conductivity of 1 x 10^{-7} centimeters per second or less. Three types of liners and their properties are discussed in detail below.

Soil Liners (Compacted Clay)

The permeability and performance of soil liners are most affected by the following factors: soil properties; liner thickness; lift thickness, placement, and bonding; and hydraulic conductivity. Although the soil may contain all the correct properties for successful construction of the liner, the soil liner may still not meet the hydraulic conductivity criterion if the construction practices are not properly controlled. Thus, construction information is needed to verify the integrity of the liner.

Soil Properties

The permeability and performance of a soil liner depends upon the properties of the soil. The compacted clay component of a soil liner defines the liner's hydraulic conductivity. There are two systems of soil classification used in the United States to determine whether a soil is considered a clay or a silt. These two classification systems are difficult to compare. Therefore, rather than define the soils by one or the other of the classifications, soils for clay liners can be defined based upon their specific characteristics. To determine whether a soil will meet the hydraulic conductivity requirement, the following characteristics of the soil should be present:

> The United States Department of Agriculture's (USDA) soil classification system is based on grain size and uses a three-part diagram to classify all soils. The American Society of Testing and Materials' (ASTM) soil classification system does not use grain size as a criteria but instead bases the classification of clays on plasticity criteria. The ASTM system uses a plasticity diagram and the slope of line "A" to distinguish between clays and silts (those soils that fall in the area above the "A" line are considered to be clays, those below silts) (EPA 1989c).

- At least 20 percent fines (fine, silt and clay sized particles); however, some soils with less fines may meet the hydraulic conductivity of 10^{-7} cm/sec (EPA 1989c)
- A plasticity index (PI) of the soil between 10 and 30 percent (soils with a PI greater than 30 percent are sticky and difficult to work with) (EPA 1989c)
- No more than 10 percent gravel-sized particles (coarse fragments can cause zones with higher conductivity) (EPA 1989c)
- No soil particles or chunks of rock greater than 1 to 2 inches in diameter (large particles can form permeable "windows" through a layer) (EPA 1989c).

Generally, natural soil materials are recommended for surface disposal sites; however, soils amended or blended with different additives (e.g., lime, cement, bentonite clays, and borrow clays) may also meet the criteria for hydraulic conductivity.

Thickness of Liner

A thickness of two feet is generally considered the minimum thickness needed to obtain adequate compaction of the soil and meet the hydraulic conductivity requirement (EPA 1992a).

The most common additive used for soil amendment is sodium bentonite. This clay mineral, generally in the form of a dry powder, when mixed with water expands by absorbing the water into the mineral matrix. The addition of a relatively small amount (5 to 10 percent) of this mineral to a noncohesive soil makes the soil more cohesive.

Lift Thickness, Placement, and Bonding

Soil liners are most often constructed in a series of lifts, each compacted separately. The lift thickness (generally 5-9 inches) is dependent upon soil properties, compaction equipment, and the compaction needed to meet the hydraulic conductivity requirement. At smaller sites, the soil liner may be constructed over the entire site at one time. At larger sites with multi-unit designs the liners may be constructed in segments over the life of the site. In the case of multi-unit designs, the design should address how the old and new liner segments will be bonded together to maintain the hydraulic conductivity requirement (EPA 1992a).

Hydraulic Conductivity

The hydraulic conductivity of a liner is the most important design parameter when evaluating a constructed soil liner. The hydraulic conductivity determines the ease with which water passes through the liner material. The hydraulic conductivity depends upon the degree of compaction, compaction method, soil moisture content, and density of the soil during liner construction. Hydraulic conductivity is also dependent upon the viscosity and density of the leachate and on the shape, size, and area of the conduits though which the liquid flows. Leachates from surface disposal sites have physical properties similar to those of water so water is appropriate for testing the compacted soil liner and source materials. The hydraulic conductivity of a partially saturated soil is less than the hydraulic conductivity of the same soil when saturated, due to a reduction of flow area from air entrapment. Hydraulic conductivity testing should be conducted on samples that are fully saturated (EPA 1992a).

The lowest hydraulic conductivity of compacted clay soil usually occurs when the soil is compacted at a moisture content slightly higher than the optimum moisture content, generally in the range of 1 to 7 percent (EPA 1989c). When compacting clay, water content and compactive effort are the two factors that should be controlled to meet the maximum hydraulic conductivity criterion. Since it is impractical to specify and construct a clay liner to a specific moisture content and to a specific compaction, and because moisture content is difficult to control in the field during construction, the design plan usually specifies a range of moisture contents and corresponding soil densities (percent compaction) to achieve the required hydraulic conductivity. During construction of the liner, soil testing is conducted to ensure that the design specifications are being met. The amount of soil testing to define these construction parameters is dependent on the degree of natural variability of the source material (EPA 1992a).

Laboratory and field testing are performed to determine compaction requirements and moisture contents of material delivered to the site. Laboratory testing is usually conducted on field samples for determination of hydraulic conductivity of the in-place liner. In laboratory testing, soil samples can be fully saturated and the effects of a large overburden stress on the soil, which is not easily performed in the field, can be simulated (EPA 1989c).

Differences between laboratory and field conditions (e.g., uniformity of material, control of water content, compactive effort, and compaction equipment) may make it unlikely that minimum hydraulic conductivity values measured in the laboratory on remolded, pre-construction borrow source samples are the same as the values achieved during actual liner construction. Laboratory testing also does not account for operational problems that may occur in the field. Methods that can be used to measure hydraulic conductivity in the lab are provided below.

Laboratory Methods To Measure Hydraulic Conductivity

EPA Method 9100 for measuring hydraulic conductivity of soil samples in publication SW-846, *Test Methods for Evaluating Solid Waste — Physical/Chemical Methods (EPA 1986).*

U.S. Army Corps of Engineers Engineering Manual 1110-2-1906 (1970) (4) and the newly published Measurement of Hydraulic Conductivity of Saturated Porous Materials

American Standards and Testing Methods (ASTM) D-5084 *Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter* [To verify full saturation of the sample, this method may be performed with back pressure saturation and electronic pore pressure measurement (EPA 1992a)].

Field tests provide an opportunity to check representative areas of the liner for conformance with compaction specifications (including density and moisture content). Field tests are the most accurate method of determining hydraulic conductivity because laboratory values generally are lower than those measured in test fills or actual liners (EPA 1992a). Therefore, the results of both field tests and laboratory tests should be evaluated when determining the compliance of soil liners with the hydraulic conductivity requirement.

There are four kinds of field hydraulic conductivity tests, as described below:

- Borehole test — A hole is drilled into the soil and filled with water. The rate at which water percolates into the borehole is measured.

- Porous probe test — A porous probe is driven into the soil and water is poured into the probe. The amount of water that is released from the probe into the soil is measured.

- Infiltrometer test — An infiltrometer is embedded into the surface of the soil liner so that the rate of flow of a liquid into the liner can be measured. There are two types of infiltrometers -- open and sealed. Open rings are less desirable than popular sealed rings because they make it difficult to account for evaporative basis when measuring the drop in water levels. Also, double-ringed infiltrometers are preferred to single rings because double-ringed infiltrometers are less susceptible to the effects of temperature.

- Underdrain test — Underdrains, which are installed during construction of the liner, are the most accurate in-situ permeability testing device because they measure the exact amount of leachate that migrates from the bottom of the liner (EPA 1989c).

Flexible Membrane Liners (Geomembranes)

Flexible membrane liners (FMLs), also called geomembranes, are generally polymeric materials, particularly plastics and synthetic rubbers, mixed with a variety of other ingredients, such as carbon black, pigments, fillers, plasticizers, processing aids, crosslinking chemicals, anti-degradants, and biocides. There are several types of polymeric materials that are used in the manufacture of the FML sheeting, including (EPA 1992a):

- Thermoplastics, such as polyvinyl chloride (PVC)
- Crystalline thermoplastics, such as high density polyethylene (HDPE), very low density polyethylene (VLDPE), and linear low density polyethylene (LLDPE)
- Thermoplastic elastomers, such as chlorinated polyethylene (CPE) and chlorosulfonated polyethylene (CSPE).

In assessing whether a FML will meet the hydraulic conductivity requirement, the following important information should be examined:

- Thickness — The thickness of an FML affects permeability and can range anywhere from 20 to 120 mils. However, the recommended minimum thickness for all FMLs is 30 mils [with the exception of high density polyethylene (HDPE) which should be at least 60 mils for proper seaming] (EPA 1992a).
- Chemical compatibility with the contained waste — Plastics and rubber exhibit various degrees of compatibility with different leachates. Materials used in an FML should be selected based on exposure to the leachate during its intended life. Compatibility testing is often performed prior to installation. The most common test is the EPA Method 9090 Compatibility Test found in the EPA document entitled, *Test Methods for Evaluating Solid Waste, SW-846*. This test simulates the conditions to which the FML may be exposed during operation of the disposal site and what effects, if any, the leachate and wastes will have on the liner.

Composite Liners

Composite liners are combinations of flexible membrane liners and compacted soil liners often used to reduce the impact of penetrations of the FML. The use of a flexible membrane liner, in addition to the soil, increases the leachate collection efficiency of the liner and provides a more effective hydraulic barrier. The ability of a composite liner to meet the hydraulic conductivity requirement should be assessed in a manner similar to that described above for each of the liner components: the soil liner and the FML.

APPENDIX C

INFORMATION SOURCES

INFORMATION SOURCES

Many EPA, State, Federal, and other organizations distribute technical publications that can provide valuable information on various issues that may arise during the permitting process. The following list of information sources, arranged alphabetically, provides a brief description of the types of information these sources can provide. Following the list of sources is a list of documents published by EPA to aid in the implementation of Part 503. The last information source is a list of EPA Regional sludge (biosolids) coordinators. The Regional coordinators can provide Region-specific guidance and provide the names of appropriate State personnel.

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Building Seismic Safety Council
1201 L St., NW
Suite 400
Washington, DC 2005
(202) 289-7800

The Building Seismic Safety Council (BSSC) is dedicated to wide distribution of technology for designing seismic safety into buildings. FEMA stocks all BSSC publications and will send the requestor copies at no charge by calling FEMA publications at (202) 646-3484.

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U.S. Federal Emergency Management Agency (FEMA)
Flood Map Distribution Center
6930 (A-F) San Thomas Rd.
Baltimore, MD 21227-6227

U.S. Federal Emergency Management Agency (FEMA)

(800) 638-6620	Continental U.S. only, except Maryland
(800) 492-6605	Maryland only
(800) 638-6831	Continental U.S., Hawaii, Alaska, Puerto Rico, Guam, and the Virgin Islands

The U.S. Federal Emergency Management Agency (FEMA) can provide assistance and information on flooding and floodplains. *The National Flood Insurance Program Community Status Book* is published bimonthly and can be obtained by calling the toll-free numbers listed above. Flood insurance rate maps and other flood maps, including those delineating 100-year floodplains, may be obtained from the map distribution center.

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National Climatic Data Center
Federal Building
Asheville, NC 28801
(704) 259-0682

The National Climatic Data Center stocks various weather publications for the United States. National Weather Service meteorological data older than one year is available from the center. A useful guide for determining rainfall in the western U.S., on a state by state basis is *Precipitation Frequency Atlas of the Western United States - NOAA Atlas 2.* A publication for the eastern and central U.S. entitled *5 to 60 Minute Precipitation Frequency for Eastern and Central United States* is available from NTIS (see above). The order number is PB 272112/AS. The center is open Monday through Friday from 8:00 a.m. to 4:00 p.m. EST.

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National Earthquake Information Center
P.O. Box 25046
Denver Federal Center MS 967
Denver, CO 80225
(303) 273-8500

The National Earthquake Center (NEIC) is the national data center and archive for earthquake information. NEIC maintains a data base that has cataloged earthquake data that covers a time period from 2100 BC to approximately four weeks behind the current date. There is a charge for this data base service. To obtain further information the permit writer should call (303) 273-8406.

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National Information Service for Earthquake Engineering
University of California, Berkeley
404A Davis Hall
Berkeley, CA
(510) 231-9401

The National Information Service for Earthquake Engineering provides information for earthquake engineering through a series of research reports, computer software programs, databases and library services. The center is open from 8:00 a.m. to 12:00 p.m. and from 1:00 p.m. to 5:00 p.m. Monday through Friday. There is a charge for publications and software. The permit writer should call the service for the specific information required.

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National Technical Information Service (NTIS)
5285 Port Royal Rd.
Springfield, VA 22151
(703) 487-4650
(800) 553-6847

The National Technical Information Service provides information about technical reports published by various sources, including EPA. NTIS has a large inventory of technical publications which are available for a charge. The hours of operation are from 8:30 a.m. to 5:00 p.m. Monday through Friday. Information on NTIS services and ordering information can be accessed by calling one of the numbers listed above.

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RCRA/Superfund Industrial Assistance Hotline
(800) 424-9346

The RCRA/Superfund Hotline provides information to the public and the regulated community in understanding EPA regulations and policy on Resource Conservation and Recovery Act (RCRA) which includes regulation of municipal solid waste landfills. Although the hotline does not deal with the subject of sewage sludge disposal, they can provide state and local contacts for a variety of agencies. The hotline also can be a source of information for the latest publications from the U. S. EPA, in particular, solid waste disposal, methane gas control, covers, liners, and leachate collection systems. The phone call is toll free and the hours of operation are from 8:30 a.m. to 7:30 p.m. EST, Monday through Friday.

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U.S. Army Corps of Engineers
Publication Depot
2803 52nd Ave.
Hyattsville, MD 20781-1102
(301) 436 2063

The Corps of Engineers Publication Depot has many documents pertaining to flooding and floodplains. The *Federal Manual for Identifying and Delineating Jurisdictional Wetlands* is available from the Depot. All publications are free, however, they must be ordered in writing, no phone orders are accepted. The Depot is open from 7:30 a.m. to 4:00 p.m. EST Monday through Friday.

The Corps of Engineers Hydrologic Engineering Center can supply the HEC models. The Center will distribute the models to Federal Agencies only from this location. The software is available to the public from NTIS. The center can be contacted at:

Hydrologic Engineering Center
609 2nd St.
Davis, CA 95616
(916) 756-1104

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U. S. Department of Agriculture
Soil Conservation Service (SCS)
P.O. Box 2890
Washington, DC 20013

Publication Distribution Office
Room 0054E
South Building
Washington, DC 20250
(202) 720-5157

The Soil Conservation Service (SCS) of the United States Department of Agriculture can provide technical assistance in determining the nitrogen requirements of crops or vegetation, and calculating the agronomic rate. SCS has a nationwide network of nearly 3,000 offices and focuses its assistance on non-Federal land. SCS district offices can provide on-site assistance in determining the acceptability of sites to receive sewage sludge for land application. SCS can provide publications to assist the permit writer on subjects including wetlands delineation, floodplains and erosion control.

For SCS programs and assistance, the permit writer should find the local office in the phone book which is listed under the United States Government, Department of Agriculture. If the permit writer needs specific documents that are not available at the local office, the Publication Distribution Office should be contacted.

U.S. Department of Interior
Fish and Wildlife Service
Publications Unit
4401 N. Fairfax St.
130 Webb Building
Arlington, VA 22203
(703) 358-1711
(703) 358-2283 (FAX)

The Publication Unit of the Fish and Wildlife Department distributes free publications that may be helpful for determining the presence of endangered species and delineating wetlands. The Publication Unit is open from 7:45 a.m. to 4:30 p.m. EST Monday through Friday. Publications are free to the public and may be ordered by phone, fax, or written request.

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U.S. Geological Survey (USGS)
Earth Science Information Center
12201 Sunrise Valley Drive
Reston, VA 22092
(800) USA-MAPS (872-6277)

The USGS Earth Science Information Center stocks an extensive supply of maps covering the entire United States. The Center is open from 8:00 a.m. to 4:00 p.m. EST, Monday through Friday. The toll-free telephone number allows the caller a variety of options for obtaining information.

INFORMATION SOURCES (Continued)

The types of maps available from the Center that are mentioned in this manual as very useful to the permit writer are:

1) Algermissen S.T., et. al. 1990. *Probabalistic Earthquake Acceleration and Velocity Maps for the United States and Puerto Rico*. Map MF 2120. (Maps of horizontal acceleration useful for determining whether a sewage sludge disposal unit lies within a seismic impact zone.)

2) USGS. 1978. *Preliminary Young Fault Maps*. Map MF 916. (Delineates Holocene faults in the United States.)

Other maps available include topographic maps, state geologic maps, and various specialized maps that may be useful in determining the suitability of a location for a sewage sludge disposal unit.

State seismicity maps can be obtained from USGS Map Sales offices. Mail orders can be addressed to:

U.S. Geological Survey
Map Distribution
Denver Federal Center, Box 25286
Denver, CO 80225
(303)236-7477

The EROS Data Center distributes aerial photographs that may be useful for delineating fault traces and structural lineaments. The center carries the National Aerial Photographic Program/National High Altitude Program (NAPP/NHAP) stèreo photos, landsat photos, and other aerial photographs. The center is open from 7:30 a.m. to 4:00 p.m. Monday through Friday. The center can be contacted at:

U.S. Geological Survey
EROS Data Center
Sioux Falls. SD 57198
(605) 594-6151

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U.S. Environmental Protection Agency
Center for Environmental Research Information (CERI)
26 West Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7562

The Office of Research and Development (ORD) has centralized most of its information distribution and technology transfer activities at CERI. CERI serves as the distribution center for ORD reports and research results. The permit writer can contact CERI to request information for summary reports and technical documents on a wide range of topics including landfill covers, liners, construction techniques, etc.

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U.S. Environmental Protection Agency
Office of Air Quality and Standards
Research Triangle Park
(919) 541-5381 (Joe Tuma)

Information on the availability and cost of the air dispersion models can be obtained by calling Joe Tuma at the number given above.

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U.S. Environmental Protection Agency
Office of Water Resource Center
RC-4100
401 M Street, S.W.
Washington, DC 20460

The Office of Water Resource Center distributes all available Office of Water documents. All the implementation guidance documents listed below are currently available. Many of these documents and other listed references are also available from NTIS.

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U.S. Environmental Protection Agency
Reduction Risk Engineering Laboratory (RREL)
Cincinnati, OH
(513) 569-7834

The *Geotechnical Analysis for Review of Dike Stability (GARDS)* software package was developed to assist in evaluating earth dike stability. GARDS may be obtained from RREL. There is no charge for the program, however, the program must be copied onto discs which the user must supply.

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PART 503 IMPLEMENTATION GUIDANCE DOCUMENTS

Environmental Regulations and Technology: Control of Pathogens and Vector Attraction in Sewage Sludge (EPA 625-R-92-013), December 1992.

Preparing Sewage Sludge For Land Application or Surface Disposal: A Guide for Preparers of Sewage Sludge on the Monitoring, Recordkeeping, and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503 (EPA 831-B-93-002a), August 1993.

Domestic Septage Regulatory Guidance: A Guide to the EPA 503 Rule (EPA 832-B-92-005), September 1993.

Surface Disposal of Sewage Sludge: A Guide for Owners/Operators of Surface Disposal Facilities on the Monitoring, Recordkeeping, and Reporting Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503 (EPA 831-B-93-002c), May 1994.

THC Continuous Emission Monitoring Guidance for Part 503 Sewage Sludge Incinerators (EPA 833-B-94-003), June 1994.

A Plain English Guide to the EPA Part 503 Biosolids Rule (EPA 832-R-93-003), September 1994.

Land Application of Sewage Sludge: A Guide for Land Appliers on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503 (EPA 831-B-93-002b), December 1994.

INFORMATION SOURCES (Continued)

EPA REGIONAL SLUDGE COORDINATORS

Region 1
Thelma Hamilton
JFK Federal Building
Boston, MA 02203
(617) 565-3569

Region 2
Alia Roufaeal
290 Broadway
New York, NY 10007-1866
(212) 637-3864

Region 3
Ann Carkhuff
841 Chestnut Street
Philadelphia, PA 19107-4431
(215) 597-9406

Region 4
Vince Miller
345 Courtland Street
Atlanta, GA 30365
(404) 347-3012 x2953

Region 5
John Colletti
77 W. Jackson Blvd.
Chicago, IL 60604-3590
(312) 886-6106

Region 6
Stephanie Kordzi
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733
(214) 665-7520

Region 7
John Dunn
726 Minnesota Avenue
Kansas City, KS 66101
(913) 515-7594

Region 8
Bob Brobst
999 18th Street, Suite 500
Denver, CO 80202-2405
(303) 293-1627

Region 9
Lauren Fondahl
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-1909

Region 10
Dick Hetherington
1200 Sixth Avenue
Seattle, WA 98101-9797
(206) 553-1941

APPENDIX D

DETERMINING CONTROL EFFICIENCIES FOR PART 503, SUBPART E

DETERMINING CONTROL EFFICIENCIES FOR PART 503, SUBPART E

The pollutant limits for metals presented in Section 503.43 are calculated, in part, from sewage sludge incinerator control efficiencies (CE) for each of these metal pollutants. Section 503.43 states that CE shall be determined from a performance test of a sewage sludge incinerator. The regulatory definition of control efficiency can be expressed by the following formula:

$$CE = [Pollutant_{(in)} - Pollutant_{(out)}]/\ Pollutant_{(in)}$$

where:

$Pollutant_{(in)}$ = the mass of a pollutant in the sewage sludge fed to an incinerator,

$Pollutant_{(out)}$ = the mass of the same pollutant in the exit gas from the incinerator stack.

Without CE determinations sewage sludge limits cannot be established. Part 503 does not establish specific procedures to be followed to determine CE. The following discussion is intended to guide permit writers and incinerator operators to appropriate test procedures that can be used to determine and document values for CE.

Control efficiency performance testing involves three elements: determining the mass of a pollutant in the exit gas from the sewage sludge incinerator stack; determining the mass of that pollutant in the sewage sludge fed to a sewage sludge incinerator; and determining the operating parameters of the incinerator's air pollution control device during the performance test of the incinerator. The first two elements are components of the regulatory definition of CE. The third element is not part of the definition of CE, however, it is important since it can be used for on-going documentation of CE values after performance testing has been completed. Each of these elements will be discussed individually in greater detail.

Determining pollutant mass in the incinerator exit gas

In order to accurately determine the mass of a pollutant in an incinerator's exit gas, sampling and subsequent analysis of the incinerator exit gas stream must be conducted in discrete time periods. It is important to understand that these procedures, known as stack tests in air pollution control jargon, only provide data about the incinerator exit gas when gas sampling took place. Stack tests, therefore, only provide a "snap-shot" of an incinerator's exit gas.

Appendix A of Part 60 contains test methods that are used to determine emission rates for various pollutants from stationary sources. Although these methods are used primarily to determine compliance with EPA's New Source Performance Standards (NSPS) and in some cases, National Emission Standards for Hazardous Air Pollutants (NESHAP), they have also been applied widely to other situations. For example, these methods have been used extensively to determine emission rates from sources subject to state air quality regulations.[1] Some of the Part 60 Appendix A stack test methods can also be applied to determine, in part, the mass of metal pollutants emitted from sewage sludge incinerator stacks.

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[1] It should be noted that some State agencies have developed their own test methods that sources must follow in order to demonstrate compliance with state specific requirements.

The mass emission rate of a particular metal pollutant from an incinerator stack can determined from the concentration of the pollutant in the incinerator exit gas and the exit gas flow rate as expressed by the following formula:

emission rate = (pollutant concentration) × (gas flow rate)

Although not included in Part 60 Appendix A, the test procedure entitled, Methodology for the Determination of Metal Emissions in Exhaust Gases from Hazardous Waste Incineration and Similar Combustion Processes, is recommended for determining metals concentrations in sewage sludge incinerator exit gases. This test method, commonly called the multi-metals method, has been used extensively to measure metals emissions from municipal solid waste, hazardous waste, and sewage sludge incinerators. The multi-metals method has been incorporated into EPA's regulations governing the burning of hazardous waste in boilers and industrial furnaces (the BIF Rule, Part 266, Subpart H).

The multi-metals method collects both volatile and non-volatile fractions of metals in stack gases and can be applied to the following metals: total chromium, cadmium, arsenic, nickel, manganese, beryllium, copper, zinc, lead, selenium, phosphorus, thallium, silver, antimony, barium, and mercury. In this method, the stack gas sample is withdrawn isokinetically from the emission source, with particulate emissions collected in the probe and on a heated filter, and gaseous emissions collected in a series of chilled impingers containing solutions of nitric acid in hydrogen peroxide and of acidic potassium permanganate. After sampling is completed, sample train components are recovered and digested in separate front- and back-half fractions. Materials collected in the sampling train are acid-digested to dissolve inorganics and to remove organics that may create analytical interferences. After digestion, both fractions are brought up to their required volumes for metals analyses. Depending on the metals of interest and necessary analytical sensitivities, the fractions are analyzed by atomic absorption spectroscopy (AAS), graphite furnace AAS, inductively coupled argon plasma emission spectroscopy, and/or cold vapor AAS. The analytical results from both fractions can be combined to yield metals values for the entire train. The multi-metals method specifies a normal sampling run of one hour in duration, collecting a stack gas sample volume of 1.25 m^3. In many situations, greater sensitivity is needed to quantify metal emission rates, therefore the method allows the sampling duration and sample volume to be increased to 4 hours and 5 m^3, respectively to increase method detection limits. The multi-metals method expresses resulting metals concentrations as milligrams per dry standard cubic meter.

The flow rate of an incinerator's exit gas can be determined by using EPA Methods 1,2, and 4 from Part 60, Appendix A. The following table briefly describes each of these methods.

TABLE D-1. EPA REFERENCE METHODS TO DETERMINE GAS FLOW RATES

Method	Method Description
EPA Method 1	Sample and velocity traverses for stationary sources
EPA Method 2	Determination of stack gas velocity and volumetric flow rate (type S pitot tube)
EPA Method 4	Determination of moisture content in stack gases

Determining pollutant mass in the feed to the incinerator

- Determined by multiplying the average metal concentrations in the sludge fed to the incinerator while stack gas sampling took place by the amount of sludge fed to the incinerator while stack gas sampling took place.

- Metal concentrations in sludge is determined by sampling and analysis of the sludge before it is fed to the incinerator.

  - Grab samples should be taken at various times during the test run and later combined to form a composite sample for the run.

  - The composite sample should be representative of the sludge that is actually fed to the incinerator. One grab sample should be taken every 15 minutes unless data is available to indicate that less frequent sampling is adequate. The size of the composite sample must be established so that "representativeness" is ensured.

  - Sludge sampling should be conducted simultaneously with stack gas sampling. Since sludge residence times and gas residence times of the incinerator can differ significantly, sludge sampling should begin and end before stack gas sampling begins and ends; the "off-set" should be equal to the difference between sludge and stack gas residence times.

  - The resulting composite sample should be "flow-weighted" on a dry sludge basis. If the sludge feed rate (dry basis) and the metal concentrations in the sludge both vary over the duration of the performance test, the resulting composite sample will not be indicative of the metals introduced to the incinerator if sampling is not flow-weighted.

  - Flow-weighted samples require that the sludge feed rate to the incinerator be measured and recorded and that the moisture content of the sludge be measured.

  - Previous discussions of sludge sampling and compositing apply to all feed streams into the incinerator (sludge and scum).

  - Sampling, sample handling and preparation, and analyses procedures should primarily follow EPA's "Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846" and the ASTM Annual Book of ASTM Standards. (OTHER METHODS MAY ALSO BE APPLICABLE)

- The amount of sludge fed to the incinerator during a test can be determined by obtaining an average of the sewage sludge feed rate during the performance test run and multiplying by the duration of the test run.

  - This method requires the use of a sludge feed rate monitor; precautions must be taken to evaluate and ensure the accuracy of the monitor. The monitor must be certified for accuracy and maintained and calibrated properly.

  - In some cases, the amount of sludge fed to an incinerator could be determined by measuring the difference in sludge feed tank levels before and after each test run. This method requires that the feed tank be sized such that accurate and precise level measurements could be taken and that sludge was not added to the tank during the test run.

Documenting operating parameters of air pollution control devices (APCD) during CE performance testing

- Not directly related to the determination of CE.

- Regulations require that permit conditions for APCD operating parameters be based on CE performance testing.

- The operating parameter values observed during the performance test establish "baseline" conditions that can be used to compare with future operations. If these parameters deviate from the values observed during the performance test, a difference in the measured CE value could be indicated.

- Operating parameter values should be monitored and recorded as continuously as possible to provide an indication of the actual parameter values, as well as the variability of these values during sampling.

- The incinerator operator should clearly understand the importance of documenting APCD parameter values during testing to future incinerator operations. The operator may want to perform testing at unusual conditions to establish worst-case operating parameters that could provide flexibility of future operations.

- Operating parameters depend on the type of APCD. See guidance in Chapter 7 of text.

APPENDIX E

DETERMINING SITE-SPECIFIC POLLUTANT LIMITS FOR PART 503, SUBPART C

DETERMINING SITE-SPECIFIC POLLUTANT LIMITS FOR PART 503, SUBPART C

In accordance with Section 503.23(b), "the owner/operator of a surface disposal site may request site-specific pollutant limits for an active sewage sludge unit without a liner and leachate collection system when the existing values for site parameters specified by the permitting authority are different from the values for those parameters used to develop the pollutant limits in Table 1 of Section 503.23." The concentration of each regulated pollutant "shall not exceed either the concentration for the pollutant determined during a site-specific assessment, as specified by the permitting authority, or the existing concentration of the pollutant in the sewage sludge, whichever is lower."

The final rule for surface disposal sites (Table 1 of Section 503.23), includes regulations for only three pollutants: arsenic, chromium and nickel. The groundwater pathway (Pathway 14) is the only one of concern for site-specific modeling, since the regulated pollutants are metals, and therefore do not volatilize. In addition, the national EPA pollutant concentration limits were based on either the lowest risk-based criteria value or the pollutant concentration representing the 99th percentile of sewage sludge samples analyzed for the National Sewage Sludge Survey (NSSS) (U.S. EPA, 1992). In particular, the national pollutant limit for nickel was based on the NSSS 99th percentile value of 420 mg/kg, rather than the risk-based limit of 690 mg/kg.

When a permittee requests site-specific pollutant limits, the permit writer will have to make several decisions. First, she must decide if the reasons for the request are appropriate, e.g. is a high groundwater recharge rate a reason to approve site-specific limits. If the parameter is appropriate, she must know what value was used to determine the pollutant limits in Part 503, and what is an appropriate pollutant limit based on the permittee's values. The models used to develop the surface disposal pollutant limits include numerous parameters. The tables at the end of this section were developed to allow permit writers to look up values for the three pollutants when certain parameter values are changed. If a permit writer chooses to allow site-specific pollutant limits based on other parameters, he will have to make decisions based on his own BPJ.

The following list includes some of the different parameters that could be considered for the development of site-specific pollutant tables:

- Sewage sludge condition,
- Site geometry,
- Soil type,
- Depth to groundwater,
- Distance from edge of active sewage sludge unit to property boundary,
- Groundwater recharge,
- Soil-water partition coefficients,
- Hydraulic gradient, and
- Aquifer thickness.

Criteria for Identifying Candidate Parameters for Site-Specific Pollutant Limit Tables

The definition of "surface disposal" includes a range of disposal facilities, including sludge-only monofills, lagoons, waste piles, dedicated sites for land application and others. The physical characteristics of these types of facilities vary significantly, and specific modeling of each of the different types of facilities was not considered practical for the final rule. Instead, two "prototype" facilities (a monofill and a surface impoundment with continuous inflow) were selected to represent the broader universe of facility types. For each pollutant and exposure pathway, the more limiting of criteria calculated for these two prototype facilities was used for the final regulation.

The use of prototypes presents some complications for site-specific modeling of individual facilities. If the site under consideration is a waste pile, for example, how should the pile's slope or height be represented with input parameters used in two models designed respectively for a surface impoundment filled with liquid or a monofill with a cover layer of soil? If the facility is a surface impoundment receiving only occasional deposits of sludge, what parameters are appropriate to describe these deposits for a model that assumes continuous inflow?

In order to avoid the need to develop new models for additional facility prototypes, parameters that describe the actual surface disposal unit such as sewage sludge condition and site geometry were not considered in the tables. Another important factor to consider when selecting parameters is the ease with which the parameter can be measured or estimated. Parameters that are likely to have substantial variability for a single site were not used in developing the tables because data based on a limited number of samples does not adequately represent an entire site. The following section explains why four possible parameters were not used in the development of the site-specific look-up tables.

Groundwater recharge was found to have a significant impact upon estimated pollutant limits. However, because of the difficulty in measuring local recharge, it was not considered as a variable for the site-specific tables. This issue is complicated by the differences in recharge below different surface disposal facility types. For example, a surface impoundment, which is assumed to have a standing head of water, is modelled differently than a monofill, which has a temporary cover soil and eventually a permanent cover.

Soil-water partition coefficients (K_d) for metals can be estimated from numerous site-specific variables including temperature, pH, total dissolved solids, presence of iron oxides, clay, and organic matter. Because of the potential spatial variability, however, it can be difficult to estimate K_d values which are representative of the entire site. As a result, laboratory-derived K_d values often do not correspond to field values that have been calibrated over large areas. Accurately estimating site-specific K_d values requires substantial sampling effort. For this reason, soil-water partition coefficients were not used as a site-specific parameter.

The hydraulic gradient can fluctuate due to weather and the potential effects of surrounding pumping wells. In addition, model results (and hence pollutant limits) are relatively insensitive to the values chosen for hydraulic gradient. For these reasons, hydraulic gradient was not used as a site-specific parameter.

Aquifer thickness affects criteria, although not as significantly as the other site-specific parameters discussed here (i.e., depth to groundwater, distance, and soil type). For example, an order of magnitude change in the aquifer thickness (from 5m to 50m) only produces a five-fold increase in the allowable concentration, with little or no change occurring for greater thicknesses. By comparison, a difference of a factor of two in the depth to groundwater or change in soil type may lead to as much as an order of magnitude or more change in the criteria. Due to the relatively insignificant effect on criteria and the additional computational burden of including four independent variables, aquifer thickness was not included for the site-specific tables.

Site-Specific Parameters

The site-specific pollutant tables were derived using the assumptions, models and methodology used to derive the national limits (U.S. EPA, 1992). The three parameters used in developing the site-specific pollutant tables are:

- Soil type,
- Depth to groundwater, and
- Distance from edge of active sewage sludge unit to property boundary.

Below is a description of each of the site-specific parameters.

Soil Type

Soil type refers to the uppermost portion of the vadose zone, which is characterized by significant biological activity. The soil type can impact the transport of pollutants through such processes as filtration, biodegradation, sorption, and volatilization. For metals, filtration and sorption are the only relevant processes. Consistent with the methodology used to determine the national pollutant limits, the site-specific model assumes that the soil is homogeneous throughout the soil column and that one soil type is being modeled. In the site-specific modelling, soil type is represented by the following set of parameters:

- Hydraulic conductivity,
- Bulk density,
- Porosity,
- Water retention parameters, and
- Residual water content.

Soil types are based on a soil group classification system developed by the Soil Conservation Service (USDA, 1972). The SCS classification consists of four groups (A, B, C and D), that are in order of decreasing percolation potential. For each SCS soil group, the site-specific model assumes fixed values for the soil type parameters listed above. The four SCS groups are associated with soil characteristics as follows (USDA, 1972; McCuen, 1982):

Group A: Soils having a high infiltration rate when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands: deep sand, deep loess, aggregated silts.

Group B: Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture: shallow loess, sandy loam.

Group C: Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture: clay loams, shallow sandy loam, soils low in organic content, and soils usually high in clay.

Group D: Soils having a very slow infiltration rate when thoroughly wet. These consist chiefly of clays that have high shrink-swell potential: soils that swell significantly when wet, heavy plastic clays, and certain saline soils.

For a particular site, the SCS soil group can be identified using any of the following:

- Soil characteristics,
- Saturated hydraulic conductivity, or
- County soil surveys.

The soil characteristics associated with each group are listed above. Site-specific soil characteristics are best obtained by doing site-specific soil analysis. A soil analysis can also be used to estimate the hydraulic conductivity (a measure of the soils ability to transmit water), which can be correlated with the SCS soil groups. The following table shows the correlation between saturated hydraulic conductivity and soil group (Brakensiek and Rawls, 1983).

Group	Saturated Hydraulic Conductivity (cm/hr)
A1	10.0 - 61
A	1.0 - 10.0
B	0.60 - 1.0
C	0.20 - 0.60
D	0.005 - 0.20

SCS county soil surveys, where available, can give a detailed description of soils at locations within a county, and can be used to identify the soil group. Additionally, the SCS (U.S.D.A., 1972) has assigned hydrologic soil groups to over four thousand soils in the U.S. and Puerto Rico. Other sources for identifying the soil group include:

- U.S. Geological Survey,
- State Geological Survey,
- State Department of Natural/Water Resources,
- U.S. Department of Agriculture Soil Conservation Service, or
- Private Consulting Firms

If the soil group has been identified as being Group A using either the soil characteristics, or county surveys, then the hydraulic conductivity should be measured to distinguish which range within Group A is appropriate. Alternately, permeability values can be obtained from such sources as SCS county soil surveys. For cases where the site-specific permeability is not measured, and a range of permeability values are available, the larger (more conservative) value of the reported range should be used (e.g., for a reported range of 2.0-6.0 in/hr, the larger value of 6.0 in/hr or 15.2 cm/hr should be used, which would correspond to soil Group A1). Because county soil surveys may cover larger areas than a particular surface disposal site (possibly resulting in greater ranges in hydraulic conductivity), measured hydraulic conductivity will be more accurate. Since hydraulic conductivity can have a strong influence on estimated site-specific criteria, it is recommended that measured hydraulic conductivity be used to determine the site-specific soil group.

Once the soil group has been identified, the model assumes fixed values for a set of input soil parameters. Table E-1 shows the site-specific values assumed for each of the soil parameters, as well as the applicable ranges for hydraulic conductivity. A discussion of each soil parameter and the values assumed is presented below.

Table E-1. Soil Group

SCS Soil Group[a]	Associated intervals for saturated hydraulic conductivity[b], K_s (cm/hr)	Saturated hydraulic conductivity[c], K_s (cm/hr)	Bulk density[d] (kg/m^3)	Van Genuchten water retention parameters[e]			Porosity[f]	Residual water content[g], θ_r
				α, cm^{-1}	β	γ		
A1	**10.0 < x ≤ 61**	**61.0**	**1600**	**14.5**	**2.68**	**0.627**	**0.4**	**0.045**
A2	1.0 < x ≤ 10.0	10.0	1600	1.45	2.68	0.627	0.4	0.045
B	0.60 < x ≤ 1.0	1.0	1603	7.5	1.89	0.47	0.4	0.065
C	0.20 < x ≤ 0.60	0.60	1663	1.9	1.31	0.24	0.37	0.095
D	0.005 < x ≤ 0.20	0.20	1693	1.0	123	0.19	0.36	0.089

Notes:

[a] U.S.D.A., SCS, 1972 and McCuen, 1982.
[b] Based on Brakensiek and Rawls, 1983.
[c] Upper end of range from Brakensiek and Rawls, 1983.
[d] Adjusted using Carsel et al., 1988 to be consistent with U.S. EPA, 1993.
[e] van Genuchten, 1980.
[f] Derived based on bulk density (Carsel et al, 1988) and particle density (Freeze and Cherry, 1979).
[g] Based on Carsel and Parrish, 1988.

Saturated Hydraulic Conductivity

Saturated hydraulic conductivity refers to the ability of soil to transmit water, which is governed by the amount and interconnection of void spaces in the saturated zone. In general, high hydraulic conductivities are associated with high rates of contaminant transport. Values for the saturated hydraulic conductivity (Table E-1) are taken from Brakensiek and Rawls (1983), except for the value of 61 cm/hr which is the value used to generate the national pollutant limits.

Bulk Density

The bulk density of soil is defined as the mass of dry soil divided by its total (or bulk) volume. Bulk density directly influences the retardation of solutes and is related to soil structure. In general, as soils become more compact, their bulk density increases. Values for bulk density were derived from Carsel et al. (1988), that provided descriptive statistics for bulk density according to the four SCS soil groups.

Porosity

Porosity is the ratio of the void volume of a given soil or rock mass to the total volume of that mass. If the total volume is represented by V_t and the volume of the voids by V_v, the porosity can be defined as $\Theta_t = V_v/V_t$. Porosity is usually reported as a decimal fraction or percentage, and ranges from 0 (no pore spaces) to 1 (no solids). Porosity values were calculated from the bulk density:

$$\theta_t = (1 - \frac{BD}{\rho_{so}})$$

where:

- BD =bulk density of soil (kg/m^3)
- ρ_{so} =particle density of soil (kg/m^3), and
- θ_t =porosity of soil (dimensionless).

A value of 2650 was used as a typical particle density for mineral soils (Freeze and Cherry, 1979).

Water Retention Parameters

The water-retention characteristic of the soil describes the soil's ability to store and release water and is defined as the relationship between the soil water content and the soil suction or matric potential (Maidment, 1993). The unsaturated hydraulic conductivity is a non-linear function of volumetric soil water content, and varies with soil texture. The van Genuchten (1980) water retention parameters were used to determine the soil water content and the unsaturated hydraulic conductivity.

In order to select values for the soil-retention parameters it is necessary to relate a soil type to each soil group. Carsel and Parish (1988) provide descriptive statistics for the van Genuchten parameters for twelve soil types: clay, clay loam, loam, loamy sand, silt, silty loam, silty clay, silty clay loam, sand, sandy clay, sandy clay loam, and sandy loam. The following assignments were made to each soil group, based on relative permeability:

- Group A: Sand
- Group B: Sandy Loam

- Group C: Clay Loam
- Group D: Silty Clay Loam.

Residual Water Content

Values for the residual water content were taken from Carsel and Parrish (1988), using sand for Group A, sandy loam for Group B, clay loam for Group C, and silty clay loam for Group D.

Depth to Groundwater

The depth to groundwater is defined as the distance from the lowest point of the active sewage sludge unit to the water table. The water table is itself defined as the subsurface boundary between the unsaturated zone (where the pore spaces contain both water and air) and the saturated zone (where the pore spaces contain water only). For the purposes of site-specific modeling, the water table is defined as being the ***high water table***, or the "highest level of a saturated zone in the soil in most years" (USDA, 1989). The depth to groundwater determines the distance a contaminant must travel before reaching the aquifer, and affects the attenuation of contaminant concentration during vertical transport. As this depth increases, attenuation also tends to increase, thus reducing potential pollution of the groundwater.

Seven depths are used to represent the depth to groundwater at an active sewage sludge unit. Table E-2 shows the depth along with the applicable ranges. Where a site-specific value falls between two values in Table E-2, the smaller value should be used (e.g., a site-specific value of 6 feet or roughly 1.8 meters would correspond to one meter). SCS county soil surveys can be useful sources for depths to groundwater, although site-specific measurements are preferred. Other sources for the depth to groundwater include:

- U.S. Geological Survey,
- State Geological Survey,
- State Department of Natural/Water Resources,
- U.S. Department of Agriculture Soil Conservation Service, or
- Private Consulting Firms.

Distance from Edge of Active Sewage Sludge Unit to Property Boundary

Consistent with the methodology for the national pollutant criteria, the site-specific model assumes that a drinking water well is located at the site's property boundary, directly down-gradient of the site. Thirteen distances are used to represent the distance from the edge of the unit to the property boundary. Table E-3 shows the distances along with the applicable ranges. When site-specific values fall between two values in Table E-3, the smaller (closer) value should be used (e.g., a site-specific value of 175 meters corresponds to 150 meters).

Table E-2. Depth to Groundwater (m)

Depth to Groundwater(m)	Range (m)
1	< 5
5	$5 \le x < 10$
10	$10 \le x < 15$
15	$15 \le x < 20$
20	$20 \le x < 30$
30	$30 \le x < 50$
50	≥ 50

Table E-3. Distance to Property Boundary

Distance (m)	Range (m)
0	< 25
25	$25 \le x < 50$
50	$50 \le x < 75$
75	$75 \le x < 100$
100	$100 \le x < 125$
125	$125 \le x < 150$
150	**$150 \le x < 200$**
200	$200 \le x < 250$
250	$250 \le x < 300$
300	$300 \le x < 400$
400	$400 \le x < 500$
500	$500 \le x < 1000$
1000	≥ 1000

Site-Specific Pollutant Limit Look-Up Tables

The site-specific pollutant limits are presented in Tables E-4 to E-6 for arsenic, chromium, and nickel, respectively. To determine the site-specific pollutant limit for an individual active sewage sludge unit, the permit writer should locate the matrix which corresponds to the appropriate soil group, and find the column representing the distance to the edge of the site and the row representing the depth to groundwater. If the site-specific value estimated for either the depth to groundwater or the distance to the edge of the site falls between two values in the table, then the lower value should be used. The national pollutant limits for each pollutant are in bold, and correspond to: Soil Group A1, a one meter depth to groundwater, and a 150 meter distance from the edge of the active sewage sludge unit to the boundary property (U.S. EPA, 1993).

DETERMINING SITE-SPECIFIC POLLUTANT LIMITS FOR PART 503, SUBPART C (Continued)

Table E-4. Risk-Based Site-Specific Pollutant Criteria for Arsenic (in mg/kg)

Soil group A1

Depth to GW (m)	Distance to Edge of Site (m)												
	0	25	50	75	100	125	150	200	250	300	400	500	1,000
1 (m)	30	34	39	46	53	62	73	97	120	150	230	340	4,800
5 (m)	36	40	46	53	61	70	80	100	130	160	250	430	11,000
10 (m)	48	53	59	66	74	84	95	110	150	200	380	780	38,000
15 (m)	61	66	73	80	90	100	110	150	210	310	720	1,700	Unlimited
20 (m)	75	81	88	98	110	130	160	240	370	580	1,400	3,800	Unlimited
30 (m)	120	140	170	210	260	340	440	750	1,300	2,200	7,000	21,000	Unlimited
50 (m)	650	890	1,200	1,700	2,400	3,400	4,900	10,000	20,000	41,000	Unlimited	Unlimited	Unlimited

Soil group A2

Depth to GW (m)	Distance to Edge of Site (m)												
	0	25	50	75	100	125	150	200	250	300	400	500	1,000
1 (m)	43	49	57	67	79	92	100	140	190	290	730	2,000	Unlimited
5 (m)	46	52	60	70	82	95	110	160	250	420	1,300	4,500	Unlimited
10 (m)	53	60	68	78	91	110	140	240	450	860	3,400	14,000	Unlimited
15 (m)	62	69	80	99	120	160	230	450	940	2,000	9,500	45,000	Unlimited
20 (m)	73	88	110	140	200	290	420	920	2,100	4,800	26,000	Unlimited	Unlimited
30 (m)	130	190	280	420	650	1,000	1,600	4,100	10,000	28,000	Unlimited	Unlimited	Unlimited
50 (m)	880	1,500	2,700	4,700	8,500	15,000	27,000	88,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group B

Depth to GW (m)	Distance to Edge of Site (m)												
	0	25	50	75	100	125	150	200	250	300	400	500	1,000
1 (m)	49	56	65	76	89	100	120	170	260	440	1,400	4,800	Unlimited
5 (m)	51	58	67	78	91	100	130	210	380	730	2,900	12,000	Unlimited
10 (m)	57	65	74	87	100	140	190	370	770	1,700	8,600	46,000	Unlimited
15 (m)	65	74	91	110	160	220	330	750	1,700	4,300	26,000	Unlimited	Unlimited
20 (m)	77	98	130	180	270	410	640	1,600	4,200	11,000	81,000	Unlimited	Unlimited
30 (m)	150	230	350	570	940	1,500	2,700	8,100	24,000	75,000	Unlimited	Unlimited	Unlimited
50 (m)	980	1,900	3,600	6,900	13,000	26,000	51,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group C

Depth to GW (m)	Distance to Edge of Site (m)												
	0	25	50	75	100	125	150	200	250	300	400	500	1,000
1 (m)	51	58	67	79	92	100	120	180	290	500	1,600	6,200	Unlimited
5 (m)	53	60	70	81	95	110	140	240	450	880	3,800	17,000	Unlimited
10 (m)	59	67	77	92	110	150	210	440	960	2,100	12,000	71,000	Unlimited
15 (m)	67	79	99	130	180	260	400	940	2,300	5,900	40,000	Unlimited	Unlimited
20 (m)	83	100	150	210	330	510	820	2,100	5,900	16,000	Unlimited	Unlimited	Unlimited
30 (m)	170	270	430	720	1,200	2,100	3,700	11,000	38,000	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	1,200	2,500	5,000	9,900	20,000	40,000	82,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group D

Depth to GW (m)	Distance to Edge of Site (m)												
	0	25	50	75	100	125	150	200	250	300	400	500	1,000
1 (m)	52	59	69	80	94	110	120	180	300	510	1,700	6,300	Unlimited
5 (m)	54	61	71	83	97	110	140	240	450	900	3,800	18,000	Unlimited
10 (m)	60	68	78	93	110	150	210	450	980	2,200	12,000	75,000	Unlimited
15 (m)	68	79	100	130	180	270	400	970	2,400	6,200	43,000	Unlimited	Unlimited
20 (m)	84	110	150	220	330	520	840	2,200	6,200	17,000	Unlimited	Unlimited	Unlimited
30 (m)	170	270	440	740	1,200	2,200	3,900	12,000	41,000	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	1,200	2,600	5,300	10,000	21,000	45,000	93,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Table E-5. Risk-Based Site-Specific Pollutant Criteria for Chromium (in mg/kg)

Soil group A1

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	200	220	260	300	360	450	600	1,100	2,300	5,200	28,000
5 (m)	240	290	400	570	880	1,300	2,200	6,400	19,000	58,000	Unlimited
10 (m)	600	1,000	1,700	3,100	5,900	11,000	21,000	82,000	Unlimited	Unlimited	Unlimited
15 (m)	2,300	4,800	10,000	21,000	45,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	10,000	25,000	60,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group A2

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	290	340	440	640	1,000	1,800	3,300	13,000	58,000	Unlimited	Unlimited
5 (m)	350	560	1,000	2,100	4,700	11,000	27,000	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	900	2,200	5,900	16,000	48,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	3,400	11,000	40,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	14,000	66,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group B

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	330	390	550	880	1,500	3,000	6,300	31,000	Unlimited	Unlimited	Unlimited
5 (m)	400	680	1,300	3,200	8,200	22,000	64,000	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	990	2,800	8,400	27,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	3,600	14,000	59,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	15,000	85,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group C

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	340	410	590	960	1,700	3,400	6,300	31,000	Unlimited	Unlimited	Unlimited
5 (m)	420	740	1,500	3,800	10,000	29,000	64,000	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	1,100	3,300	10,000	36,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	4,300	19,000	81,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	19,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group D

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	350	420	590	960	1,700	3,400	6,300	31,000	Unlimited	Unlimited	Unlimited
5 (m)	420	740	1,500	3,800	10,000	29,000	64,000	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	1,100	3,300	10,000	36,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	4,300	19,000	81,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	19,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Table E-6. Risk-Based Site-Specific Pollutant Criteria for Nickel (in mg/kg)

Soil group A1

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	210	240	270	320	390	510	690	1,400	3,100	7,400	47,000
5 (m)	260	340	470	720	1,100	1,900	3,200	10,000	33,000	Unlimited	Unlimited
10 (m)	760	1,300	2,500	4,800	9,400	19,000	39,000	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	3,200	7,500	16,000	37,000	86,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	16,000	44,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group A2

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	310	360	490	750	1,200	2,300	4,500	19,000	Unlimited	Unlimited	Unlimited
5 (m)	390	660	1,300	2,900	7,000	18,000	48,000	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	1,100	3,100	9,000	27,000	89,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	4,800	18,000	71,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	22,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group B

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	350	430	620	1,000	1,900	4,000	4,500	19,000	Unlimited	Unlimited	Unlimited
5 (m)	440	810	1,700	4,500	12,000	37,000	48,000	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	1,200	3,900	13,000	47,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	5,100	24,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	24,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group C

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	360	450	660	1,100	2,100	4,600	8,800	50,000	Unlimited	Unlimited	Unlimited
5 (m)	460	890	2,000	5,300	15,000	49,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	1,300	4,600	16,000	63,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	6,100	31,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	30,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

Soil group D

Depth to GW (m)	Distance to Edge of Site (m)										
	0	25	50	75	100	125	150	200	250	300	400
1 (m)	370	450	660	1,100	2,100	4,600	8,800	50,000	Unlimited	Unlimited	Unlimited
5 (m)	460	890	2,000	5,300	15,000	49,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
10 (m)	1,300	4,600	16,000	63,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
15 (m)	6,100	31,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
20 (m)	30,000	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
30 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
50 (m)	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

[1]National Pollutant limits for nickel were based on 99th percentile value for the NSSS (420 mg/kg).

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APPENDIX F

INTERIM APPLICATION FORM

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

Form Approved
OMB Number 2040-0086
Approval Expires 8/31/95

INTERIM SEWAGE SLUDGE PERMIT APPLICATION FORM

Paperwork Reduction Act Notice
Public reporting burden for this application is estimated to average 8.4 hours per application, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate, any other aspect of this collection of information, or suggestions for improving this form, including suggestions which may increase or reduce this burden, to: Chief, Information Policy Branch, PM-223Y, U.S. Environmental Protection Agency, 401 M Street, SW, Washington, DC, 20460, or Director, Office of Information and Regulatory Affairs, Office of Management and Budget, Washington, DC, 20503.

PRELIMINARY INFORMATION

This page is designed to indicate whether the applicant is to complete Part 1 or Part 2. Answer each question. Then complete Part 1 or Part 2, as indicated.

For purposes of this form, the term "you" refers to the applicant. "This facility" and "your facility" refer to the facility for which application information is submitted.

1. *Is this facility required to have, or is it requesting, site-specific pollutant limits?*

   _____ Yes _____ No

2. Does this facility have a currently effective NPDES permit?

   _____ Yes _____ No

3. Is this facility required by the permitting authority to submit a full permit application at this time?

   _____ Yes _____ No

If the answers to the above questions are **all** no, complete Part 1 only (see instructions). If the answer to **any** of the above questions is yes, complete Part 2 rather than Part 1.

Send the completed application form to:

FACILITY NAME: | PERMIT NUMBER: | EPA ID NUMBER: (for official use only)

Form Approved
OMB Number 2040-0086
Approval Expires 8/31/95

PART 1: LIMITED BACKGROUND INFORMATION

This part should be completed only by "sludge-only" facilities—that is, facilities that do not currently have, and are not now applying for, an NPDES permit for a direct discharge to a surface body of water. This part also does not pertain to facilities that are requesting, or that are required to have, site-specific pollutant limits in their permits.

For purposes of this form, the term "you" refers to the applicant. "This facility" and "your facility" refer to the facility for which application information is submitted.

1. Facility Identification.

a. Name of facility: ____________________

b. Facility contact. Name: ____________________
Title: ____________________
Phone: ( ) __________

c. Facility mailing address.
Street or P.O. Box: ____________________
City or Town: __________ State: _____ Zip: _____

d. Facility location.
Street or Route #: ____________________
County: ____________________
City or Town: __________ State: _____ Zip: _____

2. Owner/Operator Information.

a. Are you the owner of this facility? _____ Yes _____ No

If no, provide the owner's:
Name: ____________________
Phone: ( ) __________
Street or P.O. Box: ____________________
City or Town: __________ State: _____ Zip: _____

b. Are you the operator of this facility? _____ Yes _____ No

If no, provide the operator's:
Name: ____________________
Phone: ( ) __________
Street or P.O. Box: ____________________
City or Town: __________ State: _____ Zip: _____

c. Indicate the type of facility:
_____ Publicly owned treatment works (POTW)
_____ Privately owned treatment works
_____ Federally owned treatment works
_____ Blending or treatment operation
_____ Surface disposal site
_____ Sewage sludge incinerator
_____ Other. If other, explain:
____
____
____

3. Sewage Sludge Amount. Provide the total dry metric tons per 365-day period of sewage sludge handled under the following practices:

a. Amount generated at the facility: __________
b. Amount received from off site: __________
c. Amount treated on site (including blending): __________
d. Amount sold or given away in a bag or other container for application to the land: __________
e. Amount of bulk sewage sludge shipped off site for treatment or for sale/give-away in a bag or other container for application to the land: __________
f. Amount applied to the land in bulk form: __________
g. Amount placed on a surface disposal site: __________
h. Amount fired in a sewage sludge incinerator: __________
i. Amount sent to a municipal solid waste landfill: __________
j. Amount used or disposed by another practice: __________
Describe: ____________________
____
____

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

4. Pollutant Concentrations. Using the table below or a separate attachment, provide existing data on the pollutant concentrations in sewage sludge from this facility. Provide all data for the last two years. If data from the last two years are unavailable, provide the most recent data.

POLLUTANT	CONCENTRATION (mg/kg dry weight)	SAMPLE TYPE	SAMPLE DATE	DETECTION LEVEL FOR ANALYSIS
Arsenic				
Cadmium				
Chromium				
Copper				
Lead				
Mercury				
Molybdenum				
Nickel				
Selenium				
Zinc				

5. Treatment Provided at Your Facility.

a. Which class of pathogen reduction does the sewage sludge meet at your facility?

_____ Class A _____ Class B _____ Neither or unknown

b. Describe, on this form or another sheet of paper, any treatment processes used at your facility to reduce pathogens in sewage sludge:

____

____

____

____

c. Which vector attraction reduction option is met for the sewage sludge at your facility?

_____ Option 1 (Minimum 38 percent reduction in volatile solids)
_____ Option 2 (Anaerobic process, with bench-scale demonstration)
_____ Option 3 (Aerobic process, with bench-scale demonstration)
_____ Option 4 (Specific oxygen uptake rate for aerobically digested sludge)
_____ Option 5 (Aerobic processes plus raised temperature)
_____ Option 6 (Raise pH to 12 and retain at 11.5)
_____ Option 7 (75 percent solids with no unstabilized solids)
_____ Option 8 (90 percent solids with unstabilized solids)
_____ Option 9 (Injection below land surface)
_____ Option 10 (Incorporation into soil within 6 hours)
_____ Option 11 (Covering active sewage sludge unit daily)
_____ None or unknown

d. Describe, on this form or another sheet of paper, any treatment processes used at your facility to reduce vector attraction properties of sewage sludge:

____

____

____

____

6. **Treatment Provided at Other Facilities.** Is sewage sludge from your facility provided to another facility for treatment, distribution, use, or disposal?

_____ Yes _____ No

If yes, provide the following information for the facility receiving the sewage sludge:

a. Name of facility: ____________________

b. Facility contact. Name: ____________________
Title: ____________________
Phone: ( ) ____________

c. Facility mailing address.
Street or P.O. Box: ____________________
City or Town: ____________ State: _____ Zip: ________

d. Facility location.
Street or Route #: ____________________
County: ____________________
City or Town: ____________ State: _____ Zip: ________

e. Which activities does the receiving facility provide? (Check all that apply):
_____ Treatment (e.g., blending, dewatering, composting, heat drying)
_____ Sale or give-away in bag or other container
_____ Land application _____ Surface disposal
_____ Other (describe): _____ Incineration

____
____
____

7. **Use and Disposal Sites.** Provide the following information for each site on which sewage sludge from this facility is used or disposed:

a. Site name or number: ____________________

b. Site contact. Name: ____________________
Title: ____________________
Phone: ( ) ____________

c. Site location.
Street or Route #: ____________________
County: ____________________
City or Town: ____________ State: _____ Zip: ________

d. Site type:
_____ Agricultural _____ Lawn or home garden
_____ Forest _____ Surface disposal
_____ Public contact _____ Incineration
_____ Reclamation _____ Other (describe):

____
____
____

8. **Certification.** Sign the certification statement below. (Refer to instructions to determine who is an officer for purposes of this certification.)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with the system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature of Officer: ____________________
Name of Officer: ____________________
(typed or printed)
Official Title of Officer: ____________________
Telephone Number: ____________________
Date Signed: ____________________

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: (for official use only)

Form Approved
OMB Number 2040-0086
Approval Expires 8/31/95

PART 2: PERMIT APPLICATION INFORMATION

Complete this part if you answered "yes" to any of the questions in the PRELIMINARY INFORMATION section (page 1). In other words, complete this part if your facility has, or is applying for, an NPDES permit or if your facility (including a "sludge-only" facility) is requesting, or is required to have, site-specific pollutant limits in its permit.

For purposes of this form, the term "you" refers to the applicant. "This facility" and "your facility" refer to the facility for which application information is submitted.

SCREENING INFORMATION — SEWAGE SLUDGE USE OR DISPOSAL INFORMATION

Part 2 is divided into six sections (A-F). Sections A and F pertain to all applicants. The applicability of Sections B, C, D, and E depends on your facility's sewage sludge use or disposal practices. *The information provided on this page will indicate which sections of Part 2 to fill out.*

1. All applicants must complete **Section A (General Information).**

2. Does this facility generate sewage sludge?

   _____ Yes _____ No

   Does this facility derive a material from sewage sludge?

   _____ Yes _____ No

   If you answered **Yes** to either, complete **Section B (Generation of a Sewage Sludge or Preparation of a Sewage Sludge or Preparation of a Sewage Sludge Product).**

3. Does this facility apply sewage sludge to the land?
   _____ Yes _____ No

   Is sewage sludge from this facility applied to the land?
   _____ Yes _____ No

   If you answered **Yes** to either, answer the following three questions:

   a. Does sewage sludge from this facility meet the pollutant concentrations, Class A pathogen reduction requirements, and one of vector attraction reduction options 1-8, as identified in the instructions? _____ Yes _____ No

   b. Is sewage sludge from this facility placed in a bag or other container for sale or give-away? _____ Yes _____ No

   c. Is sewage sludge from this facility sent to another facility for treatment (including blending) or placement in a bag or other container for sale or give-away?
   _____ Yes _____ No

   If you answered **No** to all three, complete **Section C (Land Application of Bulk Sewage Sludge).**

   If you answered **Yes** to a., b., or c., **skip Section C.**

4. Do you own or operate a surface disposal site?

   _____ Yes _____ No

   If **Yes**, complete **Section D (Surface Disposal).**

5. Do you own or operate a sewage sludge incinerator?

   _____ Yes _____ No

   If **Yes**, complete **Section E (Incineration).**

6. All applicants must complete **Section F (Other Information).**

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

A. GENERAL INFORMATION

All applicants must complete this section.

A.1. Facility identification.

a. Name of facility: ______________________

b. Facility contact. Name: ______________________
Title: ______________________
Phone: ( ) __________

c. Facility mailing address.
Street or P.O. Box: ______________________
City or Town: __________ State: ____ Zip: ______

d. Facility location.
Street or Route #: ______________________
County: ______________________
City or Town: __________ State: ____ Zip: ______

e. Facility latitude: __________ Facility longitude: __________

Method of latitude/longitude determination:
____ USGS map ____ Other (describe:)
____ Field survey ______________________

If map used, provide datum and scale: ______________________

f. Is this facility a Class I sludge management facility?

____ Yes ____ No

g. Indicate whether this facility is currently: ____ Active ____ Inactive
Date on which facility became active/inactive: __________

h. SIC Codes (4-digit, in descending order of priority):
Code: ______ Specify: ______________________
Code: ______ Specify: ______________________
Code: ______ Specify: ______________________
Code: ______ Specify: ______________________

A.2. Permit information.

a. Facility's NPDES permit number (if applicable): __________

b. List, on this form or an attachment, all other Federal, State, and local permits or construction approvals received or applied for that regulate this facility's sewage sludge management practices:

Permit Number:	Type of Permit:

A.3. Owner/Operator information.

a. Are you the owner of this facility? ____ Yes ____ No
If no, provide the owner's:
Name: ______________________
Phone: ( ) __________
Street or P.O. Box: ______________________
City or Town: __________ State: ____ Zip: ______

b. Are you the operator of this facility? ____ Yes ____ No
If no, provide the operator's:
Name: ______________________
Phone: ( ) __________
Street or P.O. Box: ______________________
City or Town: __________ State: ____ Zip: ______

c. Indicate the type of facility:
____ Publicly owned treatment works (POTW)
____ Privately owned treatment works
____ Federally owned treatment works
____ Blending or treatment operation
____ Surface disposal site
____ Sewage sludge incinerator
____ Other. If other, explain: ______________________

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

A.4. Indian Lands. Does any generation, treatment, storage, application to land, or disposal of sewage sludge from this facility occur on Indian lands?

_____ Yes _____ No

If yes, describe:

____

____

____

A.5. Topographic Map. Provide a topographic map or maps (or other appropriate map(s) if a topographic map is unavailable) that shows the following items of information. Map(s) should include the area one mile beyond all property boundaries of the facility:

a. Location of all sewage sludge management facilities, including locations where sewage sludge is generated, treated, or disposed.

b. Location of all water bodies within one mile beyond the facility's property boundaries.

c. Location of all wells used for drinking water listed in public records or otherwise known to the applicant within 1/4 mile of the property boundaries.

A.6. Hazardous Waste Characteristics. Attach the results of any testing that has been conducted in the last five years to determine whether the sewage sludge is a hazardous waste.

A.7. Pollutant Concentrations. Using the table below or a separate attachment, provide existing data on the pollutant concentrations in sewage sludge from this facility. Provide all data for the last two years. If data from the last two years are unavailable, provide the most recent data.

POLLUTANT	CONCENTRATION (mg/kg dry weight)	SAMPLE TYPE	SAMPLE DATE	DETECTION LEVEL FOR ANALYSIS
Arsenic				
Cadmium				
Chromium				
Copper				
Lead				
Mercury				
Molybdenum				
Nickel				
Selenium				
Zinc				

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

B. GENERATION OF SEWAGE SLUDGE OR PREPARATION OF A MATERIAL DERIVED FROM SEWAGE SLUDGE

Complete this section if your facility generates sewage sludge or derives a material from sewage sludge.

B.1. Amount Generated On Site.

Total dry metric tons per 365-day period generated at your facility: ______________

B.2. Amount Received from Off Site. If your facility receives sewage sludge from another facility for treatment, use, or disposal, provide the following information for each facility from which sludge is received. If you receive sewage sludge from more than one facility, attach additional pages as necessary.

a. Name of facility: ______________________________

b. Facility contact. Name: ______________________________
Title: ______________________________
Phone: (   ) ______________

c. Facility mailing address.
Street or P.O. Box: ______________________________
City or Town: ______________ State: _____ Zip: __________

d. Facility location.
Street or Route #: ______________________________
County: ______________________________
City or Town: ______________ State: _____ Zip: __________

e. Total dry metric tons per 365-day period received from this facility: ______________

f. Describe, on this form or on another sheet of paper, any treatment processes known to occur at the off-site facility, including blending activities and treatment to reduce pathogens or vector attraction characteristics:

____
____
____
____

B.3. Treatment Provided at Your Facility.

a. Which class of pathogen reduction is achieved for the sewage sludge at your facility?

_____ Class A _____ Class B _____ Neither or unknown

b. Describe, on this form or another sheet of paper, any treatment processes used at your facility to reduce pathogens in sewage sludge:

____
____
____
____

c. Which vector attraction reduction option is met for the sewage sludge at your facility?

_____ Option 1 (Minimum 38 percent reduction in volatile solids)
_____ Option 2 (Anaerobic process, with bench-scale demonstration)
_____ Option 3 (Aerobic process, with bench-scale demonstration)
_____ Option 4 (Specific oxygen uptake rate for aerobically digested sludge)
_____ Option 5 (Aerobic processes plus raised temperature)
_____ Option 6 (Raise pH to 12 and retain at 11.5)
_____ Option 7 (75 percent solids with no unstabilized solids)
_____ Option 8 (90 percent solids with unstabilized solids)
_____ None or unknown

d. Describe, on this form or another sheet of paper, any treatment processes used at your facility to reduce vector attraction properties of sewage sludge:

____
____
____
____

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

e. Describe, on this form or another sheet of paper, any other sewage sludge treatment (including blending) activities not identified in (a) - (d) above:

____

____

____

____

Complete Section B.4 if sewage sludge from your facility meets the pollutant concentrations in Table 3 of 40 CFR 503.13, the Class A pathogen reduction requirements in §503.32(a), and one of the vector attraction reduction requirements in §503.33(b)(1)-(8). Skip this section if sewage sludge from your facility does not meet all of these criteria.

B.4. Preparation of Sewage Sludge Meeting Pollutant Concentrations, Class A Pathogen Requirements, and One of Vector Attraction Reduction Options 1-8.

a. Total dry metric tons per 365-day period of sewage sludge subject to this section that is applied to the land: ______________

b. Is sewage sludge subject to this section placed in bags or other containers for sale or give-away?

_____ Yes _____ No

c. Is sewage sludge subject to this section provided to another facility for distribution (including placement in a bag or other container for sale or give-away)?

_____ Yes _____ No

If yes, provide the following information if available for each facility distributing this sewage sludge:

Name of facility: ______________________________

Facility contact. Name: ______________________________

Title: ______________________________

Phone: (   ) ______________

Street or P.O. Box: ______________________________

City or Town: ______________ State: _____ Zip: __________

List, on this form or an attachment, the receiving facility's NPDES permit number, as well as the numbers of all other Federal, State, and local permits that regulate the receiving facility's sewage sludge management practices:

Permit Number:	Type of Permit:

Complete Section B.5 if you place sewage sludge in a bag or other container for sale or give-away prior to land application. Skip this section if the sewage sludge is covered in Section B.4.

B.5. Sale or Give-Away in a Bag or Other Container.

a. Total dry metric tons per 365-day period of sewage sludge placed in a bag or other container at your facility for sale or give-away: ______________

b. Attach, with this application, a copy of all labels or notices that accompany the sewage sludge being sold or given away in a bag or other container.

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

Complete Section B.6 if sewage sludge from your facility is provided to another facility that provides treatment *or* that places the sewage sludge in a bag or other container for sale or give-away. This section does not apply to sewage sludge sent directly to a land application or surface disposal site. Skip this section if the sewage sludge is covered in Sections B.4 or B.5. If you provide sewage sludge to more than one facility, attach additional pages as necessary.

B.6. Shipment Off Site for Treatment or for Sale or Give-Away.

a. Name of receiving facility: ______________________

b. Facility contact. Name: ______________________
Title: ______________________
Phone: (   ) ____________

c. Facility mailing address.
Street or P.O. Box: ______________________
City or Town: ____________ State: ____ Zip: ________

d. Total dry metric tons per 365-day period of sewage sludge provided to receiving facility: ____________

e. List, on this form or an attachment, the receiving facility's NPDES permit number, as well as the numbers of all other Federal, State, and local permits that regulate the receiving facility's sewage sludge management practices:

Permit Number:	Type of Permit:

f. Does the receiving facility provide additional treatment to reduce pathogens in sewage sludge from your facility? _____ Yes _____ No

Which class of pathogen reduction is achieved for the sewage sludge at the receiving facility?

_____ Class A _____ Class B _____ Neither or unknown

Describe, on this form or another sheet of paper, any treatment processes used at the receiving facility to reduce pathogens in sewage sludge:

____
____
____
____

g. Does the receiving facility provide additional treatment to reduce vector attraction characteristics of the sewage sludge? _____ Yes _____ No

Which vector attraction reduction option is met for the sewage sludge at the receiving facility?

_____ Option 1 (Minimum 38 percent reduction in volatile solids)
_____ Option 2 (Anaerobic process, with bench-scale demonstration)
_____ Option 3 (Aerobic process, with bench-scale demonstration)
_____ Option 4 (Specific oxygen uptake ratefor aerobically digested sludge)
_____ Option 5 (Aerobic processes plus raised temperature)
_____ Option 6 (Raise pH to 12 and retain at 11.5)
_____ Option 7 (75 percent solids with no unstabilized solids)
_____ Option 8 (90 percent solids with unstabilized solids)
_____ None

Describe, on this form or another sheet of paper, any treatment processes used at the receiving facility to reduce vector attraction properties of sewage sludge:

____
____
____
____

h. Does the receiving facility provide any additional treatment (including blending) activities not identified in (f) or (g) above? _____ Yes _____ No

If yes, describe—on this form or another sheet of paper—the treatment (including blending) activities not identified in (f) or (g) above:

____
____
____
____

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

i. If you answered yes to (f), (g), or (h), attach a copy of any information you provide the receiving facility to comply with the "notice and necessary information" requirement of 40 CFR 503.12(g).

j. Does the receiving facility place sewage sludge from your facility in a bag or other container for sale or give-away? _____ Yes _____ No

If yes, provide a copy of all labels or notices that accompany the product being sold or given away.

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

Complete Section B.7 if sewage sludge from your facility is applied to the land, unless the sewage sludge is covered in:

- **Section B.4 (it meets Table 3 pollutant concentrations, Class A pathogen requirements, and one of vector attraction reduction options 1-8); or**
- **Section B.5 (you place it in a bag or other container for sale or give-away); or**
- **Section B.6 (you send it to another facility for treatment or for sale or give-away).**

B.7. Land Application of Bulk Sewage Sludge.

a. Total dry metric tons per 365-day period of sewage sludge applied to all land application sites: ______________

b. Nitrogen content in the sewage sludge that is applied to the land in bulk form, expressed as percent dry weight or mg/kg dry weight:

	Content	Units
Ammonium nitrogen:	______	______
Nitrate nitrogen:	______	______
Total Kjeldahl nitrogen (TKN):	______	______

c. Do you identify all land application sites in Section C of this application?

_____ Yes _____ No

If no, submit a copy of the land application plan with this application (see instructions).

d. Are any land application sites located in States other than the State where you generate sewage sludge or derive a material from sewage sludge?

_____ Yes _____ No

If yes, describe—on this form or another sheet of paper—how you notify the permitting authority for the States where the land application sites are located. Provide a copy of the notification.

____

____

____

____

Complete Section B.8 if sewage sludge from your facility is placed on a surface disposal site.

B.8. Surface Disposal.

a. Total dry metric tons of sewage sludge from your facility placed on all surface disposal sites per 365-day period: ______________

b. Do you own or operate all surface disposal sites to which you send sewage sludge for disposal?

_____ Yes _____ No

If no, answer B.8.c - B.8.h for each surface disposal site that you do not own or operate. If you send sewage sludge to more than one such surface disposal site, attach additional pages as necessary.

c. Site name or number: ______________________________

d. Site contact. Name: ______________________________
Title: ______________________________
Phone: ( ) ______________
Contact is: _____ Site owner _____ Site operator

e. Site mailing address.
Street or P.O. Box: ______________________________
City or Town: ______________ State: _____ Zip: __________

f. Site location.
Street or Route #: ______________________________
County: ______________________________
City or Town: ______________ State: _____ Zip: __________

g. Total dry metric tons of sewage sludge from your facility placed on this surface disposal site per 365-day period: ______________

h. List, on this form or an attachment, the site's NPDES permit number, as well as the numbers of all other Federal, State, and local permits that regulate sewage sludge disposal at the site:

Permit Number:	Type of Permit:
______________	______________________
______________	______________________
______________	______________________

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

Complete Section B.9 if sewage sludge from your facility is fired in a sewage sludge incinerator.

B.9. Incineration.

a. Total dry metric tons of sewage sludge from your facility fired in all sewage sludge incinerators per 365-day period: ________________

b. Do you own or operate all sewage sludge incinerators in which sewage sludge from your facility is fired?

_____ Yes _____ No

If no, complete B.9.c - B.9.h for each sewage sludge incinerator that you do not own or operate. If you send sewage sludge to more than one such sewage sludge incinerator, attach additional pages as necessary.

c. Incinerator name or number: ________________________________

d. Incinerator contact. Name: ________________________________

Title: ________________________________

Phone: ( ) ______________

Contact is incinerator: _____ Owner _____ Operator

e. Incinerator mailing address.

Street or P.O. Box: ________________________________

City or Town: ________________ State: _____ Zip: __________

f. Incinerator location.

Street or Route #: ________________________________

County: ________________________________

City or Town: ________________ State: _____ Zip: __________

g. Total dry metric tons of sewage sludge from your facility fired in this sewage sludge incinerator per 365-day period: ________________

h. List, on this form or an attachment, the numbers of all other Federal, State, and local permits that regulate the firing of sewage sludge in this incinerator:

Permit Number:	Type of Permit:

Complete Section B.10 if sewage sludge from this facility is placed on a municipal solid waste landfill.

B.10. Disposal in a Municipal Solid Waste Landfill. *Provide the following information for each municipal solid waste landfill on which sewage sludge from your facility is placed. If sewage sludge is placed on more than one municipal solid waste landfill, attach additional pages as necessary.*

a. Name of landfill: ________________________________

b. Landfill contact. Name: ________________________________

Title: ________________________________

Phone: ( ) ______________

Contact is: _____ Landfill owner _____ Landfill operator

c. Mailing address for municipal solid waste landfill.

Street or P.O. Box: ________________________________

City or Town: ________________ State: _____ Zip: __________

d. Location of municipal solid waste landfill.

Street or Route #: ________________________________

County: ________________________________

City or Town: ________________ State: _____ Zip: __________

e. Total dry metric tons of sewage sludge from your facility placed in this municipal solid waste landfill per 365-day period: ________________

f. List, on this form or an attachment, the numbers of all other Federal, State, and local permits that regulate the operation of this municipal solid waste landfill:

Permit Number:	Type of Permit:

g. Submit, with this application, information to determine whether the sewage sludge meets applicable requirements for disposal of sewage sludge in a municipal solid waste landfill (e.g., results of paint filter liquids test and TCLP test).

h. Does the municipal solid waste landfill comply with applicable criteria set forth in 40 CFR Part 258?

_____ Yes _____ No

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

C. LAND APPLICATION OF BULK SEWAGE SLUDGE

Complete Section C for sewage sludge that is applied to the land, unless any of the following conditions apply:

- **The sewage sludge meets the Table 3 pollutant concentrations, Class A pathogen requirements, and one of vector attraction reduction options 1-8 *(fill out B.4 instead)*; or**
- **The sewage sludge is sold or given away in a bag or other container *(fill out B.5 instead)*; or**
- **You provide the sewage sludge to another facility for treatment or placement in a bag or other container *(fill out B.6 instead)*.**

In other words, complete Section C only for the sewage sludge that you reported in Section B.7.

C.1. Identification of Land Application Site.

a. Site name or number: ____________________

b. Site location.
Street or Route #: ____________________
County: ____________________
City or Town: ____________ State: _____ Zip: ________

Latitude: __________ Longitude: __________

C.2. Owner Information.

a. Are you the owner of this land application site? _____ Yes _____ No

b. If no, provide the following information for the owner:

Name: ____________________
Phone: (   ) __________
Street or P.O. Box: ____________________
City or Town: ____________ State: _____ Zip: ________

C.3. Applier Information.

a. Are you the person who applies, or who is responsible for application of, sewage sludge to this land application site? _____ Yes _____ No

b. If no, provide the following information for the person who applies:
Name: ____________________
Phone: (   ) __________
Street or P.O. Box: ____________________
City or Town: ____________ State: _____ Zip: ________

C.4. Site Type. Identify the type of land application site from among the following:

_____ Agricultural land
_____ Forest
_____ Public contact site
_____ Reclamation site
_____ Lawn or home garden
_____ Other. If other, specify:
____
____

C.5. Crop or Other Vegetation.

a. What type of crop or other vegetation is grown on this site?

____
____

b. What is the nitrogen requirement for this crop or vegetation?

____
____

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

C.6. Vector Attraction Reduction.

Are any vector attraction reduction requirements met when sewage sludge is applied to the land application site?

_____ Yes _____ No

If yes, answer C.6.a and C.6.b:

a. *Indicate which vector attraction reduction option is met:*

_____ Option 9 (Injection below land surface)
_____ Option 10 (Incorporation into soil within 6 hours)

b. Describe, on this form or another sheet of paper, any treatment processes used at the land application site to reduce vector attraction properties of sewage sludge:

____
____
____
____

C.7. Ground-Water Monitoring.

Are any ground-water monitoring data available for this land application site?

_____ Yes _____ No

If yes, submit the ground-water monitoring data with this permit application. Also submit a written description of the well locations, approximate depth to ground water, and the ground-water monitoring procedures used to obtain these data.

FACILITY NAME: | **PERMIT NUMBER:** | **EPA ID NUMBER:** *(for official use only)*

Complete Question C.8 only if the sewage sludge applied to this site since July 20, 1993, is subject to the cumulative pollutant loading rates (CPLRs) in 40 CFR 503.13(b)(2) (see instructions).

C.8. Cumulative Loadings and Remaining Allotments.

a. Have you contacted the permitting authority in the State where the bulk sewage sludge subject to CPLRs will be applied, to ascertain whether bulk sewage sludge subject to CPLRs has been applied to this site on or since July 20, 1993?

_____ Yes _____ No

If no, sewage sludge subject to CPLRs may not be applied to this site.
If yes, continue on to the next question.

b. Based upon this inquiry, has bulk sewage sludge subject to CPLRs been applied to this site since July 20, 1993?

_____ Yes _____ No

If no, skip the rest of this section.
If yes, answer questions C.8.c - C.8.g.

c. Site size, in hectares: _______________

d. Dry metric tons of sewage sludge per hectare from your facility applied to this site, per 365-day period: _______________

e. Total dry metric tons of sewage sludge per hectare from your facility applied to this site, over the life of the site: _______________

f. Provide the following information for every facility other than yours that is sending, or has sent, bulk sewage sludge subject to CPLRs to this site since July 20, 1993. If more than one such facility sends sewage sludge to this site, attach additional pages as necessary.

Name of facility: _______________
Facility contact. Name: _______________
Title: _______________
Phone: ( ) _______________
Facility mailing address.
Street or P.O. Box: _______________
City or Town: _______________ State: _____ Zip: _______________

g. Provide the total loading and allotment remaining, in kg/hectare, for each of the following pollutants:

	Cumulative loading	Allotment remaining
Arsenic	_______	_______
Cadmium	_______	_______
Chromium	_______	_______
Copper	_______	_______
Lead	_______	_______
Mercury	_______	_______
Molybdenum	_______	_______
Nickel	_______	_______
Selenium	_______	_______
Zinc	_______	_______

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

D. SURFACE DISPOSAL

Complete this section if you own or operate a surface disposal site.

Complete Section D.1 once for each surface disposal site that you own or operate.

D.1. Site Information. Provide the following information for the surface disposal site:

a. Site name or number: ______________________

b. Are you the owner of this surface disposal site? _____ Yes _____ No

If no, provide the following information:

Name of owner: ______________________

Facility contact. Name: ______________________

Title: ______________________

Phone: ( ) ____________

Owner mailing address.

Street or P.O. Box: ______________________

City or Town: ____________ State: _____ Zip: ________

c. Are you the operator of this surface disposal site? _____ Yes _____ No

If no, provide the following information:

Name of operator: ______________________

Facility contact. Name: ______________________

Title: ______________________

Phone: ( ) ____________

Operator mailing address.

Street or P.O. Box: ______________________

City or Town: ____________ State: _____ Zip: ________

Facility location.

Street or Route #: ______________________

County: ______________________

City or Town: ____________ State: _____ Zip: ________

FACILITY NAME: | **PERMIT NUMBER:** | **EPA ID NUMBER:** *(for official use only)*

Complete Sections D.2 - D.6 for each active sewage sludge unit.

D.2. Information on Active Sewage Sludge Units.

a. Unit name or number: ______________________

b. Total dry metric tons of sewage sludge placed on the active sewage sludge unit per 365-day period: ____________

c. Does the active sewage sludge unit have a liner with a minimum hydraulic conductivity of 1 x 10^{-7} cm/sec? _____ Yes _____ No

If yes, describe the liner (or attach a description):

____

____

____

d. Does the active sewage sludge unit have a leachate collection system?

_____ Yes _____ No

If yes, describe the leachate collection system (or attach a description). Also describe the method used for leachate disposal and provide the numbers of any Federal, State, or local permit(s) for leachate disposal:

____

____

____

e. If you answered no to either D.2.c or D.2.d, answer the following question:

Is the boundary of the active sewage sludge unit less than 150 meters from the property line of the surface disposal site? _____ Yes _____ No

If yes, provide the actual distance in meters: ____________

D.3. Sewage Sludge from Other Facilities. Is sewage sludge sent to this active sewage sludge unit from any facilities other than your facility?

_____ Yes _____ No

If yes, provide the following information for each such facility. If sewage sludge is sent to this active sewage sludge unit from more than one such facility, attach additional pages as necessary.

a. Name of facility: ______________________

b. Facility contact. Name: ______________________

Title: ______________________

Phone: ( ) ____________

c. Facility mailing address.

Street or P.O. Box: ______________________

City or Town: ____________ State: _____ Zip: ________

d. List, on this form or an attachment, the facility's NPDES permit number, as well as the numbers of all other Federal, State, and local permits that regulate the facility's sewage sludge management practices:

<u>Permit Number</u>:	<u>Type of Permit</u>:
____________	______________________
____________	______________________
____________	______________________

e. Which class of pathogen reduction is achieved before sewage sludge leaves the other facility?

_____ Class A _____ Class B _____ None or unknown

f. Describe, on this form or another sheet of paper, any treatment processes used at the other facility to reduce pathogens in sewage sludge:

____

____

____

FACILITY NAME:	PERMIT NUMBER:	EPA ID NUMBER: *(for official use only)*

g. Which vector attraction reduction option is achieved before sewage sludge leaves the other facility?

_____ Option 1 (Minimum 38 percent reduction in volatile solids)
_____ Option 2 (Anaerobic process, with bench-scale demonstration)
_____ Option 3 (Aerobic process, with bench-scale demonstration)
_____ Option 4 (Specific oxygen uptake rate for aerobically digested sludge)
_____ Option 5 (Aerobic processes plus raised temperature)
_____ Option 6 (Raise pH to 12 and retain at 11.5)
_____ Option 7 (75 percent solids with no unstabilized solids)
_____ Option 8 (90 percent solids with unstabilized solids)
_____ None or unknown

h. Describe, on this form or another sheet of paper, any treatment processes used at the other facility to reduce vector attraction properties of sewage sludge:

____
____
____

i. Describe, on this form or another sheet of paper, any other sewage sludge treatment activities performed by the other facility that are not identified in (e) - (h) above:

____
____
____

D.4. Vector Attraction Reduction.

a. Which vector attraction reduction option, if any, is met when sewage sludge is placed on this active sewage sludge unit?

_____ Option 9 (Injection below land surface)
_____ Option 10 (Incorporation into soil within 6 hours)
_____ Option 11 (Covering active sewage sludge unit daily)

b. Describe, on this form or another sheet of paper, any treatment processes used at the active sewage sludge unit to reduce vector attraction properties of sewage sludge:

____
____
____

D.5. Ground-Water Monitoring.

a. Is ground-water monitoring currently conducted at this active sewage sludge unit, or are ground-water monitoring data otherwise available for this active sewage sludge unit ?

_____ Yes _____ No

If yes, provide a copy of available ground-water monitoring data. Also provide a written description of the well locations, the approximate depth to ground water, and the ground-water monitoring procedures used to obtain these data.

____
____
____

b. Has a ground-water monitoring program been prepared for this active sewage sludge unit?

_____ Yes _____ No

If yes, submit a copy of the ground-water monitoring program with this permit application.

c. Have you obtained a certification from a qualified ground-water scientist that the aquifer below the active sewage sludge unit has not been contaminated?

_____ Yes _____ No

If yes, submit a copy of the certification with this permit application.

D.6. Site-Specific Limits. Are you seeking site-specific permit limits for the sewage sludge placed on the active sewage sludge unit?

_____ Yes _____ No

If yes, submit information to support the request for site-specific pollutant limits with this application.

FACILITY NAME: PERMIT NUMBER: EPA ID NUMBER: *(for official use only)*

E. INCINERATION

Complete this section if you fire sewage sludge in a sewage sludge incinerator.

Complete this section once for each incinerator in which you fire sewage sludge. If you fire sewage sludge in more than one sewage sludge incinerator, attach additional copies of this section as necessary.

E.1. Incinerator Identification. Provide the following information for the sewage sludge incinerator:

a. Incinerator name or number: ____________________

b. Are you the owner of this sewage sludge incinerator? _____ Yes _____ No

If no, provide the following information:
Name of owner: ____________________
Facility contact. Name: ____________________
Title: ____________________
Phone: ( ) ____________

Owner mailing address.
Street or P.O. Box: ____________________
City or Town: ____________ State: _____ Zip: ________

c. Are you the operator of this sewage sludge incinerator? _____ Yes _____ No

If no, provide the following information:
Name of operator: ____________________
Facility contact. Name: ____________________
Title: ____________________
Phone: ( ) ____________

Operator mailing address.
Street or P.O. Box: ____________________
City or Town: ____________ State: _____ Zip: ________

Facility location.
Street or Route #: ____________________
County: ____________________
City or Town: ____________ State: _____ Zip: ________

E.2. Amount Fired. Dry metric tons per 365-day period of sewage sludge fired in the sewage sludge incinerator:

____

E.3. Beryllium NESHAP.

a. Is the sewage sludge fired in this incinerator "beryllium-containing waste," as *defined in the instructions?*

_____ Yes _____ No

Submit, with this application, information, test data, and description of measures taken that demonstrate whether the sewage sludge incinerated is beryllium-containing waste, and will continue to remain as such.

b. If the answer to (a) is yes, submit—with this application—a complete report of the latest beryllium emission rate testing and documentation of ongoing incinerator operating parameters indicating that the NESHAP emission rate limit for beryllium has been and will continue to be met.

E.4. Mercury NESHAP.

a. How is compliance with the mercury NESHAP being demonstrated?
_____ Stack testing (if checked, complete E.4.b)
_____ Sewage sludge sampling (if checked, complete E.4.c)

b. If stack testing is conducted, submit the following information with this application:

- A complete report of stack testing and documentation of ongoing incinerator operating parameters indicating that the incinerator has met, and will continue to meet, the mercury NESHAP emission rate limit.
- Copies of mercury emission rate tests for the two most recent years in which testing was conducted.

c. If sewage sludge sampling is used to demonstrate compliance, submit a complete report of sewage sludge sampling and documentation of ongoing incinerator operating parameters indicating that the incinerator has met, and will continue to meet, the mercury NESHAP emission rate limit.

E.5. Dispersion Factor.

a. Dispersion factor, in micrograms/cubic meter per gram/second: ______________

b. Name and type of dispersion model: ______________________________

c. Submit a copy of the modeling results and supporting documentation with this application.

E.6. Control Efficiency.

a. Control efficiency, in hundredths, for the following pollutants:

Arsenic:	________	Lead:	________
Cadmium:	________	Nickel:	________
Chromium:	________		

b. Submit a copy of the results of performance testing and supporting documentation (including testing dates) with this application.

E.7. Risk Specific Concentration for Chromium.

a. Risk specific concentration (RSC) used for chromium, in micrograms per cubic meter: ________

b. Which basis was used to determine the RSC?
_____ Table 2 in 40 CFR 503.43
_____ Equation 6 in 40 CFR 503.43 (site-specific determination)

c. If Table 2 was used, identify the type of incinerator used as the basis:
_____ Fluidized bed with wet scrubber
_____ Fluidized bed with wet scrubber and wet electrostatic precipitator
_____ Other types with wet scrubber
_____ Other types with wet scrubber and wet electrostatic precipitator

d. If Equation 6 was used, provide the following:

Decimal fraction of hexavalent chromium concentration to total chromium concentration in stack exit gas: ________

Submit results of incinerator stack tests for hexavalent and total chromium concentrations, including date(s) of test, with this application.

E.8. Operational Standard for Total Hydrocarbons (THC).

a. Raw value for THC concentration in stack emissions, in ppm: ________
b. Moisture content in stack gas, in percent: ________
c. Oxygen concentration in stack gas, in percent: ________
d. Corrected value for THC concentration in stack emissions, in ppm: ________

e. Submit, with this application, documentation used to derive raw THC concentration, moisture content, oxygen concentration, and corrected THC concentration.

E.9. Operating Parameters.

a. Incinerator type: ______________________________

b. Combustion temperature: ______________________________

Submit, with this application, supporting documentation such as testing date(s), a description of temperature measurement and data recording and handling systems, and a description of how such combustion temperature data have been averaged.

c. Sewage sludge feed rate, in dry metric tons/day: ____________

Indicate whether value submitted is:
_____ Average use _____ Maximum design

Submit, with this application, supporting documentation describing how the feed rate was calculated.

d. Incinerator stack height, in meters: ______________

Indicate whether value submitted is:
_____ Actual stack height _____ Creditable stack height

e. Submit, with this application, information documenting the operating parameters for the air pollution control device(s) used for this sewage sludge incinerator.

E.10. Monitoring Equipment. List the equipment in place to monitor the following parameters:

a. Total hydrocarbons: ______________________________
b. Percent oxygen: ______________________________
c. Moisture content: ______________________________
d. Combustion temperature: ______________________________
e. Other: ______________________________

E.11. Air Pollution Control Equipment. Submit, with this application, a list of all air pollution control equipment used with this sewage sludge incinerator.

FACILITY NAME:	**PERMIT NUMBER:**	**EPA ID NUMBER:** *(for official use only)*

F. CERTIFICATION

All applicants must sign the certification in this section.

Read and submit the following certification statement with this application.

Refer to the instructions to determine who is an officer for purposes of this certification.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with the system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature of Officer: ______________________________

Name of Officer: ______________________________
(typed or printed)

Official Title of Officer: ______________________________

Telephone Number: ______________________________

Date Signed: ______________________________

APPENDIX G

SAMPLE PERMIT

Permit No.:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
DENVER PLACE
999 18TH STREET, SUITE 500
DENVER, COLORADO 80202-2466

AUTHORIZATION TO LAND APPLY/LANDFILL SLUDGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended, (33 U.S.C. §1251 et seq; the "Act"),

the

is authorized to Land Apply/Landfill Treated Sewage Sludge,

in accordance with application sites, specific limitations, monitoring requirements, management practices and other conditions set forth herein. Authorization to land apply sewage sludge is limited to the outfall specifically listed in the permit.

This permit shall become effective **July 1, 1994.**

This permit and the authorization to Land Apply/Landfill Treated Sewage Sludge shall expire at midnight, **March 31, 1999.**

Signed this **6th** day of **May 1994.**

Authorized Permitting Official

Max H. Dodson
Director
Water Management Division
Title

TABLE OF CONTENTS

I. SPECIFIC LIMITATIONS AND MONITORING REQUIREMENTS

A. Definitions.

1. "Animals" for the purposes of this permit are domestic livestock.

2. "Annual Whole Sludge Application Rate" is the amount of sewage sludge (dry-weight basis) that can be applied to a unit area of land during a cropping cycle.

3. "Agronomic Rate" is the whole sludge application rate (dry-weight basis) designed to: (1) provide the amount of nitrogen needed by the crop or vegetation grown on the land; and (2) minimize the amount of nitrogen in the sewage sludge that passes below the root zone of the crop or vegetation grown on the land to the ground water.

4. "Annual Pollutant Loading Rate" is the maximum amount of a pollutant (dry-weight basis) that can be applied to a unit area of land during a 365-day period.

5. "Application Site or Land Application Site" means all contiguous areas of a users' property intended for sludge application.

6. "Batch" is when a pile of sludge is created, allowed to sit for a specific period of time and then removed from the site. A batch of sludge could be compost piles or long-term treatment piles.

7. "Biosolids" means any sludge or material derived from sludge that can be beneficially used. Beneficial use includes, but is not limited to, land application to agricultural land, forest land, a reclamation site or sale or give away to the public for home lawn and garden use.

8. "Bulk Sewage Sludge" is sewage sludge that is not sold or given away in a bag or other container for application to the land.

9. "Composite Sludge Sample" is a sample taken either in a wastewater treatment process, dewatering facility, or application device consisting of a series of individual grab samples. For liquid sludges, a minimum of three grab samples of 500 milliliters taken during the first one-third, second one-third and final one-third of a pumping cycle and combined in equal volumetric amounts. For semi-dewatered, dewatered or dried sludge, a composite sample consisting of a minimum of three grab samples of 0.5 pounds taken over a period of 24 hours not less than two hours apart or another representative sample as defined or approved by the permitting authority.

A. Definitions. (Continued)

10. "Cumulative Pollutant Loading Rate" is the maximum amount of an inorganic pollutant (dry-weight basis) that can be applied to a unit area of land.

11. "CWA" means the Clean Water Act (formerly referred to as either the Federal Water Pollution Act or the Federal Water Pollution Control Act Amendments of 1972), Pub. L. 92-500, as amended by Pub. L. 95-217, Pub. L. 95-576, Pub. L. 96-483, Pub. L. 97-117, and Pub. L. 100-4.

12. "Daily Maximum" ("Daily Max.") is the maximum value allowable in any single sample or instantaneous measurement.

13. "Director" means Director of the United States Environmental Protection Agency, Water Management Division.

14. "Dry Weight-basis" means 100 percent solids (i.e., zero percent moisture).

15. "EPA" means the United States Environmental Protection Agency.

16. A "grab" sample, for monitoring requirements, is defined as a single "dip and take" sample collected at a representative point anywhere in wastewater treatment or sludge land application processes.

17. "Grit and Screenings" are sand, gravel, cinders, other materials with a high specific gravity and relatively large materials such as rags generated during preliminary treatment of domestic sewage at a treatment works and shall be disposed of according to 40 CFR 258.

18. "Ha" means hectare. One hectare is equal to 2.47 acres.

19. "High Potential for Public Contact Site" is land with a high potential for contact by the public. This includes, but is not limited to, public parks, ball fields, cemeteries, plant nurseries, turf farms, and golf courses.

20. An "instantaneous" measurement, for monitoring requirements, is defined as a single reading, observation, or measurement.

A. Definitions. (Continued)

21. "Land Application" is the spraying or spreading of sewage sludge onto the land surface; the injection of sewage sludge below the land surface; or the incorporation of sewage sludge into the land so that the sewage sludge can either condition the soil or fertilize crops or vegetation grown in the soil. Land application includes distribution and marketing (i.e. the selling or giving away of the sludge).

22. "Low Potential for Public Contact Site" is land with a low potential for contact by the public. This includes, but is not limited to, farms, ranches, reclamation areas, and other lands which are private lands, restricted public lands, or lands which are not generally accessible to or used by the public.

23. "Monthly Average" is the arithmetic mean of all measurements taken during the month.

24. "Paint Filter Test" is a test (SW 9095) where a predetermined amount of sludge is placed in a paint filter. If any portion of the material passes through the filter in a five minute test period, the material is deemed to contain free liquids.

25. "Pathogen" means an organism that is capable of producing an infection or disease in a susceptible host.

26. "PFRP" means Processes to Further Reduce Pathogens, as described in detail in 40 CFR Part 257, Appendix II and consists of composting, heat drying, heat treatment, thermophilic aerobic digestion, irradiation or pasteurization.

27. "Pollutant" for the purposes of this permit is an organic substance, an inorganic substance, a combination of organic and inorganic substances, or pathogenic organisms that, after discharge and upon exposure, ingestions, inhalation, or assimilation into an organism either directly from the environment or indirectly by ingestion through the food-chain, could, on the basis of information available to the Administrator of EPA, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunction in reproduction), or physical deformations in either organisms or offspring of the organisms.

A. Definitions. (Continued)

28. "Pollutant Limit" is a numerical value that describes the maximum amount of a pollutant allowed per unit amount of sewage sludge (e.g., milligrams per kilogram of total solids); the maximum amount of a pollutant that can be applied to a unit area of land (e.g., pounds per acre); the maximum density of a microorganism per unit amount of sewage sludge (e.g., Most Probable Number per gram of total solids); the maximum volume of a material that can be applied to a unit area of land (e.g., gallons per acre); or the maximum amount of pollutant allowed in plant tissue (e.g., parts per million).

29. "PSRP" means Processes to Significantly Reduce Pathogens, as described in detail in 40 CFR Part 257, Appendix II and consists of aerobic digestion, air drying, anaerobic digestion, composting, or lime stabilization.

30. "Runoff" is rainwater, leachate, or other liquid that drains overland on any part of a land surface and runs off of the land surface.

31. "Sewage Sludge" means solid, semi-solid, or liquid residue generated during the treatment of domestic sewage and/or a combination of domestic sewage and industrial waste of a liquid nature in a Treatment Works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the incineration of sewage sludge or grit and screenings generated during preliminary treatment of domestic sewage in a Treatment Works. These must be disposed of in accordance with 40 CFR 258.

32. "Similar Container" is either an open or closed receptacle. This includes, but is not limited to, a bucket, a box, a carton, and a vehicle or trailer with a load capacity of one metric ton or less.

33. "Specific Oxygen Uptake Rate (SOUR)" is the mass of oxygen consumed per unit time per unit mass of total solids (dry weight basis) in the sewage sludge.

34. "Total Solids" are the materials in the sewage sludge that remain as residue if the sludge is dried at 103 to 105 degrees Celsius.

A. Definitions. (Continued)

35. "Toxicity Characteristic Leaching Procedure" is test method (Method 1311) used to determine the mobility of both organic and inorganic pollutants present in liquid, solid and multiphasic wastes.

36. "Treatment Works" are either Federally owned, publicly owned, or privately owned devices or systems used to treat (including recycling and reclamation) either domestic sewage or a combination of domestic sewage and industrial waste of a liquid nature.

37. "Unstabilized Solids" are organic materials in sewage sludge that have not been treated in either an aerobic or anaerobic treatment process.

38. "Vector Attraction" is the characteristic of sewage sludge that attracts rodents, flies, mosquitos or other organisms capable of transporting infectious agents.

39. "Volatile Solids" is the amount of the total solids in sewage sludge lost when the sludge is combusted at 550 degrees Celsius for 15-20 minutes in the presence of excess air.

B. Description of Sludge Generation, Treatment and Use/Disposal

The authorization to land apply treated sewage sludge provided under this permit is limited to those sludges produced from the treatment works owned and operated by the City of and specifically designated below.

1. Description of Sludge Generating Facilities

Outfall Serial Number(s)	Description of Sludge Source
201	Sludge produced at the City of treatment works is gravity thickened, anaerobically digested and land applied to agricultural land during most of the year.
202	In the winter the sludge is anaerobically digested, dewatered with a belt filter press and landfilled.

2. Change in Treatment System or Use/Disposal Practice

The permittee must inform the EPA and the Department of Environment and Natural Resources at least 180 days prior to any significant change in the sludge generation and handling processes at the plant and any major change in use/disposal practices. This includes, but is not limited to, the addition or removal of sludge treatment units (e.g., digesters, drying beds, etc.) and/or any other change which would require a major modification of the permit (e.g., changing from land application to surface disposal).

C. Specific Limitations and Self-Monitoring Requirements

1. Outfall 201

All sludge generated by this facility to be used for land application shall meet the requirements of Part I.C.1.a, b and c listed below. These limits are effective immediately. However, if significant construction is necessary to meet these limits, then they must be achieved by February 19, 1995.

a. Chemical Pollutant Limitations

1) If the sludge is to be land applied to agricultural land, forest land, a public contact site or a reclamation site it must meet at all times:

a) The maximum pollutant concentrations listed in Table 1 and the cumulative pollutant loadings in Table 2; or

b) The maximum pollutant concentrations in Table 1 and the monthly average pollutant concentrations in Table 3.

If the sludge does not meet these requirements it cannot be land applied.

2) If the sludge is to be sold or given away in a bag or similar enclosure for application to the land for other than lawn or home garden use it shall meet:

a) The maximum pollutant concentrations in Table 1 and the annual pollutant loading rates in Table 4; or

b) The maximum pollutant concentrations in Table 1 and the monthly average pollutant concentrations in Table 3.

If the sludge does not meet these requirements it cannot be sold or given away for land application.

3) If the sludge is to be applied to a lawn or home garden it shall meet:

a) The monthly average pollutant concentrations in Table 3.

If the sludge does not meet these requirements it cannot be sold or given away for application to a lawn or home garden.

C. <u>Specific Limitations and Self-Monitoring Requirements</u> (Continued)

1. Outfall 201 (Continued)

a. Chemical Pollutant Limitations (Continued) c/

	Table 1	Table 2	Table 3	Table 4
	Daily Maximum mg/Kg a/b/	Cumulative Loading Kg/Ha	Monthly Average mg/Kg a/d/	Annual Loading Kg/Ha/365 Day Period
Total Arsenic	75	41	41	2.0
Total Cadmium	85	39	39	1.9
Total Chromium	3000	3000	1200	150
Total Copper	4300	1500	1500	75
Total Lead	840	300	300	15
Total Mercury	57	17	17	0.85
Total Molybdenum	75	N/A	N/A	N/A
Total Nickel	420	420	420	21
Total Selenium	100	100	36	5.0
Total Zinc	7500	2800	2800	140

a/ See Part I.A. for definition of terms.

b/ The limitations represent maximum allowable levels of pollutants in any sludge generated at Outfall 201 intended for land application.

c/ Dry-weight Basis.

d/ These limitations represent the maximum allowable levels of pollutants based on an average of all samples taken during a 30-day period in any sludge generated at Outfall 201 intended for land application.

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

b. Pathogen Limitations

If the sludge is to be land applied to agricultural land, forest land, a public contact site or a reclamation site it shall be either Class A or Class B (including the site restrictions) as described below. If the sludge does not meet Class B it cannot be land applied.

If the sludge is to be sold or given away in a bag or similar enclosure for application to land or for use on a lawn or home garden it shall be Class A as described below.

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

b. Pathogen Limitations (Continued)

1) Class A Pathogen Requirements a/

Fecal Coliform and Salmonella Limits		Process Requirements (One of the following):
Fecal Coliforms shall be < 1000 MPN/gram of total solids b/ **OR** *Salmonella* shall be < 3 MPN/4 grams of total solids b/	**AND**	1. Composting using either the within-vessel or static aerated pile composting method, the temperature of the sludge while in the composting process is maintained at 55°C or higher for three days. 2. Composting using the windrow method, the temperature of the windrowed sludge shall be maintained at 55°C or higher for 15 days or longer, with a minimum of 5 turnings of the pile during those 15 days.

a/ There are additional pathogen reduction and vector attraction reduction alternatives available in 40 CFR 503.32 and 40 CFR 503.33. If the permittee intends to use one of these alternatives the EPA and the State of must be informed at least 30 days prior to its use. This change may be made without additional public notice.

b/ Based on a geometric mean of a minimum of seven (7) samples of sludge collected over a two week period (or as approved by the permitting authority in your sampling and analysis plan, if you were required to have one).

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

b. Pathogen Limitations (Continued)

2) Class B Pathogen Requirements a/

Fecal Coliform Limit		Process Requirements (One of the following):
Fecal Coliforms shall be < 2,000,000 MPN or CFU/gram of total solids b/	**OR**	1. The sludge is anaerobically digested between these times specified: 15 days at 35-55°C and 60 days at 20°C. 2. Composting using the within-vessel, static pile or windrow methods, the temperature while in the composting process shall be maintained at 40°C or higher for 5 days. During those 5 days the temperature in the pile shall exceed 55°C for 4 hours.

a/ There are additional pathogen reduction and vector attraction reduction alternatives available in 40 CFR 503.32 and 40 CFR 503.33. If the permittee intends to use one of these alternatives the EPA and the State of must be informed at least 30 days prior to its use. This change may be made without additional public notice.

b/ Based on a geometric mean of a minimum of seven (7) samples of sludge collected over a two week period (or as approved by the permitting authority in your sampling and analysis plan, if you were required to have one).

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

b. Pathogen Limitations (Continued)

3) Site Restrictions

If the sludge is **Class B** with respect to pathogens, the permittee shall comply with all of the site restrictions listed below:

a) Food crops with harvested parts that touch the sludge/soil mixture and are totally above the land surface shall not be harvested for 14 months after application.

b) Food crops with harvested parts below the land surface shall not be harvested for 20 months after application if the sludge remains on the land surface for four months or more prior to incorporation into the soil.

c) Food crops with harvested parts below the land surface shall not be harvested for 38 months after application if the sludge remains on the land surface for less than four months prior to incorporation into the soil.

d) Other food crops and feed crops shall not be harvested from the land for 30 days after application.

e) Animals shall not be allowed to graze on the land for 30 days after application.

f) Turf grown on land where sludge is applied shall not be harvested for one year after application if the harvested turf is placed on either land with a high potential for public exposure or a lawn.

g) Public access to land with a high potential for public exposure shall be restricted for one year after application.

h) Public access to land with a low potential for public exposure shall be restricted for 30 days after application.

Specific Limitations and Self-Monitoring Requirements
(Continued)

1. Outfall 201 (Continued)

c. Vector Attraction Reduction Limitations

If the sludge is to be land applied to agricultural land, forest land, a public contact site or a reclamation site it shall meet one of the alternatives listed below.

If the sludge is to be sold or given away in a bag or similar enclosure for application to land or for use on a lawn or home garden it shall meet one of the first 4 alternatives listed below.

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

c. Vector Attraction Reduction Limitations (Continued) a/

1) The mass of volatile solids in the sludge shall be reduced by a minimum of 38 percent prior to land application.

2) If an anaerobically digested sludge cannot meet the 38 percent volatile solids reduction requirement, a portion of the previously digested sludge shall be digested anaerobically in the laboratory in a bench-scale unit for an additional 40 days at 30°C or higher. At the end of the 40 days, the volatile solids content shall have been reduced by no more than 17 additional percent.

3) The sludge shall be treated in an aerobic process for 14 days or longer with a temperature remaining above 40°C. The average temperature shall be greater than 45°C.

4) The pH of the sludge shall be raised to a minimum of 12 by alkali addition, but without the addition of more alkali, the pH shall remain at 12 or above for 2 hours and remain at a minimum of 11.5 for an additional 22 hours.

5) The sludge shall be injected below the surface of the land and no significant amount of sludge shall be present on the land surface within one hour after the sludge is injected. If the sludge meets the Class A pathogen requirements (Part I.C.1.b.1)), the sludge shall be injected below the land surface within 8 hours after the sludge is discharged from the pathogen reduction process.

a/ There are additional pathogen reduction and vector attraction reduction alternatives available in 40 CFR 503.32 and 40 CFR 503.33. If the permittee intends to use one of these alternatives the EPA and the State of must be informed at least 30 days prior to its use. This change may be made without additional public notice.

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

c. Vector Attraction Reduction Limitations (Continued) a/

6) Sludge applied to the land surface shall be incorporated into the soil within 6 hours after application to the land. Sewage sludge that is incorporated into the soil and meets the Class A pathogen requirements (Part I.C.1.b.1)) shall be applied to or placed on the land within 8 hours after being discharged from the pathogen treatment process.

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

d. Self-Monitoring Requirements

1) At a minimum, upon the effective date of this permit, all chemical pollutants, pathogens and applicable vector attraction reduction requirements shall be monitored on a **bimonthly** basis. Samples or measurements shall be representative of the nature of the sludge.

2) If this facility does not collect samples on a regular basis because sampling occurs from long-term treatment piles, compost piles, drying beds, etc. a sampling and analysis plan is to be prepared and submitted to the EPA and the State of within 90 days of issuance of this permit. If, when the permit was issued the permittee was not sampling in this manner but a change in process necessitated this form of sampling, then the plan must be submitted 30 days before the change occurs. This plan is to detail how representative samples are to be obtained and should include elements presented in Section 2.13 of the latest version of the Region VIII Biosolids Management Handbook. The number of samples collected will be at least as many as those that would be collected annually as required from the amount of sludge produced (i.e. six for this facility).

3) Deep soil monitoring for nitrate-nitrogen is required for all land application sites (does not apply to sludge that is sold or given away in bags or similar containers). A minimum of six samples per 320 (or less) acre area are to be collected. These samples are to be collected down to either 5 feet or to the confining layer, whichever is shallower. Each one foot increment is to be composited with the other samples from the site and one analysis for nitrate is to be done for each increment. Samples are required to be taken once every five years for non-irrigated sites or annually for irrigated sites.

4) Soil monitoring for phosphorus (reported as P) is required for all land application sites (does not apply to sludge that is sold or given away). Six samples of one foot depth each are to be collected for each 320 acre area and composited. Samples are required to be taken once every five years for non-irrigated sites or annually for irrigated sites.

C. Specific Limitations and Self-Monitoring Requirements (Continued)

1. Outfall 201 (Continued)

d. Self-Monitoring Requirements

5) Sample collection, preservation and analysis shall be performed in a manner consistent with the requirements of 40 CFR Part 503 and/or other criteria specified in this permit. Metals analysis is to be performed using method SW 846 with method 3050 used for digestion. For the digestion procedure, an amount of sludge equivalent to one gram dry weight shall be used. The methods are also described in the latest version of the Region VIII Biosolids Management Handbook. Monitoring for soil nitrate and phosphorus is to be performed using the methods in *Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties*. Page, A. L., Ed., American Society of Agronomy and Soil Science Society of America, Madison, WI, 1982.

6) Material derived from a sludge that meets the chemical limitations in Table 3 (Part I.C.1.a.), the pathogen requirements in Part I.C.1.b. and one of the first 4 vector attraction reduction requirements in Part I.C.1.c. is not required to be monitored unless otherwise required by the permitting authority. **The sludge itself is required to be monitored as stated above.** The permitting authority may request additional monitoring for material derived from sludge if the data shows a potential for concern.

7) After two years of monitoring at the frequency specified, the permittee may request that the permitting authority reduce the sampling frequency for the chemical pollutants in Part I.C.1.a. The frequency cannot be reduced to less than once per year for land applied sludge for any parameter. The frequency also cannot be reduced for any of the pathogen or vector attraction reduction requirements listed in this permit.

8) If pollutant concentrations in the sludge no longer meet the limitations in Table 3, the limitations in Table 2 and/or Table 4 must be used. The permittee shall determine cumulative pollutant loadings and/or annual pollutant loadings for each land application site or for sludge that is sold or given away.

C. <u>Specific Limitations and Self-Monitoring Requirements</u> (Continued)

1. Outfall 201 (Continued)

d. Self-Monitoring Requirements

9) The permittee must provide written notification to the EPA and the State of   within 90 days of the effective date of the permit of the location of any present land application site where sludge subject to the cumulative pollutant loading rates has been applied. This same notification must be given for new sites as soon as possible, but in no case later than 30 days after the sludge sample was collected.

C. Specific Limitations and Self-Monitoring Requirements

2. Outfall 202

a. Chemical Pollutant Limitations

1) Sludge that is to be landfilled shall be in strict compliance with 40 CFR 258. It is the responsibility of the permittee to demonstrate that sludge disposal into the landfill is in accordance with 40 CFR 258 by submitting routine "Paint Filter Test" and "Toxicity Characteristic Leaching Procedure" results to the EPA.

2) The permittee shall report to the EPA the annual amount and percent solids of sludge transferred to the landfill.

C. Specific Limitations and Self-Monitoring Requirements (Continued)

2. Outfall 202 (Continued)

b. Vector Attraction Reduction Limitations

Sludge to be landfilled shall meet one of the alternatives listed in Part I.C.1.c. with this additional alternative: Sludge placed in a landfill shall be covered with soil or other material at the end of each operating day.

There are additional vector attraction reduction alternatives available in 40 CFR 503.33. If the permittee intends to use one of these alternatives the EPA must be informed at least 30 days prior to its use. **These limits are effective immediately. However, if construction is necessary to meet these limits, then they must be achieved by February 19, 1995.**

C. Specific Limitations and Self-Monitoring Requirements (Continued)

2. Outfall 202 (Continued)

c. Self-Monitoring Requirements

1) At a minimum, upon the effective date of this permit, the paint filter test, determination of percent solids and applicable vector attraction reduction requirements shall be monitored on a **bimonthly** basis. The toxicity characteristic leaching procedure shall be monitored **once during the life of the permit**. Samples or measurements shall be representative of the nature of the sludge.

2) Sample collection and preservation shall be performed in a manner consistent with the requirements of 40 CFR Part 503, 40 CFR 261 and/or other criteria specified in this permit.

D. <u>Management Practices</u>

1. Land Application Management Practices

If the sludge or material derived from sludge meets the metals limits in Table 3 (Part I.C.1.a.), the Class A pathogen reduction limits in Part I.C.1.b.1) and one of the first 4 vector attraction reduction alternatives in Part I.C.1.c., the following management practices are not required unless requested by the permitting authority through permit modification procedures under Part IV.O. of this permit.

The permittee shall operate and maintain the land application site operations in accordance with the following requirements:

a. The permittee shall provide to the EPA and the State of within 90 days of the effective date of this permit a land application plan. At a minimum, the plan is to include the components listed in section 2.3 of the latest version of the Region VIII Biosolids Management Handbook.

b. Application of sludge shall be conducted in a manner that will not contaminate the groundwater or impair the use classification for that water (if the State has classified it) underlying the sites. The permittee must submit information to the EPA indicating the State's classification for this groundwater.

c. Application of sludge shall be conducted in a manner that will not cause a violation of any receiving water quality standard from discharges of surface runoff from the land application sites. Sludge shall not be applied to land 10 meters or less from waters of the United States (as defined in 40 CFR 122.2).

d. Application of sludge shall be conducted in a manner that does not exceed the agronomic rate for available nitrogen of the crops grown on the site. At a minimum, the permittee is required to follow the methods for calculating agronomic rate outlined in the latest version of the Region VIII Biosolids Management Handbook (other methods may be approved by the permitting authority). The treatment plant shall provide written notification to the applier of the sludge of the concentration of total nitrogen (as N on a dry weight basis) in the sludge. Written permission from the permitting authority is required to exceed the agronomic rate.

e. Application of sludge to frozen, ice-covered, or snow covered sites where the slope of the site exceeds six percent is prohibited.

I. Management Practices (Continued)

1. Land Application Management Practices (Continued)

f. No person shall apply sludge for beneficial use to frozen, ice-covered, or snow-covered land where the slope of such land is greater than three percent and is less than or equal to six percent unless one of the following requirements is met:

   1) there is 80 percent vegetative ground cover; or,

   2) approval has been obtained based upon a plan demonstrating adequate runoff containment measures.

g. Sludge shall not be applied to sites where the available phosphorous content of the soil exceeds the following:

   1) for sodium bicarbonate extraction, 100 ppm;

   2) for AB-DPTA extraction, 50 ppm;

   3) for Bray P1 extraction, 170 ppm;

   4) available phosphorus levels shall be determined based upon the Bray P1 extraction when the soil pH is 6.5 or less.

   The permittee may request these limits be modified if different limits would be justified based on local conditions. The limits are required to be developed in cooperation with the local agricultural extension office or university.

h. Sludge shall not be applied to any site area with standing surface water. If the annual high groundwater level is known or suspected to be within five feet of the surface, additional deep soil monitoring for nitrate-nitrogen as described in Part I.C.1.d.3) is to be performed. At a minimum, this additional monitoring will involve a collection of more samples in the affected area and possibly more frequent sampling. The exact number of samples to be collected will be outlined in a deep soil monitoring plan to be submitted to the EPA and the State of within 90 days of the effective date of this permit. The plan is subject to approval by the permitting authority.

i. The specified cover crop shall be planted during the next available planting season. If this does not occur, the permittee shall notify the Director in writing. Additional restrictions may be placed on the application of the sludge on that site on a case-by-case basis to control nitrate movement. Deep soil monitoring may be increased under the discretion of the permitting authority.

C. Management Practices (Continued)

1. Land Application Management Practices (Continued)

j. The sludge or the application of the sludge shall not cause or contribute to the harm of a threatened or endangered species or result in the destruction or adverse modification of critical habitat of a threatened or endangered species after application.

k. When weather and or soil conditions prevent adherence to the sewage sludge application procedure, sewage sludge shall not be applied on the site.

l. For sludge that is sold or given away, either a label shall be affixed to the bag or similar enclosure or an information sheet shall be provided to the person who receives the sludge. The label or information sheet shall contain:

    1) The name and address of the person who prepared the sludge for sale or give away for application to the land.

    2) A statement that prohibits the application of the sludge to the land except in accordance with the instructions on the label or information sheet.

    3) The annual whole sludge application rate for the sludge that does not cause the annual pollutant loading rates in Table 4 (Part I.C.1.a.) to be exceeded.

m. Sludge subject to the cumulative pollutant loading rates in Table 2 (Part I.C.1.a.) shall not be applied to agricultural land, forest, a public contact site, or a reclamation site if any of the cumulative pollutant loading rates in Table 2 have been reached.

n. If the treatment plant applies the sludge, it shall provide the owner or lease holder of the land on which the sludge is applied notice and necessary information to comply with the requirements in this permit.

D. <u>Management Practices</u> (Continued)

1. Land Application Management Practices (Continued)

o. Before sludge subject to the cumulative pollutant loading rates in Table 2 (Part I.C.1.a.) is applied to the land, the person who proposes to apply the sludge shall contact the permitting authority to determine whether sludge subject to the cumulative pollutant loading rates in Table 2 has been applied to the site since July 19, 1993.

1) If sludge subject to the cumulative loading limits in Table 2 has not been applied since July 19, 1993, the cumulative amount for each pollutant listed in Table 2 may be applied to the site in accordance with Table 2.

2) If sludge subject to the cumulative loading limits in Table 2 has been applied since July 19, 1993, and the cumulative amount of each pollutant applied to the site in the sludge since that date is known, the cumulative amount of each pollutant applied to the site shall be used to determine the additional amount of each pollutant that can be applied to the site in accordance with Table 2.

3) If sludge subject to the cumulative loading limits in Table 2 has been applied since July 19, 1993, and the cumulative amount of each pollutant applied to the site in the bulk sewage sludge since that date is not known, an additional amount of each pollutant shall not be applied to the site.

p. For sludge or material derived from sludge that is stored in piles for one year or longer, measures shall be taken to ensure that erosion (whether by wind or water) does not occur. However, best management practices should also be used for piles used for sludge treatment. If a treatment pile is considered to have caused a problem, best management practices could be added as a requirement in the next permit renewal.

q. The permittee shall inspect the application of the sludge to active sites to prevent malfunctions and deterioration, operator errors and discharges which may cause or lead to the release of sludge to the environment or a threat to human health. The permittee must conduct these inspections often enough to identify problems in time to correct them before they harm human health or the environment. The permittee shall keep an inspection log or summary including at least the date and time of inspection, the printed name and the handwritten signature of the inspector, a notation of observations made and the date and nature of any repairs or corrective action.

D. Management Practices (Continued)

2. Landfilling Management Practices

The permittee shall follow these management practices:

a. Landfilling of sludge shall be conducted in a manner that will not contaminate the groundwater underlying the site.

b. Landfilling of sludge shall be conducted in a manner that will not cause a violation of any receiving water quality standard from discharges of surface runoff.

c. The landfilling of sludge shall not cause or contribute to the harm of a threatened or endangered species or result in the destruction or adverse modification of critical habitat of a threatened or endangered species.

d. Landfilling of sludge shall not restrict the flow of a 100-year flood.

e. Public access to the site shall be restricted so that the public is not exposed to potential health and safety hazards.

f. Explosive gases generated by the facility shall not exceed 25 percent of the lower explosive limit for the gases in the facility structures and 100 percent of the lower explosive limit at the property line.

E. Special Conditions on Sludge Storage

Permanent storage of sewage sludge is prohibited. Sludge shall not be temporarily stored for more than two years. Written permission to store sludge for more than two years must be obtained from the permitting authority. Storage of sludge for more than two years will be allowed only if it is determined that significant treatment is occurring.

F. Recordkeeping

1. Recordkeeping for Land Application

a. If the permittee **prepared material derived from sludge** that meets the limits in Table 3 (Part I.C.1.a.), the Class A pathogen requirements in Part I.C.1.b.1) and one of the first 4 vector attraction reduction alternatives in Part I.C.1.c., the permittee is not required to keep records on that material unless otherwise required by the permitting authority.

b. The permittee is required to keep the following information for at least 5 years:

1) Concentration of each pollutant in Table 1 (Part I.C.1.a.).

2) A description of how the pathogen reduction requirements in Part I.C.1.b. were met.

3) A description of how the vector attraction reduction requirements in Part I.C.1.c. were met.

4) A description of how the management practices in Part I.D. were met (if necessary).

5) A description of how the site restrictions in Part I.C.1.b.3) were met (if necessary).

F. Recordkeeping (Continued)

1. Recordkeeping for Land Application (Continued)

7) The following certification statement:

"I certify under the penalty of law, that the pathogen requirements in Part I.C.1.b., one of the vector attraction reduction alternatives in Part I.C.1.c., the management practices in Part I.D. (if necessary) and the site restrictions in Part I.C.1.b.3) (if necessary) have been met. This determination has been made under my direction and supervision in accordance with the system designed to assure that qualified personnel properly gather and evaluate the information used to determine that the pathogen requirements, the vector attraction reduction requirements, the management practices and the site restrictions have been met. I am aware that there are significant penalties for false certification including the possibility of imprisonment."

2. Landfill Recordkeeping

a. The permittee is required to keep the following information for at least 5 years:

1) Results of the paint filter tests, determination of percent solids and toxicity characteristic leaching procedure tests (Part I.C.2.a.).

2) A description of how the vector attraction reduction requirements in Part I.C.2.b. were met.

3) A description of how the management practices in Part I.D. were met.

E. Recordkeeping (Continued)

2. Landfill Recordkeeping (Continued)

4) The following certification statement:

"I certify under the penalty of law, that the paint filter tests and toxicity characteristic leaching procedure tests Part I.C.2.a., one of the vector attraction reduction alternatives in Part I.C.2.b. and the management practices in Part I.D. have been met. This determination has been made under my direction and supervision in accordance with the system designed to assure that qualified personnel properly gather and evaluate the information used to determine that the pathogen requirements, the vector attraction reduction requirements, the management practices and the site restrictions have been met. I am aware that there are significant penalties for false certification including the possibility of imprisonment."

3. Records of monitoring information shall include:

a. The date, exact place, and time of sampling or measurements;

b. The initials or name(s) of the individual(s) who performed the sampling or measurements;

c. The date(s) analyses were performed;

d. The time(s) analyses were initiated;

e. The initials or name(s) of individual(s) who performed the analyses;

f. References and written procedures, when available, for the analytical techniques or methods used; and,

g. The results of such analyses, including the bench sheets, instrument readouts, computer disks or tapes, etc., used to determine these results.

E. Recordkeeping (Continued)

4. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit and records of all data used to complete the application for this permit for the life of the permit. Data collected on site, copies of Sludge Report forms, and a copy of this NPDES sludge-only permit must be maintained on site during the duration of activity at the permitted location.

II. MONITORING, RECORDING AND REPORTING REQUIREMENTS

A. Representative Sampling. Sludge samples used to measure compliance with Part I of this Permit shall be collected at locations representative of the quality of sludge generated at the treatment works and immediately prior to land application.

B. Monitoring Procedures. Monitoring must be conducted according to test procedures approved under 40 CFR Part 503 unless other test procedures have been specified in this permit. See Part I.C. for any applicable sludge monitoring procedures.

C. Penalties for Tampering. The Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than two years per violation, or by both. Second conviction is punishable by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four years, or both.

D. Reporting of Monitoring Results.

The permittee shall provide the results of all monitoring performed in accordance with Part I.C., and information on management practices, land application sites, site restrictions and certifications shall be provided no later than **February 19** of each year. Each report is for the previous calendar year. If no sludge was applied to the land during the reporting period, "no sludge was applied" shall be reported. Until further notice, sludge monitoring results may be reported in the testing laboratory's normal format (there is no EPA standard form at this time), but should be on letter size pages. Legible copies of these, and all other reports required herein, shall be signed and certified in accordance with the Signatory Requirements (see Part IV), and submitted to the Director, Water Management Division and the Department of Environment and Natural Resources at the following addresses:

D. <u>Reporting of Monitoring Results</u> (Continued)

original to: United States Environmental
Protection Agency
Region VIII
Denver Place
999 18th Street, Suite 500
Denver, Colorado 80202-2466

Attention: Water Management Division
Regional Sludge Program,
NPDES Branch (8WM-C)

copy to:

E. Additional Monitoring by the Permittee. If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR 503 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted on the Sludge Report form. Such increased frequency shall also be indicated.

F. Twenty-four Hour Notice of Noncompliance Reporting

1. The permittee shall report any noncompliance including transportation accidents, spills, and uncontrolled runoff from sludge transfer or land application sites which may seriously endanger health or the environment as soon as possible, but no later than 24 hours from the time the permittee first became aware of the circumstances. The report shall be made to the EPA, Region VIII, Emergency Response Branch at (303) 293-1788 and the State of

2. The following occurrences of noncompliance shall be reported by telephone to the EPA, Region VIII, Compliance Branch at (303) 293-1628 by the first workday (8:00 a.m. - 4:30 p.m. Mountain Time) and the State of
by the first workday (8:00 a.m. - 4:30 p.m. Central Time) following the day the permittee became aware of the circumstances:

   a. Violation of any of the Table 1 metals limits, the pathogen limits, the vector attraction reduction limits or the management practices for sludge that has been land applied.

3. A written submission shall also be provided within five days of the time that the permittee becomes aware of the circumstances. The written submission shall contain:

   a. A description of the noncompliance and its cause;

   b. The period of noncompliance, including exact dates and times;

   c. The estimated time noncompliance is expected to continue if it has not been corrected; and,

   d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

4. The Director may waive the written report on a case-by-case basis if the oral report has been received within 24 hours by the Compliance Branch, Water Management Division, Denver, Colorado, by phone, (303) 293-1628.

5. Reports shall be submitted to the addresses in Part II.D., Reporting of Monitoring Results.

G. Other Noncompliance Reporting. Instances of noncompliance not required to be reported within 24 hours shall be reported at the time that monitoring reports for Part II.D. are submitted. The reports shall contain the information listed in Part II.F.3.

H. Inspection and Entry. The permittee shall allow the Director,

or authorized representative thereof, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, including, but not limited to, sludge treatment, collection, storage facilities or area, transport vehicles and containers, and land application sites; and,

4. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Act, any substances or parameters at any location, including, but not limited to, digested sludge before dewatering, dewatered sludge, sludge transfer or staging areas, any ground or surface waters at the land application sites, or sludges, soils, or vegetation on the land application sites.

5. The permittee shall make the necessary arrangements with the landowner or leaseholder to obtain permission or clearance, so that the Director,

or authorized representative thereof, upon the presentation of credentials and other documents as may be required by law, will be permitted to enter without delay for the purposes of performing their responsibilities.

III. COMPLIANCE RESPONSIBILITIES

A. Duty to Comply. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination, revocation and reissuance, modification, or for denial of a permit renewal. The permittee shall give the Director advance notice of any planned changes at the permitted facility or of any activity which may result in permit noncompliance.

B. Penalties for Violations of Permit Conditions.

1. The Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, 402, or 405 of the Act is subject to a civil penalty not to exceed $25,000 per day for each violation. Any person who negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, 402 or 405 of the Act is subject to a fine of $2,500 to $25,000 per day of violation, or imprisonment for not more that 1 year, or both. Any person who knowingly violates such sections or such conditions is subject to a fine of $5,000 to $50,000 per day of violation, or imprisonment for not more than 3 years, or both. Any person who violates Sections 301 302, 303, 306, 307, 308, 318, 402, or 405 of the Act and who knows at that time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine of not more than $250,000 or imprisonment of not more than 15 years, or both.

2. Any person who violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, 402, or 405 of the Act may be assessed an administrative penalty by the Administrator. Administrative penalties are not to exceed $10,000 per day for each day during which the violation continues, with the maximum amount of any penalty not to exceed $125,000.

C. Need to Halt or Reduce Activity not a Defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. Duty to Mitigate. The permittee shall take all reasonable steps to minimize or prevent any land application in violation of this permit.

E. Proper Operation and Maintenance. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances), including but not limited to, all treatment, transportation, and application equipment which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

IV. GENERAL REQUIREMENTS

A. Planned Changes. The permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

1. The alteration or addition could significantly change the nature or increase the quantity of pollutant land applied. This notification applies to pollutants which are not subject to limitations in the permit; or,

2. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source.

B. Anticipated Noncompliance. The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

C. Permit Actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

D. Duty to Reapply. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application should be submitted at least 180 days before the expiration date of this permit.

E. Duty to Provide Information. The permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.

F. Other Information. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Director, it shall promptly submit such facts or information.

G. Signatory Requirements. All applications, reports or information submitted to the Director shall be signed and certified.

1. All permit applications shall be signed by either a principal executive officer or ranking elected official.

2. All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

    a. The authorization is made in writing by a person described above and submitted to the Director; and,

    b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

3. Changes to authorization. If an authorization under Part IV.G.2. is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Part IV.G.2. must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

4. Certification. Any person signing a document under this section shall make the following certification:

    "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

H. Penalties for Falsification of Reports. The Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than six months per violation, or by both.

I. Availability of Reports. Except for data determined to be confidential under 40 CFR Part 2, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Department of Environment and Natural Resources and the Director. As required by the Act, permit applications, permits and all data necessary to determine compliance with the permit conditions or applicable Federal or State sludge regulations shall not be considered confidential.

J. Oil and Hazardous Substance Liability. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

K. Property Rights. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

L. Severability. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

M. Transfers. This permit may be automatically transferred to a new permittee if:

1. The current permittee notifies the Director at least 30 days in advance of the proposed transfer date;

2. The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit responsibility, coverage, and liability between them; and,

3. The Director does not notify the existing permittee and the proposed new permittee of his or her intent to modify, or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in paragraph 2. above.

N. State or Federal Laws. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by Section 510 of the Act or any applicable Federal or State transportation regulations, such as but not limited to the Department of Transportation regulations.

O. Reopener Provision. This permit may be reopened and modified (following proper administrative procedures) to include the appropriate sewage sludge limitations (and compliance schedule, if necessary), management practices, other appropriate requirements to protect public health and the environment, or if there have been substantial changes (or such changes are planned) in sludge use or disposal practices; applicable management practices or numerical limitations for pollutants in sludge have been promulgated which are more stringent than the requirements in this permit; and/or it has been determined that the permittee's sludge use or land application practices do not comply with existing applicable state or federal regulations.

APPENDIX H

NUTRIENT MANAGEMENT PLANNING

NUTRIENT MANAGEMENT PLANNING

Nutrient Management Planning

Many factors can affect the likelihood of nitrate leaching from land-applied sewage sludge to ground water. These range from physical factors, such as soil type and climatic conditions, to management techniques used during the application of sewage sludge. Table H-1 describes the major physical factors influencing the transport of land-applied nitrogen to ground water. Many of the factors that affect the off-site transport of nutrients to surface water are described in Table H-2. This table focuses on physical factors, although management techniques used in the application of sewage sludge can also affect off-site transport.

Nutrient management represents the most effective way to reduce offsite nitrogen transport, as it incorporates principles that lower nitrogen losses to all environmental media -- surface water, ground water, air, and soil. Simply put, the most effective way to reduce the loss of fertilizer-derived nitrate to ground water is to reduce the quantity of nitrogen applied. Comprehensive nutrient management planning incorporates a variety of measures that minimize the edge-of-field delivery of nutrients and minimize the leaching of nutrients from the root zone by eliminating the application of excess nutrients, improving the timing of nutrient application, and using agronomic crop production technology to increase nutrient use efficiency. Many localities and States require nutrient management planning for an array of land use types, especially agricultural lands. The principal components of nutrient management planning are summarized in Table H-3. Additional sources of information on nutrient management planning include county extension agents, soil conservation service district conservationists, and agricultural consultants. Some of the recommendations included in Table H-3, especially these associated with the consideration of environmentally high risk areas, need an assessment of site-specific conditions (e.g., depth to ground water and soil type).

Nutrient management planning is particularly important to understand when sewage sludge or any nutrient source is land applied to more environmentally sensitive areas, such as:

- Lands near surface water or wetlands
- Soils with high leaching indices
- Irrigated land in humid regions
- Highly erodible soils
- Shallow aquifers
- Karst topography containing sink holes and shallow soils over fractured bedrock.

In some instances, it may be better to avoid the application of sewage sludge altogether. Such locations include:

- Areas having a shallow depth to ground water, or seasonal high water table, especially if soils are coarse-textured.

- Soils with very high (sands) or very low (clay) permeability, and poorly drained soils.

- Steep slopes. If impossible to avoid application, use erosion and sediment controls.

- Areas where the soil cover is limited (e.g., less than approximately 4 feet thick in the humid east coast) over bedrock, sink holes, and water table.

Nutrient management planning, as described in the previous section, is the most effective way of reducing the quantity of land-applied nutrients available to contaminate surface and ground water. In addition to nutrient management planning to reduce the quantity of nutrients applied and increase nutrient uptake efficiency, sediment-bound nutrients (e.g, orthophosphate) should be managed using erosion and sediment controls.

Nutrient runoff from the land is a function of the nutrient quantity and concentration in its carrier (water or sediment), the mass of the carrier, and the ease at which delivery to receiving waters can occur. Nutrient management planning serves to reduce nutrient quantities and concentrations. A variety of best management practices (BMPs) to control erosion and sediment can be used to reduce the carrier mass and reduce pollutant delivery. Table H-4 briefly defines these BMPs. The choice of BMPs and their effectiveness depends on complex site-specific factors such as soil type, slope, local climatic conditions, crop type and farming technique, and farmer diligence. It is impossible to describe in this document all of the considerations that must be taken into account when identifying BMPs to be used on a particular site. Most State and local agricultural agencies have done extensive research on the effectiveness and suitability of BMPs for their jurisdictions. For example, the USDA - Soil Conservation Service sponsors a series of Field Office Technical Guides (FOTGs) that contain a variety of information on soil conservation practices and resource management, including standards and specifications for BMPs. These guides are prepared for specific geographic areas.

When evaluating BMPs to reduce erosion and sediment run-off, it is critical to recognize that some techniques, depending on site-specific conditions, can actually have the potential to increase nitrogen leaching by reducing and/or storing the carrier mass. Techniques that reduce the carrier mass (e.g., conservation tillage, terracing) may increase the concentration of nutrients, while techniques to contain sediments (e.g., sediment detention basins) may increase the amount of time available for leaching. The potential for enhanced ground-water contamination from these practices is extremely site-specific. Table H-5 provides general information on the effectiveness of certain BMPs on protecting ground and surface water bodies. It is interesting to note that only nutrient management planning and the use of cover crops definitively protect both surface and ground water resources.

TABLE H-1 MAJOR FACTORS INFLUENCING TRANSPORT OF LAND-APPLIED NITROGEN TO GROUND WATER

Factor	Impact on Ground Water
Climate	
Precipitation	Precipitation and/or irrigation has a dominant effect on the leaching of nitrate to ground water. The extent of nitrate leaching is directly related to the amount of water infiltrating the soil. Nitrate is most likely to leach below the root zone when soil is at or near saturation (enables maximum hydraulic conductivity). Heavy precipitation immediately after application also increases nitrate losses to ground water, especially if soil is permeable.
Evapotranspiration	Evapotranspiration rates in excess of precipitation and/or irrigation will reduce the potential for nitrate leaching as there is usually insufficient water to transport nitrate past the root zone. Conversely, if evapotranspiration rates are low, water and dissolved materials (e.g., nitrates) can move downward below the root zone.
Temperature	Temperature affects all nitrogen transformation processes (e.g, immobilization, mineralization, nitrification, and denitrification). However, temperature impacts on the movement of water and solutes in soils are poorly understood and are likely to be only a small factor in nitrate leaching.
Soil Properties	
Water Content	Soluble nitrate is transported by soil water. Increased soil water levels increase the movement of water and nitrate within and below the root zone.
Bulk Density	Decreasing porosity or increasing bulk density (the two are inversely related) decreases the leaching potential of nitrogen by decreasing the cross-sectional area available for mass flow and increasing path lengths of water flow.
Hydraulic Conductivity	Soils with high hydraulic conductivity in relation to the initial infiltration of water (e.g., sands) have a greater potential for the mass transport of water and dissolved solutes below the root zone.
Texture	Particle size distribution affects water retention, porosity, hydraulic conductivity, and adsorption capability. In general, coarser soils (e.g., sands) have greater capacity for mass transport and fewer opportunities for adsorption of nitrogen. Finer soils (e.g., silts and clays) have a greater capacity for adsorption, which reduces the leaching potential of nitrate. Soils with extremely high or extremely low permeability should be avoided. Highly permeable soils are too susceptible to leaching, while soils with low permeability may have internal drainage problems that restrict sludge decomposition.
Soil Structure	Highly structured soils have preferential pathways allowing the mass transport of water and solutes below the root zone.
Depth to Ground Water	Shallow ground water has a greater potential for contamination with nitrates because the distance and resulting travel time for materials leached below the root zone is lessened.

Source: Adapted from Spectrum Research, Inc.

TABLE H-2 MAJOR FACTORS INFLUENCING TRANSPORT OF LAND-APPLIED NUTRIENTS TO SURFACE WATER

Factor	Impact on Surface Water	
	Nitrogen	**Phosphorus**
Climate Rainfall/run-off	Highest concentration of N in run-off occurs with first significant rainfall/run-off event after application. Because of high solubility/mobility of N, the concentration and availability of N at the soil surface dissipates with time.	Highest concentration and loss of P in run-off occurs with first significant rainfall/run-off event after application. The availability of soluble P in run-off dissipates rapidly with time, because P has a propensity to adsorb to soil particles. Since mass loss of P is related to sediment transport, peak run-off loading of P corresponds to peak sediment loads.
Rainfall Intensity	Run-off occurs when precipitation exceeds infiltration. As rainfall intensity increases, infiltration decreases and run-off rate increases. Increased amount and velocity of run-off increases the energy available for nitrogen extraction and transport.	Run-off occurs when precipitation exceeds infiltration. As rainfall intensity increases, infiltration decreases and run-off rate increases. Increased amount and velocity of run-off increases the energy available for sediment transport, and therefore, phosphorous loss.
Rainfall Duration/Amount	As rainfall duration/amount increase, conditions for subsurface leaching of nitrogen also increase. Nitrogen may leach below the zone of surface run-off leach extraction and transport, thus decreasing nitrogen concentration in run-off.	Increased rainfall duration/amount may affect depth of surface interaction with soil-adsorbed phosphorus. Since phosphorus is much less soluble and mobile than nitrogen, the concentration of phosphorus in run-off is altered less than that of nitrogen.
Time to Run-off After Application	Nitrogen concentration in run-off and time to run-off are inversely related; run-off concentrations of nitrogen increase as time to run-off decreases. As the time from application to run-off event increases, a greater proportion of the nitrogen is immobilized or leached below the zone of surface run-off extraction.	Phosphorus concentration in run-off and time to run-off are inversely related; run-off concentrations of phosphorus increase as time to run-off decreases. As the time from application to run-off event increases, a greater proportion of the phosphorus is immobilized or adsorbed/precipitated on soil surfaces and not available in soluble form for run-off.

TABLE H-2 MAJOR FACTORS INFLUENCING TRANSPORT OF LAND-APPLIED NUTRIENTS TO SURFACE WATER (Continued)

Factor	Impact on Surface Water	
	Nitrogen	**Phosphorus**
Soil		
Soil Texture	Soil texture affects infiltration rates, soil erodibility, particle transport potential. Run-off typically increases on fine-grained soils, while infiltration increases on coarse-grained soils (e.g., sand). Time to run-off is longer on coarse-grained soils, possibly reducing initial run-off losses of soluble nitrogen. Conversely, time to run-off typically decreases with fine-grained soils. Run-off velocity also increases with fine-grained soils.	Soil texture affects infiltration rates, soil erodibility, particle transport potential. Soil texture also affects phosphorus adsorption sites. Run-off typically increases on fine-grained soils, while infiltration increases on coarse-grained soils (e.g., sand). Time to run-off is longer on coarse-grained soils, possibly reducing initial run-off losses of soluble phosphorus.
Surface Crusting/Compaction	Decreases infiltration rates, reduces time to run-off, and increases initial concentrations of soluble-nitrogen.	Decreases infiltration rates, reduces time to run-off, and increases initial concentrations of soluble-phosphorus.
Water Content	As the water content of soil increases, especially if soils are wet at the time of application, the run-off potential may be increased, time to run-off may be reduced, and the amount of subsurface leaching reduced.	As the water content of soil increases, especially if soils are wet at the time of application, the run-off potential may be increased, time to run-off may be reduced.
Slope	Increasing slope may increase run-off rate and soil detachment/transport. In general, slopes of less than 6 percent are considered suitable for land application; less than 4 percent is ideal. Steeper slopes can be used if careful crop and soil management is employed.	Increasing slope may increase run-off rate and soil detachment/transport. In general, slopes of less than 6 percent are considered suitable for land application; less than 4 percent is ideal. Steeper slopes can be used if careful crop and soil management is employed.
Degree of Aggregation and Stability	Affects infiltration rates, crusting potential, effective depth for entrainment, sediment transport potential, and adsorbed nitrogen enrichment in sediments.	Affects infiltration rates, crusting potential, effective depth for entrainment, sediment transport potential, and adsorbed phosphorus enrichment in sediments.

Source: Adapted from Spectrum Research, Inc.

TABLE H-3 PRINCIPAL COMPONENTS OF NUTRIENT MANAGEMENT PLANNING

Application Rate: Avoid applying excess fertilizer by using rates recommended as a result of soil testing, consideration of all possible available sources of nitrogen (e.g., nitrogen available in the soil, nitrogen contributions to the soil from legumes grown in rotation or other residual crops, carryover nitrogen from previous years of fertilization, other significant sources of nutrients (e.g., irrigation water, commercial fertilizers)), and an understanding of the growth requirements of the crop. Use the minimum amount of fertilizer necessary to meet the plant needs. Ensure that crop yield estimates are realistic, based on producer-documented yield history and other relevant information. Appropriate methods include averaging the three highest yields in five consecutive crop years for the planning site, or other methods based upon criteria used in developing a State Land Grant University's nutrient recommendations. In lieu of producer yield histories, university recommendations based on interpretation of soils data may be used.
Timing of Application: Apply sludge and fertilizer as close as possible to the time required for maximum plant uptake. Avoid fall and winter applications for spring-planted crops. Time application to minimize leaching losses from rainfall or irrigation (i.e., apply after these events). Also time application to avoid periods of heavy rainfall and critical erosion periods. Use seasonally split nitrogen applications on most soils to improve efficiency of nitrogen use and reduce total site loading. Avoid application to frozen soils.
Appropriate Method of Nutrient Application. Use application methods that promote efficient nutrient use. Incorporate or inject sludge beneath the soil surface when possible. Avoid application methods that contribute to soil erosion.
Ensure Application Equipment (e.g., sprayer, spreader) Works Properly: Calibrate equipment frequently. Calibrate on similar terrain and at speeds similar to actual spraying condition. Check distribution pattern of sprayer/spreader. Ensure uniform distribution.
Practice Water Conservation: Avoid excess irrigation. Use sensors to determine the need and timing of irrigation.
Keep Detailed Records: Record information on nutrient management procedures. Include such information as brand used, formulation, date and time of application, amount of application, climatic conditions during application, irrigation schedule, and annual quantities of fertilizers used.
Leave Vegetated Buffers Around Water Bodies: Maintain and repair unfertilized vegetative buffer strips around water bodies.
Use Cover Crops: Use small grain cover crops to scavenge nutrients remaining in the soil after harvest of the principal crop, particularly on highly leachable soils.
Control Phosphorus Losses: Minimize loss of phosphorous from fields through a combination of erosion and sediment controls.

TABLE H-4 BMPs SUITABLE FOR EROSION AND SEDIMENT CONTROL

BMP Type	Description
Reduces Carrier Mass Conservation Tillage	Any tillage or planting system that leaves at least 30 percent of the soil surface covered with crop residue after planting. Primary techniques include no-till, ridge-till, and other minimum till practices. Conservation tillage decreases soil erosion and surface runoff and increases infiltration.
Contouring	A system where agricultural field preparation and tilling is conducted in the direction of the land's contour instead of cutting across contour lines. Contouring is effective at reducing soil loss associated with agricultural activities. Contouring is most effective on permeable soils with mild slopes If heavy, intense rainfalls occur, contouring loses effectiveness because the furrows may overtop and fail.
Terraces	Terraces are constructed, flattened areas suitable for planting, that cut across the natural slope of a site. By reducing slope length, terraces reduce runoff velocity and can reduce soil loss upwards of 90 percent. Terraces serve to store water temporarily, allowing sediment to deposit and water to infiltrate. If terraces are overtopped by intense precipitation, severe erosion can occur.
Cover Crops	The planting of crops (e.g., grains or grasses) to reduce the amount of time an area is left fallow. Cover crops decrease nutrient losses to ground water through plant uptake of nutrients. Legume cover crops will tie up soil nitrogen during the winter and will provide nitrogen for subsequent crops. The residual nitrogen from legumes must be considered when determining nutrient requirements for future crops.
Vegetative Filter Strips	Bands of natural or planted vegetation situated between pollutant source areas and receiving waters. Filter strips remove soil particles and soil-bound nutrients from runoff as it passes through. Filter strips work best in flatter areas, as they can lose their sediment-trapping efficiencies if inundated with high volumes of fast moving runoff. The needed widths for vegetative filter strips will vary depending on site specific conditions.
Reduces Pollutant Delivery Terraces	See above description.
Vegetative Filter Strips	See above description.
Sediment Detention Basins and Ponds	Large structures designed to reduce peak run-off rates and to remove a certain percentage of sediment and sediment-bound nutrients in run-off. There are three basic types of detention ponds: dry ponds, wet ponds, and extended wet ponds. Each type operates slightly differently and the appropriate one should be selected based on site-specific conditions and local requirements.
Infiltration Trenches	Subsurface trenches typically filled with coarse material that serves to slow and store run-off so that it can infiltrate into the soil.

Source: Adapted from Dillaha 1990.

TABLE H-5 EFFECTS OF CERTAIN BMPs ON SURFACE AND GROUND WATER

BMP-Type	Effect on	
	Surface Water	Ground Water
Conservation Tillage	Positive (P)	No Effect (NE) or Adverse (A)
Contouring	P	NE/A
Terraces	P	NE/A
Cover Crops	P	P
Vegetative Filter Strips	P	NE/A
Sediment Detention Basins and Ponds	P	A
Infiltration Trenches	P	NE/A
Nutrient Management	P	P

Source: Adapted from Dillaha 1990; Logan 1990; and Camacho 1990.