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Part 503 Implementation Guidance

PREFACE

Section 405(d) of the Clean Water Act (CWA) directs the U.S. Environmental Protection Agency (EPA) to develop regulations containing guidelines for the use or disposal of sewage sludge. This section also requires EPA to establish standards that protect public health and the environment from any reasonably anticipated adverse effects of toxic pollutants in sewage sludge that is used or disposed. On February 19th, 1993 (58 *Federal Register* 9248), EPA published a final regulation at 40 Code of Federal Regulations (CFR) Part 503 that contains the standards addressed in section 405(d). This regulation contains requirements for four sewage sludge use or disposal practices: application of sewage sludge to the land, placement of sewage sludge on a surface disposal site, placement of sewage sludge in a municipal solid waste landfill (MSWLF) unit, and firing of sewage sludge in a sewage sludge incinerator.

A key element in EPA's implementation of the Part 503 regulation is to educate Agency and State personnel about these requirements. The regulation is directly applicable to persons who use or dispose of sewage sludge through one of the Part 503 use or disposal practices, and permitting authorities can directly enforce the provisions of the rule. It also will be implemented through Federal permits and will be implemented through State permits once States become authorized to manage the Federal sewage sludge program. When work on this document was initiated, the primary focus was to educate permit writers about the Part 503 requirements and to serve as an update to the *Guidance for Writing Case-by-Case Permit Conditions for Municipal Sewage Sludge* (EPA 1990). Therefore, throughout the document, reference is made to the permit writer and the permitting authority.

However, it is now clear that the information interpreting Part 503 serves not only State and Federal permits writers, but also direct regulators and the regulated community. Readers should be aware that the term "permit writer" or "permitting authority" is intended to mean the State or Federal regulator, whether or not a permit is issued. A permit writer may use the information in the document to establish appropriate permit requirements for the use or disposal of sewage sludge. An example of an EPA-issued permit is included in Appendix G. This document may also be used as a reference manual by anyone involved in the use or disposal of sewage sludge. It is the responsibility of the sewage sludge regulators to use this document to help protect public health and the environment.

This document is a guidance manual. It is intended to provide information that may be needed to properly implement Part 503. It does not establish a binding norm. Decisions in any particular case will be made applying the law and regulation on the basis of specific facts.

Note that this document does not address the Part 503 requirements for the use or disposal of domestic septage. These requirements are addressed in a separate guidance document called *Domestic Septage Regulatory Guidance - A Guide to the EPA 503 Rule* (EPA 1993). Several other guidance documents have been published to help in the implementation of Part 503. These are listed in Appendix C along with sources to obtain these and other EPA documents.

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LIST OF ACRONYMS

APCD	Air Pollution Control Device
APLR	Annual Pollutant Loading Rate
AWSAR	Annual Whole Sludge Application Rate
BMP	Best Management Practice
BPJ	Best Professional Judgment
CE	Control Efficiency
CEM	Continuous Emission Monitoring
CFR	Code of Federal Regulations
CO	Carbon Monoxide
COE	U.S. Army Corps of Engineers
CPLR	Cumulative Pollutant Loading Rate
CWA	Clean Water Act
DF	Dispersion Factor
EPA	U.S. Environmental Protection Agency
EQ	Exceptional Quality
FEMA	U.S. Federal Emergency Management Agency
FR	Federal Register
FWS	U.S. Fish and Wildlife Service
GEP	Good Engineering Practice
LCRS	Leachate Collection and Removal System
LEL	Lower Explosive Limit
MCL	Maximum Contaminant Level
MSWLF	Municipal Solid Waste Landfill
NAAQS	National Ambient Air Quality Standard
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standard
NSSS	National Sewage Sludge Survey
PCB	Polychlorinated Biphenyl
PEC	Pathogen Equivalency Committee
PFRP	Process to Further Reduce Pathogens
POTW	Publicly Owned Treatment Works
PSRP	Process to Significantly Reduce Pathogens
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RSC	Risk Specific Concentrations
SCS	Soil Conservation Services
SDWA	Safe Drinking Water Act
SOUR	Specific Oxygen Uptake Rate
TCLP	Toxicity Characteristic Leaching Procedure
THC	Total Hydrocarbon
TKN	Total Kjedahl Nitrogen
TWTDS	Treatment Works Treating Domestic Sewage
USGS	U.S. Geological Survey

1. INTRODUCTION

QUICK REFERENCE INDEX

1.1 BACKGROUND

The primary goals of the Clean Water Act (CWA) are to protect and improve the quality of the Nation's water. To prevent contamination and deterioration of water quality, wastewater from households and commercial and industrial activities is treated at wastewater treatment plants before it is discharged to surface water or ground water. There are approximately 15,000 publicly owned treatment works (POTWs) in the United States that process almost 34 billion gallons of domestic sewage and other wastewater each day (EPA 1991). Sewage sludge is generated by POTWs and by privately owned and Federally owned treatment works during the treatment of domestic sewage. The annual amount of sewage sludge generated during the treatment of domestic sewage is estimated at about 47 pounds for every individual in the United States (58 *FR* 9249, February 19, 1993).

1.2 HISTORY OF EPA'S SEWAGE SLUDGE REGULATIONS

The use or disposal of sewage sludge has been regulated under various environmental statutes. In the past, it was regulated principally under the solid waste disposal regulations at 40 Code of Regulations (CFR) Part 257, jointly promulgated under the Resource Conservation and Recovery Act (RCRA) and the CWA. In addition, the Marine Protection, Research, and Sanctuaries Act (MPRSA) regulated the dumping of sewage sludge to oceans and estuaries, until the Ocean Dumping Ban Act of 1988 prohibited this disposal practice. Finally, the Clean Air Act (CAA) regulates the air emissions (primarily particulates) from sewage sludge incinerators.

The 1977 amendments to the CWA directed the U.S. Environmental Protection Agency (EPA) to develop regulations containing guidelines for the use or disposal of sewage sludge. In 1984, EPA's Office of Water convened a Sludge Task Force that made recommendations for the development of a sewage sludge management program and published guidance on the metals content of sewage sludge applied to land used for growing food crops. In 1987, Section 405(d) of the CWA was amended to require EPA to establish standards that adequately protect public health and the environment from any reasonably anticipated adverse effects of pollutants in sewage sludge that is used or disposed. In response, EPA developed and published technical standards and requirements on February 19, 1993 (58 *FR* 9248), codified in 40 CFR Part 503. Part 503 was amended on February 25, 1994 (59 *FR* 9095), and October 25, 1995 (60 *FR* 54764). Additional amendments were proposed on October 25, 1995 (60 *FR* 54771). Discussions in this document assume that these changes will be finalized.

The 1987 revisions to the CWA also require that any Section 402 (National Pollutant Discharge Elimination System [NPDES]) permit include sewage sludge use or disposal standards unless these requirements are included in another permit. The amendments also expanded the regulated universe to include all treatment works treating domestic sewage (TWTDS), even those not needing an NPDES permit. TWTDS include all sewage sludge or wastewater treatment systems used to store, treat, recycle, and reclaim municipal or domestic sewage. On May 2, 1989 (54 *FR* 18716), EPA revised 40 CFR Parts 122 and 124 to establish the procedures and requirements for addressing sewage sludge management in NPDES permits. At the same time, 40 CFR Part 123 was revised and 40 CFR Part 501 was promulgated to establish State program requirements and approval procedures. On February 19, 1993 (58 *FR* 9404), Parts 122 and 501 were amended to establish a tiered permit application schedule.

1.3 SUMMARY STATISTICS FOR SEWAGE SLUDGE USE OR DISPOSAL PRACTICES

In 1988, EPA collected information on the use or disposal of sewage sludge through a two-part National Sewage Sludge Survey (NSSS). A questionnaire survey was used to obtain both technical and financial information on the sewage sludge use or disposal practices employed by POTWs. Information on the quality of sewage sludge used or disposed in 1988 was obtained through an analytical survey during which samples of sewage sludge were collected at several POTWs and analyzed for several pollutants. Results of the NSSS were used to develop the Part 503 regulation and to evaluate the impact of the Part 503 regulation on POTWs. The summary statistics in this section are from the NSSS.

The NSSS focused on POTWs with either primary, secondary or advanced treatment of wastewater. The survey results show that the frequency of particular use or disposal practices varies widely by POTW size, except for land application, which is used frequently by all sizes of POTWs. For example, many small POTWs use surface disposal, while this practice is uncommon among large POTWs. Similarly, incineration and ocean disposal have been used by many large POTWs, but hardly at all by small POTWs. The tables on the following pages provide more information on POTW sewage sludge use or disposal practices obtained through the NSSS.

Table 1-1 shows national estimates of the number and percentage of POTWs that use a particular use or disposal practice and the amount of sewage sludge used or disposed through each practice. The most prevalent practice is land application (34.6 percent), followed by placement in co-disposal landfills (i.e., a municipal solid waste landfill unit) (22.2 percent) and surface disposal (10 percent).

Table 1-2 reports national estimates of the total amount and percentage of sewage sludge used or disposed annually for various use or disposal practices and for certain POTW size categories. As can be seen in the table, POTWs with a design flow rate over 100 million gallons per day (mgd) account for 28.7 percent of the sewage sludge used or disposed by POTWs. POTWs with a flow rate between 10 mgd and 100 mgd use or dispose of 39.5 percent of the annual amount of sewage sludge; and POTWs with a flow rate between one mgd and 10 mgd use or dispose of 24.1 percent of the amount of sewage sludge that is used or disposed annually by POTWs. In contrast, POTWs with a flow rate less than one mgd account for only 7.6 percent of the amount of sewage sludge used or disposed annually.

The largest amount of sewage sludge is used or disposed through co-disposal landfills (33.7 percent), land application (33.5 percent), and incineration (16.1). Only 10.4 percent of the amount of sewage sludge used or disposed annually is placed on a surface disposal site.

TABLE 1-1 NUMBER OF POTWS AND THE AMOUNT OF SEWAGE SLUDGE USED/DISPOSED ANNUALLY BY USE OR DISPOSAL PRACTICE

Use/Disposal Practice	POTWs Using a Use/Disposal Practice		Amount of Sewage Sludge Used/Disposed	
	Number	Percent of Total	Amount[a]	Percent of Total
Incineration	381	2.8	864.7	16.1
Land Application	4,657	34.6	1,787.8	33.5
Co-Disposal: Landfill	2,991	22.2	1,798.6	33.7
Surface Disposal	1,351	10.0	553.6	10.4
Ocean Disposal[b]	133	1.0	335.4	6.3
Unknown: Other	3,920	29.1	0	0.0
Unknown: Transfer	25	0.2	N/A	N/A
All POTWs	13,458[c]	100.0[d]	5,340.1	100.0[d]

[a]Thousands of dry metric tons.

[b]The National Sewage Sludge Survey was conducted before the Ocean Dumping Ban Act of 1988 prohibited the dumping of sewage sludge into the ocean. Ocean dumping of sewage sludge ended in June 1992.

[c]The total number of POTWs does not equal the number in the text because some POTWs utilize more than one use or disposal practice and are counted twice in this table.

[d]Numbers do not add up to 100 percent because of rounding.

Source: 1988 National Sewage Sludge Survey and 1988 Needs Survey. Extracted from 58 *FR* 9248, February 19, 1993.

TABLE 1-2 ESTIMATED AMOUNT OF SEWAGE SLUDGE USED OR DISPOSED ANNUALLY BY SIZE OF POTW AND USE OR DISPOSAL PRACTICE

Use or Disposal Practice	Amount of Sewage Sludge Used or Disposed by POTW Size (in thousands of dry metric tons)				Total (% of Total)
	>100 mgd	>10 to 100 mgd	>1 to 10 mgd	≤ 1 mgd	
Incineration	382.9	346.5	124.8	10.5	864.7 (16.1)
Land Application: Agricultural	203.0	400.8	423.9	143.2	1,170.9 (21.9)
Land Application: Compost	22.4	65.3	31.7	30.8	150.2 (2.8)
Land Application: Forests	4.5	24.5	1.0	1.3	31.3 (0.6)
Land Application: Public Contact Sites	62.1	60.5	40.3	6.3	169.2 (3.2)
Land Application: Reclamation Site	52.6	9.8	2.4	1.0	65.8 (1.2)
Land Application: Sale or Give Away in a Bag or Other Container	30.6	27.8	11.9	0.8	71.1 (1.3)
Land Application: Undefined	12.7	76.4	27.2	13.0	129.3 (2.4)
Co-Disposal: Landfill	518.6	674.0	495.6	110.4	1,798.6 (33.7)
Surface Disposal: Dedicated Site	34.2	124.9	63.2	36.5	258.8 (4.9)
Surface Disposal: Monofill	13.8	79.8	41.6	22.2	157.4 (3.0)
Surface Disposal: Other	31.5	60.0	17.4	28.5	137.4 (2.6)
Ocean Disposal[a]	166.1	157.9	8.0	3.4	335.4 (6.3)
Unknown: Other	0	0	0	0	0
Unknown: Transfer	N/A	N/A	N/A	N/A	N/A
Total (% of Total)	1,535.0 (28.7)	2,108.2 (39.5)	1,289.0 (24.1)	407.9 (7.6)	5,340.1 (100.0)

[a]This survey was conducted before the Ocean Dumping Ban Act of 1988 prohibited the dumping of sewage sludge into the ocean. Ocean dumping of sewage sludge ended in June 1992.

Source: 1988 National Sewage Sludge Survey and 1988 Needs Survey. Extracted from 58 *FR* 9248, February 19, 1993.

2. WHAT IS PART 503?

QUICK REFERENCE INDEX

2.1 INTRODUCTION

EPA published the Standards for the Use or Disposal of Sewage Sludge, Part 503, in the *Federal Register* on February 19, 1993. This chapter discusses what is regulated by Part 503, who is regulated by Part 503, how Part 503 is implemented, and what is not regulated by Part 503.

This chapter also discusses the seven elements of a Part 503 standard and why a Part 503 standard protects public health and the environment. The last discussion in this chapter concerns requirements that are more stringent than or in addition to the Part 503 requirements and who can establish these requirements.

2.2 GENERAL DEFINITIONS

Part 503 Subpart A contains definitions of terms used in more than one subpart in Part 503. This section provides additional information on several of the definitions in §503.9. It also discusses two key definitions in Parts 122 and 501.

CLASS I SLUDGE MANAGEMENT FACILITY

Statement of Regulation

§122.2 **Class I sludge management facility means any publicly owned treatment works (POTW), identified under 40 CFR 403.8(a) as being required to have an approved pretreatment program (including any POTW located in a State that has elected to assume local program responsibilities pursuant to 40 CFR 403.10(e)) and any other treatment works treating domestic sewage classified as a Class I sludge management facility by the Regional Administrator, or, in the case of approved State programs, the Regional Administrator in conjunction with the State Director, because of the potential for its sludge use or disposal practices to adversely affect public health and the environment.**

This is an important definition because the reporting requirements in Part 503 only apply to Class I sludge management facilities and other selected POTWs, generally known as majors.

DOMESTIC SEWAGE

Statement of Regulation

§503.9(g) **Domestic sewage is waste and wastewater from humans or household operations that is discharged to or otherwise enters a treatment works.**

There are two important aspects of this definition. First, the definition is explicit that the waste and wastewater from humans or household operations must be discharged to or otherwise enter a treatment works for those wastes and wastewater to be domestic sewage. Wastes and wastewater from humans or household operations (e.g., solid waste) that does not enter a treatment works is not domestic sewage. Second, it defines the type of wastewater that must be in the influent to a treatment works for the solids that are removed from the wastewater to be sewage sludge. This is discussed further below in the definition of sewage sludge.

PERSON

Statement of Regulation

§503.9(q) **Person is an individual, association, partnership, corporation, municipality, State or Federal agency, or an agent or employee thereof.**

The important aspect of this definition is that a person is not just an individual. A person includes, but is not limited to, the generator of sewage sludge (e.g., a privately owned treatment works), a land applier of sewage sludge (e.g., an independent contractor who receives sewage sludge from the generator and then applies the sewage sludge to the land), the owner/operator of a surface disposal site (e.g., a municipality), the owner/operator of a municipal solid waste landfill unit, and the person who fires sewage sludge in a sewage sludge incinerator.

PERSON WHO PREPARES SEWAGE SLUDGE

Statement of Regulation

§503.9(r) **Person who prepares sewage sludge is either the person who generates sewage sludge during the treatment of domestic sewage in a treatment works or the person who derives a material from sewage sludge.**

There are several ways to derive a material from sewage sludge. These are discussed below in the definition of sewage sludge. In all cases, however, the person who derives a material from sewage sludge is a person who prepares sewage sludge. This term is used in Part 503 to indicate the person responsible for certain Part 503 requirements.

SEWAGE SLUDGE AND MATERIAL DERIVED FROM SEWAGE SLUDGE

Statement of Regulation

§503.9(w) **Sewage sludge is solid, semi-solid, or liquid residue generated during the treatment of domestic sewage 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 firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.**

Sewage sludge and a material derived from sewage sludge are discussed separately below. Grit and screenings and ash are not included in the definition because they have characteristics that are different from the characteristics of sewage sludge.

As indicated above, sewage sludge is generated during the treatment of domestic sewage in a treatment works. If domestic sewage is in the influent to the treatment works, either by itself or mixed with other wastewaters (e.g., industrial wastewater), solids removed during the treatment of the domestic sewage are sewage sludge. If domestic sewage is not in the influent, the solids generated during the treatment of the wastewater are not sewage sludge.

Sewage sludge retains its identity as sewage sludge as long as it remains within the property lines of the treatment works where it is generated. While within the treatment works, sewage sludge may be stored, treated (e.g., composted with other materials), or mixed with other materials and still retain its identity as sewage sludge.

Sewage sludge also retains its identity as sewage sludge after it leaves the property line of the treatment works if the quality of the sewage sludge is not changed after it leaves. When the quality of the sewage sludge is changed, a material is derived from sewage sludge.

There are two ways in which the quality of sewage sludge that leaves the property line of the treatment works can be changed. This can be done either by treatment (e.g., composting with another sewage sludge) or by mixing with another material (e.g, mixing with water treatment plant sludge or with grit and screenings). In both cases, the resulting material is a material derived from sewage sludge. If the derived material is applied to the land, placed on a surface disposal site, placed in a municipal solid waste landfill (MSWLF) unit, or fired in a sewage sludge incinerator, the appropriate requirements in Part 503 have to be met. In these cases, the derived material itself has to meet the appropriate Part 503 requirements (e.g., the pathogen requirements have to be met for the derived material).

Sewage sludge can be placed in a MSWLF unit in which household wastes already have been placed or household wastes can be placed in the landfill unit after sewage sludge is placed in the unit. In both cases, the area of land on which the sewage sludge is placed is a MSWLF unit; the appropriate requirements for the landfill unit (i.e., 40 CFR Part 258) have to be met; and the sewage sludge must meet the Part 258 quality requirements for materials placed in a MSWLF unit.

Part 503 defines a sewage sludge incinerator as an enclosed device in which only sewage sludge and auxiliary fuel are fired. Either sewage sludge or a material derived from sewage sludge may be fed to a sewage sludge incinerator. In other cases, sewage sludge or a material derived from sewage sludge and another material may be fed to the incinerator separately (i.e., the sewage sludge and other material are mixed in the incinerator itself). In these cases, Part 503 still applies because the other material is considered auxiliary fuel.

STORE OR STORAGE OF SEWAGE SLUDGE

<u>Statement of Regulation</u>

§503.9(y) **Store or storage of sewage sludge is the placement of sewage sludge on land on which the sewage sludge remains for 2 years or less. This does not include placement of sewage sludge on land for treatment.**

If the sewage sludge remains on the land for longer than 2 years, the area of land is an active sewage sludge unit and the Part 503 surface disposal requirements have to be met unless the person who prepares the sewage sludge demonstrates that the land is not an active sewage sludge unit. This demonstration is explained in Chapter 5.

One question related to this definition is how to determine whether the sewage sludge remains on the land for longer than 2 years. This can be done either by determining the age of the sewage sludge on the land or the time that the land is used to store sewage sludge. In most cases, determining the age of the sewage sludge is more appropriate because land may be used for short-term storage over a long period (e.g., sewage sludge may be stored on the same area of land for only 6 months out of the year).

TREAT OR TREATMENT OF SEWAGE SLUDGE

Statement of Regulation

§503.9(z)	**Treat or treatment of sewage sludge is the preparation of sewage sludge for final use or disposal. This includes, but is not limited to, thickening, stabilization, and dewatering of sewage sludge. This does not include storage of sewage sludge.**

This definition is important because, with the exception of certain pathogen alternatives and vector attraction reduction options, Part 503 does not establish requirements for the treatment of sewage sludge. Instead, it establishes requirements for the use or disposal of sewage sludge.

TREATMENT WORKS TREATING DOMESTIC SEWAGE

Statement of Regulation

§122.2	**Treatment works treating domestic sewage (TWTDS) means a POTW or any other sewage sludge or wastewater treatment device or systems, regardless of ownership (including federal facilities) used in the storage, treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated for the disposal of sewage sludge. This definition does not include septic tanks or similar devices. For purposes of this definition, "domestic sewage" includes waste and wastewater from humans or household operations that are discharged to or otherwise enter a treatment works. In States where there is no approved State sludge management program under section 405(f) of the CWA, the Regional Administrator may designate any person subject to the standards for sewage sludge use and disposal in 40 CFR part 503 as a "treatment works treating domestic sewage," where he or she finds that there is a potential for adverse effects on public health and the environment from poor sludge quality or poor sludge handling, use or disposal practices, or where he or she finds that such designation is necessary to ensure that such person is in compliance with 40 CFR part 503.**

Note that the preamble to Part 501 indicates that "lands dedicated to the disposal of sewage sludge" includes land used for final disposal of sewage sludge such as monofills and surface disposal sites (54 *FR* 18726). It does not include land on which sewage sludge is applied to condition the soil or fertilize crops grown in the soil.

The above definition explains the situations when the Regional Administrator may designate someone as a TWTDS. States with approved State sewage sludge management programs can develop any appropriate program to regulate non-TWTDS users or disposers of sewage sludge to ensure compliance with Part 503.

The definition of a TWTDS is used in the sewage sludge permitting program to identify entities subject to a permit under section 405(f) of the CWA. As indicated below, this definition is different from the definition of treatment works in Part 503.

TREATMENT WORKS

Statement of Regulation

§503.9(aa) **Treatment works is either a federally owned, publicly owned, or privately owned device or system used to treat (including recycle and reclaim) either domestic sewage or a combination of domestic sewage and industrial waste of a liquid nature.**

This definition indicates the ownership of the devices or systems in which domestic sewage is treated. Note that a treatment works can treat only domestic sewage or a combination of domestic sewage and industrial waste of a liquid nature. In both cases, the solid, semi-solid, and liquid residues generated are sewage sludge.

Septic tanks or similar devices are included in the definition of a treatment works because domestic sewage is treated in those devices. For the solid, semi-solid, and liquid residues from those devices to be sewage sludge, the devices must be treatment works.

Septic tanks or similar devices are not included in the above definition of a TWTDS because the owner/operator of those devices will not receive a permit for the use or disposal of the solid, semi-solid, or liquid residues generated in the devices. However, because the residues are sewage sludge, the appropriate Part 503 requirements have to be met if the residues are used or disposed through one of the Part 503 use or disposal practices even in the absence of a permit.

2.3 WHAT DOES PART 503 REGULATE?

As mentioned previously, Part 503 contains the requirements that have to be met when sewage sludge is applied to the land, placed on a surface disposal site, placed on a municipal solid waste landfill unit, or fired in a sewage sludge incinerator. Requirements are included in Part 503 for pollutants in sewage sludge, the reduction of pathogens in sewage sludge, the reduction of the characteristics in sewage sludge that attract vectors, the quality of the exit gas from a sewage sludge incinerator stack, the quality of sewage sludge that is placed in a MSWLF unit, the sites where sewage sludge is either land applied or placed for final disposal, and for a sewage sludge incinerator.

2.3.1 POLLUTANTS

In developing the pollutant limits in Part 503, EPA first identified pollutants most likely to interfere with the use or disposal of sewage sludge. Using the information available on the toxic effects of these pollutants, the Agency then developed a list of pollutants for which an initial exposure risk assessment was conducted. Because the use or disposal of sewage sludge affects air, soil, and water, all media were considered in the risk assessment.

Based on the results of the initial exposure risk assessment, a final list of pollutants was developed for Part 503. A more detailed exposure risk assessment was then conducted to develop the limits for the pollutants in Part 503. The risk assessments conducted to develop the Part 503 pollutant limits are discussed below.

For land application, 14 pathways of exposure were considered in the detailed exposure risk assessment. The movement of a pollutant into and through the environment was simulated using models to determine the concentrations of pollutants reaching an individual, plant, or animal (see Figure 2-1). These models used human health and environmental criteria (i.e., an allowable dose) already published by EPA and an estimate of the exposure to a highly exposed individual (human, plant, or animal) to develop the amount of a pollutant (i.e., cumulative pollutant loading rate) that could be applied to the land in sewage sludge. The most stringent cumulative pollutant loading rate from the risk assessment is the loading rate for each pollutant in Table 2 of §503.13. Note that not every pathway was evaluated for every pollutant. In some cases, a pathway was not applicable for a pollutant (e.g., vapor pathway for an inorganic pollutant) and in other cases data needed to evaluate a pathway for a pollutant were not available. The pollutants for which limits are included in the land application subpart are listed in Table 2-1.

For surface disposal, two pathways were evaluated in the detailed exposure risk assessment. These were the ground-water pathway and the air or vapor pathway. These pathways are different from the ground-water and vapor pathways for land application because different assumptions were used in the pathway models for each practice. The most stringent of the pollutant limits for these two pathways are the pollutant limits for surface disposal in Part 503. The pollutants for which limits are included in the surface disposal subpart also are listed in Table 2-1.

One pathway was evaluated during the exposure risk assessment for firing of sewage sludge in a sewage sludge incinerator. This was the inhalation pathway. A risk specific concentration (i.e., allowable ambient air concentration) was developed for each pollutant during the risk assessment. That concentration is used in an equation in Part 503 along with site-specific values for certain parameters to calculate the allowable concentration of the pollutant in sewage sludge. In the case of lead, an existing standard (i.e., National Ambient Air Quality Standard) is used in an equation in Part 503 with site-specific values for other parameters to calculate the allowable concentration of lead in the sewage sludge. In addition, the National Emission Standards for beryllium and mercury have to be met when sewage sludge is fired in a sewage sludge incinerator. Table 2-1 also contains the pollutants for which limits or equations used to calculate limits are included in the Part 503 incineration subpart.

As shown in Table 2-1, Part 503 contains limits for 11 metals for one or more use or disposal practice, although not every pollutant is regulated under each practice. Part 503 also contains requirements for total hydrocarbons in the emissions from a sewage sludge incinerator stack. This is discussed further below.

2.3.2 PATHOGENS

Pathogens are disease-causing organisms. These include, but are not limited to, certain bacteria, protozoa, viruses, and helminth ova.

The pathogens for which requirements are included in Part 503 are *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova. In some cases, the level of fecal coliform in the sewage sludge can be used to show that certain pathogens have been reduced in sewage sludge. The Part 503 requirements for the reduction of pathogenic organisms in sewage sludge are technology-based operational standards.

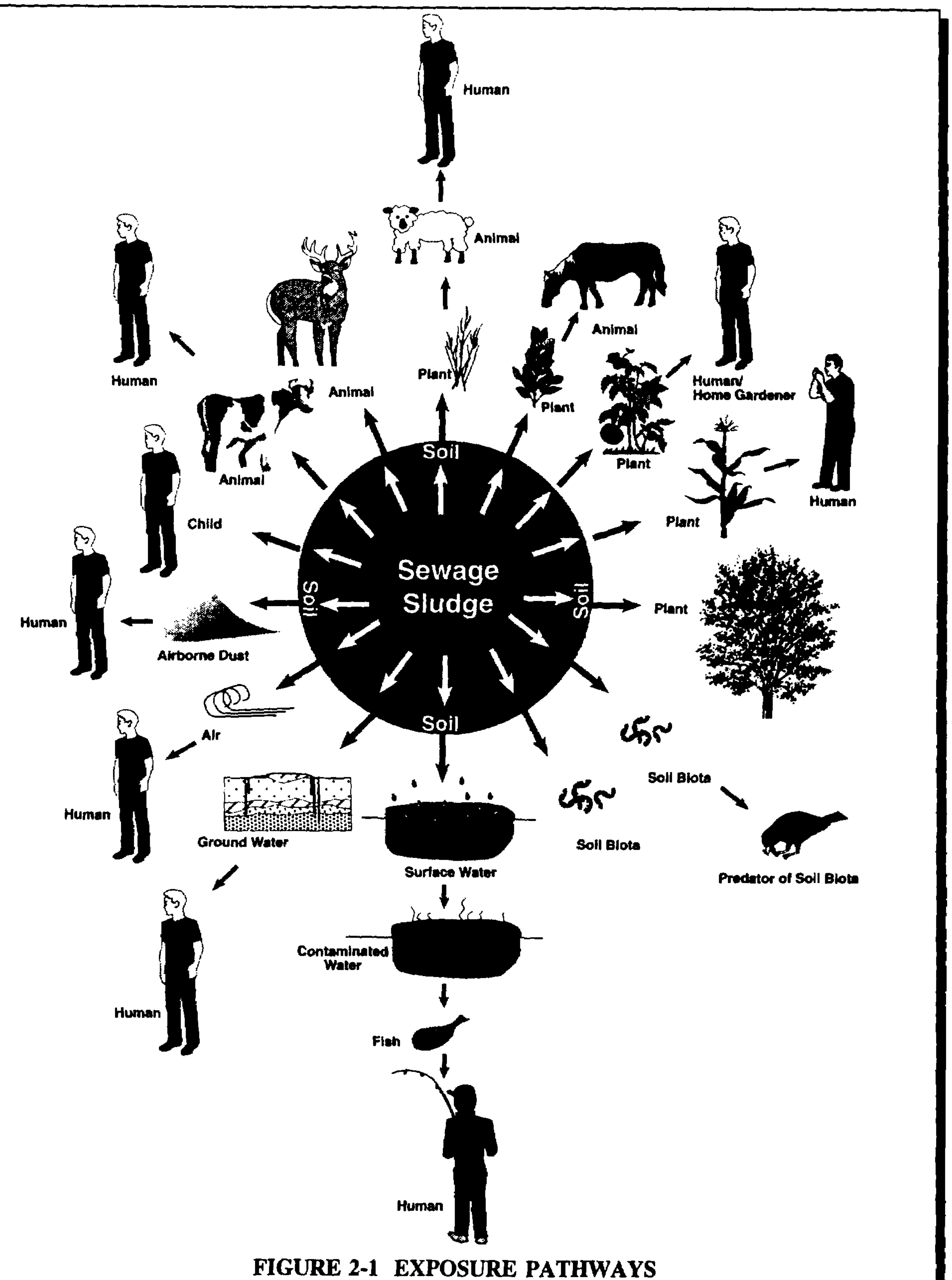

FIGURE 2-1 EXPOSURE PATHWAYS

TABLE 2-1 POLLUTANTS REGULATED BY PART 503 REGULATION

Pollutant	Land Application	Surface Disposal	Incineration
Arsenic	X	X	X
Beryllium			X
Cadmium	X		X
Chromium		X	X
Copper	X		
Lead	X		X
Mercury	X		X
Molybdenum	X		
Nickel	X	X	X
Selenium	X		
Zinc	X		

Part 503 contains requirements for two classes of pathogen reduction. The Class A pathogen requirements, which are met by treating the sewage sludge, are designed to ensure that the density of *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova in the sewage sludge are reduced to below detectable levels. Because the density of pathogens in the sewage sludge is reduced to below detectable levels by treating the sewage sludge before it used or disposed, there can be immediate exposure to the sewage sludge after it is used or disposed. For a sewage sludge to be classified Class A with respect to pathogens, one of the six Class A pathogen alternatives in Part 503 has to be met.

The Class B pathogen requirements rely on a combination of treatment of the sewage sludge to reduce the density of *Salmonella* sp. bacteria, enteric viruses, and viable helminth ova in the sewage sludge and prevention of exposure to the sewage sludge after it is used or disposed. Under this approach, restrictions are placed on the site where the sewage sludge is used or disposed to prevent exposure to the sewage sludge. This allows time for the environment to further reduce pathogens in the sewage sludge to below detectable limits. For example, when Class B sewage sludge is applied to the land, site restrictions concerning harvesting of certain crops, grazing of animals, and public access have to be met. For a sewage sludge to be classified Class B with respect to pathogens, one of the three Class B pathogen alternatives in Part 503 has to be met.

Note that some of the pathogen requirements have to be met "at the time the sewage sludge is used or disposed" while others apply to sewage sludge "that is used or disposed." The requirements that have to be met at the time of use or disposal are designed to ensure the requirements are met as close as possible to when the sewage sludge is actually used or disposed.

There are two cases related to the "at the time of use or disposal" requirement. In one case, a sample of the sewage sludge may be collected and analyzed far enough in advance to receive the analytical results before the sewage sludge is actually used or disposed. This may be 3 days or some other period depending on how long it takes to receive the analytical results. In the other case, a sample may be collected at the time of use or disposal, but the analytical results are not received prior to when the sewage sludge is actually used or disposed. In this second case, nothing can be done to correct a violation of Part 503 because the sewage sludge already has been used or disposed. In both cases, the pathogen requirement is met at the "time of use or disposal."

Pathogen requirements that apply to sewage sludge "that is used or disposed" can be met any time before the sewage sludge is actually used or disposed. For example, the Class A time/temperature requirements can be met any time before the sewage sludge is used or disposed as long as there is a record that indicates the temperature of the sewage sludge was maintained at a certain value for a certain period.

The Part 503 pathogen reduction requirements apply to sewage sludge that is applied to the land or placed on a surface disposal site. There are no pathogen reduction requirements for sewage sludge placed on a MSWLF unit because Part 503 relies on the criteria in Part 258 to achieve this reduction. In addition, there are no pathogen reduction requirements for incineration because pathogens do not survive the incineration process.

2.3.3 VECTOR ATTRACTION REDUCTION

Vector attraction is the characteristic of sewage sludge that attracts rodents, flies, mosquitos, or other organisms capable of transporting infectious agents (i.e., pathogens). The purpose of the Part 503 vector attraction reduction operational standards is to reduce the attraction of sewage sludge to vectors.

There are two approaches to vector attraction reduction. Vector attraction can be reduced by treating the sewage sludge or by placing a barrier between the sewage sludge and the vectors. Eight of the 11 vector attraction reduction options in Part 503 are based on treating the sewage sludge. The other three (i.e., injection, incorporation, and daily cover) require that a barrier be placed between the sewage sludge and vectors.

One of the vector attraction reduction options in Part 503 has to be met when sewage sludge is either applied to the land or placed on a surface disposal site. Part 503 relies on the Part 258 criteria to reduce vector attraction when sewage sludge is placed on a MSWLF unit. There are no vector attraction reduction requirements for sewage sludge that is fired in a sewage sludge incinerator because the characteristics of sewage sludge that attract vectors are reduced during incineration.

2.3.4 EXIT GAS FROM A SEWAGE SLUDGE INCINERATOR STACK

Part 503 contains a requirement that limits the concentration of either total hydrocarbons (THC) or carbon monoxide (CO) in the exit gas from a sewage sludge incinerator stack. Both requirements are operational standards because they are technology-based (see Section 2.7).

THC is a measure of the organic compounds in the exit gas. Because organic compounds are formed during the combustion process, EPA concluded that those compounds should be controlled by limiting the concentration of THC in the exit gas instead of establishing an allowable concentration for certain organic pollutants in the sewage sludge fed to the incinerator. The THC operational standard of 100 parts per million (ppm) is a measure of all organic compounds in the exit gas (i.e., those in the sewage sludge and those formed during incineration) and is based on the performance of a certain type of incinerator. In addition, economic impact was considered when establishing the allowable value for the THC operational standard.

CO can be measured in the exit gas of a sewage sludge incinerator in lieu of measuring THC. EPA concluded that if the monthly average concentration of CO in the exit gas is equal to or less than 100 ppm, the monthly average concentration of THC in the exit gas also is equal to or less than 100 ppm.

2.3.5 PART 258 QUALITY REQUIREMENTS

Part 503 requires that sewage sludge placed in a MSWLF unit meet the requirements in Part 258 concerning the quality of materials placed in a MSWLF unit. Those requirements are found in Subpart C - Operating Criteria - of Part 258.

The first requirement is in §258.20 - Procedures for excluding the receipt of hazardous waste. This subsection indicates that hazardous materials and polychlorinated biphenyls wastes can not be placed in a MSWLF unit. Thus, if sewage sludge is hazardous, as defined in 40 CFR Part 261, or is a polychlorinated biphenyls waste, as defined in 40 CFR Part 761, it can not be placed in a MSWLF unit.

The second requirement is in §258.28 - Liquid restrictions. This subsection indicates that liquid waste may not be placed in a MSWLF unit. Liquid waste is any waste determined to contain "free liquids" as defined by Method 9095 (i.e., Paint Filter Liquids Test), in EPA Publication No. SW-846. Thus, if the sewage sludge does not pass the Paint Filter Liquids Test, it can not be placed in a MSWLF unit.

2.3.6 OTHER REQUIREMENTS

In addition to establishing requirements for the quality of sewage sludge that is used or disposed, Part 503 contains management practices and other restrictions that apply to a use or disposal site under certain situations. Part 503 also contains management practices that apply to a sewage sludge incinerator.

Requirements are included in Part 503 for a use or disposal site because those requirements are needed to protect public health and the environment. To meet those requirements, control of the site must be maintained.

For example, information about a land application site has to be known to ensure that the land application agronomic rate management practice is met. Control over a land application site also is needed to ensure that the Class B site restrictions for harvesting crops and turf, for grazing of animals, and for public contact are met. In all cases, records of how the requirements pertaining to the site are met have to be kept and certifications that certain requirements are met have to be made.

For surface disposal, several of the management practices are related to locating the surface disposal site. Other management practices require that certain activities be conducted at a surface disposal site (e.g., monitor the air for methane gas). In most cases, the owner/operator of the surface disposal site is responsible to ensure that requirements related to the surface disposal site itself are met.

Part 503 also contains management practices that pertain to the operation of a sewage sludge incinerator. These management practices address the different types of instruments that have to be installed, calibrated, operated, and maintained.

2.4 WHO DOES PART 503 REGULATE?

In addition to establishing requirements for the quality of sewage sludge that is used or disposed and for sites on which sewage sludge is used or disposed, Part 503 indicates who has to ensure that the requirements are met. These include the person who prepares sewage sludge, the person who land applies sewage sludge, the owner/operator of a surface disposal site, the person who fires sewage sludge in a sewage sludge incinerator, Class I sludge management facilities, POTWs with a flow rate equal to or greater than one mgd, and POTWs that serve a population of 10,000 people or more.

2.4.1 PERSON WHO PREPARES SEWAGE SLUDGE

Part 503 contains several requirements that the person who prepares sewage sludge is responsible to ensure are met. Note that a person who prepares sewage sludge is either the generator of the sewage sludge or a person who derives a material from sewage sludge (i.e., changes the quality of sewage sludge received from the generator of the sewage sludge). The first of these requirements is in §503.7.

As indicated in §503.7, the person who prepares sewage sludge must ensure that the applicable Part 503 requirements are met when sewage sludge is applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator. The person who prepares sewage sludge also is responsible to ensure the sewage sludge meets the Part 258 quality requirements when sewage sludge is placed in a MSWLF unit.

Section 503.7 places the ultimate responsibility to ensure that the Part 503 requirements are met on the person who prepares sewage sludge even when the preparer is not the person who actually uses or disposes of the sewage sludge. For example, if the person who prepares sewage sludge provides the sewage sludge to another person who applies the sewage sludge to the land, the preparer must ensure that the Part 503 requirements for the applier are met. In this case, the preparer is responsible even if there is an agreement or contract with the applier and the preparer provides the applier the appropriate notice and necessary information about the Part 503 requirements.

Because of §503.7, preparers now have to know how and where their sewage sludge is used or disposed. This is different from the past when, in many cases, the preparer did not know what happened to their sewage sludge after it was either given or sold to another person.

In addition to overall responsibility to ensure that the Part 503 requirements are met, the preparer also is responsible for several specific Part 503 requirements. In some cases, the preparer must ensure that the pollutant limits, pathogen requirements, vector attraction reduction requirements, and management practices are met. The preparer also must provide notice and necessary information to certain persons, must keep records, and must report information to the permitting authority in certain cases.

As mentioned above, a preparer of sewage sludge is both the generator and a person who derives a material from sewage sludge. When the preparer is the person who derives a material from sewage sludge, the generator's responsibilities under Part 503 are reduced. In this case, the generator provides the person who derives a material "a raw product" from which the material is derived. The person who derives the material is responsible to ensure that the derived material meets the appropriate Part 503 requirements (e.g., pollutant limits, pathogen requirements, and vector attraction reduction requirements) and is responsible for the ultimate use or disposal of the derived material.

2.4.2 PERSON WHO APPLIES SEWAGE SLUDGE TO THE LAND

The Part 503 requirements for which the person who applies sewage sludge to the land is responsible vary depending on which of the Part 503 requirements are applicable. For example, if bulk sewage sludge is applied to the land under the cumulative pollutant loading rate concept, the applier must keep records of the amount of each of the Part 503 pollutants applied to the land in sewage sludge.

Another example of a Part 503 requirement for which the land applier is responsible is the Class B site restrictions. When bulk sewage sludge meets the Class B pathogen requirements, the land applier must ensure that the restrictions on the site are met (e.g., do not harvest root crops for 38 months after the sewage sludge is applied).

Other Part 503 requirements for which the land applier is responsible when bulk sewage sludge is applied to the land include the requirement to provide the owner or lease holder of the application site notice and necessary information, the land application management practices, the vector attraction reduction options concerning injection of sewage sludge below the land surface and incorporation of the sewage sludge into the soil, and certain recordkeeping requirements.

In the case of sewage sludge that is sold or given away in a bag or other container for application to the land, the person who applies the sewage sludge is responsible for reading and following the instructions on a label or information sheet. For example, the applier should not apply the sewage sludge at a rate that is greater than the rate specified on the bag or information sheet.

2.4.3 OWNER/OPERATOR OF A SURFACE DISPOSAL SITE

The owner/operator of a surface disposal site is responsible to ensure that several of the Part 503 surface disposal requirements are met. These include pollutant limits under certain situations, the surface disposal management practices, and certain vector attraction reduction options (i.e., those options in which a barrier is placed between the sewage sludge and the vectors).

2.4.4 PERSON WHO FIRES SEWAGE SLUDGE IN A SEWAGE SLUDGE INCINERATOR

Part 503 requires that no person shall fire sewage sludge in a sewage sludge incinerator except in compliance with the requirements in subpart E of Part 503. Thus, that person must ensure that the Part 503 incineration requirements are met.

2.4.5 CLASS I SLUDGE MANAGEMENT FACILITIES, POTWS WITH A FLOW RATE EQUAL TO OR GREATER THAN 1 MGD, AND POTWS THAT SERVE 10,000 PEOPLE OR MORE

The reporting requirements in subparts B, C, and E of Part 503 require that Class I sludge management facilities, POTWs with a flow rate equal to or greater than 1 mgd, and POTWs that serve 10,000 people or more report certain information annually.

2.5 HOW IS PART 503 IMPLEMENTED?

2.5.1 SELF-IMPLEMENTING

EPA designed Part 503 so that the standards are directly enforceable against most users or disposers of sewage sludge, whether or not they obtain a permit. This means that publication of Part 503 in the *Federal Register* serves as notice to the regulated community of its duty to comply with the requirements of the rule, except those requirements that indicate that the permitting authority shall specify what has to be done. Thus, even without the terms and conditions of a sewage sludge permit, regulated users and disposers of sewage sludge are required to meet the requirements promulgated in the rule. The proposed amendments to Part 503 delete the requirements for permit authority specification and will make the entire rule self-implementing, once they are finalized.

As required by Section 405(d) of the CWA, compliance with the Part 503 standards must be achieved as expeditiously as possible, but no later than February 19, 1994, or no later than February 19, 1995, if construction of new pollution control facilities is required to comply with the regulation. The frequency of monitoring, recordkeeping, and reporting requirements (except those for THC) were effective on July 20, 1993. Compliance with the incineration requirements that are revised in the amendments mentioned above is required no later than 90 days from publication of the final amendments. If new pollution control facilities must be constructed, compliance is required no later than 12 months from publication.

2.5.2 PERMITS

Even though Part 503 is largely self-implementing, Section 405(f) of the CWA requires the inclusion of sewage sludge use or disposal requirements in any Section 402 permit issued to a TWTDS. On May 2, 1989 (54 *FR* 18716), EPA revised Part 122 to expand its authority to issue NPDES permits with these requirements.

The sewage sludge permitting regulations (Part 122) apply to all TWTDS. This includes all sewage sludge generators, sewage sludge treaters and blenders, surface disposal sites, and sewage sludge incinerators. Persons regulated by Part 503 but not considered TWTDS, such as land appliers who do not change the quality of the sewage sludge, may be designated as a TWTDS by the Regional Administrator to protect public health or the environment or to ensure compliance with Part 503. The reasons for designating a sewage sludge user or disposer as a TWTDS should be stated in the permit's fact sheet or statement of basis.

When a State is authorized to run the Federal sewage sludge management program under Part 123 or Part 501 they must at a minimum have authority to issue permits for all TWTDS. If they wish to require permits from land appliers or other persons that are not considered TWTDS, they can do so without designating them as TWTDS. This is because States can regulate non-TWTDS sewage sludge users or disposers as they wish, as long as they ensure compliance with Part 503.

Some TWTDS are not currently required to apply for a permit because they are not regulated by Part 503. The best example of this group is industrial treatment works that generate sewage sludge from the combined treatment of industrial wastewater and domestic sewage. The treatment of domestic sewage causes them to be considered a TWTDS, but they are not presently regulated by Part 503. If Part 503 is amended to include these treatment works, they will be required to apply for a permit.

There are also numerous users and disposers of sewage sludge that are not TWTDS. These include sewage sludge baggers who do not change the quality of the sewage sludge, land appliers, and domestic septage haulers. These are the persons that can be designated as TWTDS by the Regional Administrator if it is necessary to issue them a permit.

When one preparer sends sewage sludge to another preparer, the permit requirements may be split between the preparers. Because the second preparer is changing the sewage sludge quality, most of the permit requirements should be in the permit for that person. The exact division of the requirements depends on who is doing what to the sewage sludge. In some situations the permit writer might designate two preparers co-permittees.

The following permits issued under Sections 402 and 405 of the CWA will be the principal vehicles for implementing Part 503:

- NPDES permits issued by EPA under Part 122

- State permits issued under an approved sewage sludge program that can be part of the State NPDES (Part 123) program or a non-NDPES (Part 501) sewage sludge permit program.

The Part 503 standards and requirements also may be included in permits issued under the appropriate provisions of:

- Subtitle C of the Solid Waste Disposal Act
- Part C of the Safe Drinking Water Act
- The Marine Protection, Research, and Sanctuaries Act of 1972
- The Clean Air Act [see CWA Section 405(f)(2)].

This guidance document is also intended for use by regulators in these programs.

Initially, EPA Regions are responsible for including conditions to implement Part 503 in NPDES permits issued to treatment works in all States because, currently, no State has received EPA approval of its State sludge management program.[1] Where a State has an approved NPDES program, EPA will issue a separate NPDES permit to implement the sewage sludge standards and requirements or negotiate with the State on joint issuance of NPDES permits containing the Part 503 technical standards and requirements. Rather than issue individual permits, the EPA Regions (and the States that become authorized) may choose to develop and issue general permits for different categories of TWTDS or sewage sludge use or disposal practices.

[1]EPA's sewage sludge permitting program will not displace existing State sewage sludge management programs. States are encouraged to seek program approval as soon as possible, however, and the Agency has published the *State Sludge Management Program Guidance Manual* (EPA 1990) to assist their efforts.

2.6 WHAT IS NOT REGULATED BY PART 503?

Part 503 contains the requirements that have to be met when sewage sludge is used or disposed through various use or disposal practices. This section discusses activities and materials that are not subject to Part 503 requirements.

2.6.1 TREATMENT PROCESSES

Part 503 does not establish requirements for processes used to treat domestic sewage or for processes used to treat sewage sludge prior to final use or disposal with two exceptions. The exceptions pertain to the processes used to reduce pathogens and vector attraction.

Some of the Part 503 pathogen alternatives and vector attraction reduction options are performance standards (e.g., raise the pH of the sewage sludge and reduce the volatile solids of the sewage sludge). Part 503 does not specify, however, how to meet the performance standards. They can be met through treatment of the sewage sludge or through any other approach.

2.6.2 SELECTION OF A USE OR DISPOSAL PRACTICE

Part 503 does not require that sewage sludge be used or disposed through a particular use or disposal practice. The determination of the manner in which sewage sludge is used or disposed is the responsibility of the local authority. However, if the local authority decides to apply sewage sludge to the land, place sewage sludge on a surface disposal site, place sewage sludge in a MSWLF unit, or fire sewage sludge in a sewage sludge incinerator, the appropriate requirements in Part 503 have to be met.

2.6.3 CO-FIRING OF SEWAGE SLUDGE

Part 503 does not establish requirements for sewage sludge co-fired in an incinerator with other wastes or for the incinerator in which sewage sludge and other wastes are co-fired. Other wastes do not include auxiliary fuel. Most materials fired with sewage sludge are considered auxiliary fuel.

If the auxiliary fuel is municipal solid waste, it can not exceed 30 percent of the dry weight of the sewage sludge or material derived from sewage sludge and auxiliary fuel. The requirements in 40 CFR Parts 60 and 61 apply in cases where the total mass fired contains more than 30 percent municipal solid waste. In all other cases, Part 503 applies when either sewage sludge or a material derived from sewage sludge and auxiliary fuel are fired in an incinerator.

2.6.4 SLUDGE GENERATED AT AN INDUSTRIAL FACILITY

Sludge generated at an industrial facility during the treatment of only industrial wastewater is not subject to Part 503 when it used or disposed. Because domestic sewage is not in the influent to the treatment works, solids removed from the industrial wastewater during treatment are not, by definition, sewage sludge. For this reason, the Part 503 requirements do not apply when the sludge is used or disposed.

If the sludge is applied to or placed on the land, the requirements in Part 257 have to be met. If the sludge is placed in a municipal solid waste landfill, the requirements in Part 258 have to be met.

2.6.5 SEWAGE SLUDGE GENERATED AT AN INDUSTRIAL FACILITY

Sewage sludge generated at an industrial facility during the treatment of industrial wastewater combined with domestic sewage is not subject to Part 503 when it used or disposed. In this case, solids generated during treatment of the combined wastewaters are sewage sludge because domestic sewage is in the influent to the treatment works.

The most important aspect of this exclusion is that the sewage sludge has to be generated at an industrial facility during the treatment of industrial wastewater combined with domestic sewage. If the sewage sludge is not generated at an industrial facility, the Part 503 requirements have to be met if the sewage sludge is used or disposed through one of the Part 503 practices.

EPA decided not to regulate this type of sewage sludge under Part 503 because the Agency did not have the information needed to evaluate the impact of the Part 503 regulation on industries. Instead, EPA decided to continue to subject this sewage sludge to the requirements in Part 257 if the sewage sludge is applied to or placed on the land (these are the requirements that applied to all sewage sludges applied to or placed on the land prior to Part 503). Note that Part 503 does apply to the use or disposal of sewage sludge generated at an industrial facility if domestic sewage is treated by itself at the industrial facility.

2.6.6 HAZARDOUS SEWAGE SLUDGE

Part 503 does not establish requirements for the use or disposal of sewage sludge determined to be hazardous in accordance with Part 261. Hazardous sewage sludge is subject to the requirements in 40 CFR Parts 261-268 when it is used or disposed.

2.6.7 SEWAGE SLUDGE WITH HIGH PCB CONCENTRATION

Part 503 does not establish requirements for the use or disposal of sewage sludge with a concentration of polychlorinated biphenyls (PCB) equal to or greater than 50 milligrams per kilogram of total solids (dry weight basis). The requirements in Part 761 have to be met when those sewage sludges are used or disposed.

2.6.8 INCINERATOR ASH

Part 503 also does not establish requirements for the use or disposal of ash generated during the firing of sewage sludge in a sewage sludge incinerator. Because the characteristics of ash are different from the characteristics of sewage sludge, the pollutant limits developed during the exposure risk assessments do not apply to the ash. For this reason, Part 503 also does not apply to the ash when it is used or disposed.

2.6.9 GRIT AND SCREENINGS

Part 503 does not establish requirements for the use or disposal of grit (e.g., sand, cinders, or other materials with a high specific gravity) or screenings (e.g., relatively large materials such as rags) generated during preliminary treatment of domestic sewage or a combination of domestic sewage and industrial waste of a liquid nature in a treatment works. These materials usually are generated when the wastewater passes through bar screens and a grit chamber at the beginning of the treatment works.

Because grit and screenings have characteristics that are different from the characteristics of sewage sludge, the pollutant limits developed during the exposure risk assessments do not apply to those materials. For this reason, Part 503 does not apply when grit and screenings are used or disposed.

2.6.10 DRINKING WATER TREATMENT SLUDGE

Part 503 does not establish requirements for the use or disposal of sludge generated during the treatment of either surface water or ground water used for drinking water. Because domestic sewage is not in the influent to the processes in which surface water or ground water is treated, the solids removed in those processes are not sewage sludge. Thus, Part 503 does not apply to the use or disposal of those solids.

2.6.11 COMMERCIAL AND INDUSTRIAL SEPTAGE

Part 503 also does not establish requirements for the use or disposal of commercial septage, industrial septage, a mixture of domestic septage and commercial septage, or a mixture of domestic septage and industrial septage. Part 503 only applies if the device in which the septage is generated (e.g., a septic tank) only receives domestic sewage. If the device receives any material other than domestic sewage, the solids removed from the device are not domestic septage. In this case, Part 503 does not apply when the septage is used or disposed.

Part 503 also does not apply if domestic septage is mixed with either commercial septage (e.g., grease from a grease trap at a restaurant) or industrial septage prior to use or disposal. In this case, the requirements in Part 257 have to be met if the mixture is applied to or placed on the land. Part 257 also applies if either commercial septage or industrial septage or a mixture of commercial and industrial septage is applied to or placed on the land.

2.7 ELEMENTS OF A PART 503 STANDARD

The Part 503 regulation is a complex, yet flexible regulation. For example, different pollutant limits can be met when sewage sludge is applied to the land depending on the type of sewage sludge (e.g., bulk) and the type of land on which the sewage sludge is applied. In addition, Part 503 contains several pathogen alternatives and vector attraction reduction options that can be met. This allows the person who prepares sewage sludge to "tailor" a Part 503 standard for their particular situation.

As with any standard (e.g., a water quality standard or a drinking water standard), the elements of a Part 503 standard must be understood to comply with the Part 503 regulation. This section discusses those elements, which include general requirements, pollutant limits, management practices, operational standards, frequency of monitoring requirements, recordkeeping requirements, and reporting requirements.

2.7.1 GENERAL REQUIREMENTS

The general requirements in Part 503 vary by use or disposal practice. The first general requirement for each use or disposal practice is that sewage sludge shall not be used or disposed unless the applicable Part 503 requirements are met.

The main purpose of the other general requirements is to ensure the transfer of information about the Part 503 requirements between different parties (e.g., a person who prepares sewage sludge and a land applier). These general requirements address such things as providing notice and necessary information about the Part 503 requirements to different persons, determining the amounts of different pollutants applied to the land previously in sewage sludge, notifying the permit authority about the interstate transfer of sewage sludge, and closing a surface disposal site.

The general requirements are an important element of a Part 503 standard. All persons involved in the use or disposal of sewage sludge must understand and follow the appropriate Part 503 general requirements.

2.7.2 POLLUTANT LIMITS

The pollutant limits in Part 503 describe the amount of a pollutant allowed per unit of amount of sewage sludge or the amount of a pollutant that can be applied to a unit area of land. The pollutant limits are based on the results of an exposure risk assessment and are on a dry weight basis.

Although the Part 503 pollutant limits are important, they are not the only element in a Part 503 standard. All elements of a Part 503 standard should be considered equally when determining the Part 503 requirements that have to be met.

2.7.3 MANAGEMENT PRACTICES

The Part 503 management practices contain requirements that help protect public health and the environment from the reasonably adverse effects of pollutants in the sewage sludge. Often, the management practices address situations not addressed in the exposure risk assessment (e.g., sewage sludge entering a water of the United States after being applied to frozen or snow-covered land). In other cases, the management practices address operational requirements (e.g., install an instrument).

2.7.4 OPERATIONAL STANDARDS

The CWA indicates that in cases where a risk-based limit can not be developed for a pollutant, an operational standard can be developed that in the judgment of the EPA Administrator protects public health and the environment from the reasonably anticipated adverse effects of the pollutant. EPA chose to control pathogens in sewage sludge, the attraction of vectors to sewage sludge, and the concentration of total hydrocarbons in the exit gas from a sewage sludge incinerator stack through an operational standard because either a risk assessment methodology for those parameters was not available or data needed to conduct a risk assessment were not available.

An operational standard is a separate element in a Part 503 standard to distinguish it from a pollutant limit. As indicated previously, pollutant limits are risk-based whereas the operational standards are technology-based.

2.7.5 FREQUENCY OF MONITORING

This element of a Part 503 standard indicates the frequency at which tests have to be conducted to determine whether a Part 503 requirement is met. The Part 503 frequency of monitoring requirements are based on the amount of sewage sludge that is used or disposed annually. The greater the amount used or disposed, the more frequent tests have to be conducted. In cases where no sewage sludge is used or disposed during a year, no tests have to be conducted.

The Part 503 frequency of monitoring requirements address pollutants, pathogen densities, and certain vector attraction reduction options. In cases where a value for a sewage sludge operating parameter has to be met (e.g., time/temperature requirements for pathogen reduction), the specified value should be met at all times.

2.7.6 RECORDKEEPING

A Part 503 standard contains a recordkeeping element to ensure that a record is kept that shows whether the appropriate Part 503 requirements have been met. The recordkeeping requirements in Part 503 indicate who has to keep a record, what records to keep, and for how long the record has to be kept.

2.7.7 REPORTING

The final element in a Part 503 standard is reporting. The Part 503 reporting requirements indicate who has to report information to the permitting authority, the information that has to be reported, and when that information has to be submitted.

2.8 PROTECTION OF PUBLIC HEALTH AND THE ENVIRONMENT

The Part 503 regulation contains requirements designed to protect public health and the environment when sewage sludge is used or disposed. This section discusses the elements of a Part 503 standard that provide this protection.

2.8.1 POLLUTANT LIMITS AND MANAGEMENT PRACTICES - LAND APPLICATION AND SURFACE DISPOSAL

The pollutant limits and management practices for land application and surface disposal are designed to protect public health and the environment from the reasonably anticipated adverse effects of pollutants in sewage sludge. The pollutant limits, which are pollutant concentrations or loads, are based on the results of exposure risk assessments in which available information was used to determine a limit for different pathways of exposure. The most stringent limit from the pathways evaluated for each pollutant is the limit for the pollutant in Part 503. Thus, the Part 503 limit is protective of all of the pathways evaluated for a pollutant.

The management practices also protect public health and the environment by establishing requirements for either a land application site or a surface disposal site. In many cases, the management practices establish requirements for situations not addressed in the exposure risk assessment (e.g., causing harm to threatened or endangered species). In other cases, they establish site requirements (e.g., do not locate an active sewage sludge unit in an unstable area) that address the integrity of land on which sewage sludge is applied or placed.

2.8.2 POLLUTANT LIMITS AND MANAGEMENT PRACTICES - INCINERATION

The Part 503 incineration pollutant limits and management practices are designed to protect public health from the reasonable anticipated adverse effects of pollutants in sewage sludge that is incinerated. The pollutant limits are based on the results of an exposure risk assessment in which the inhalation pathway was evaluated. Results of the risk assessment (e.g., a risk specific concentration for each pollutant) are used in an equation along with certain site-specific data to calculate the allowable concentration of an inorganic pollutant in sewage sludge that is incinerated. In the case of lead, an existing air standard is used in lieu of a risk specific concentration to calculate the limit for lead.

The Part 503 incineration management practices contain requirements for the operation of a sewage sludge incinerator and for instruments used to measure values for certain operational parameters. The management practices ensure that the incinerator is operated in a similar manner as it was during the performance test to determine the site-specific values used to calculate the pollutant limits.

2.8.3 OPERATIONAL STANDARDS

In cases where risk-based numerical limits and management practices can not be developed, the CWA indicates that alternative standards can be developed. These include a design standard, an equipment standard, a management practice, an operational standard, or a combination thereof, that in the judgment of the EPA Administrator protects public health and the environment from the reasonably anticipated adverse effects of a pollutant in sewage sludge.

Part 503 contains operational standards for pathogens, vector attraction reduction, and the concentration of total hydrocarbons in the exit gas from a sewage sludge incinerator. In EPA's judgment, the operational standards for pathogens and vector attraction reduction protect public health and the environment from pathogens and the attraction of vectors to sewage sludge when sewage sludge is land applied or placed on a surface disposal site. In the judgment of the EPA Administrator, the total hydrocarbons operational standard protects public health from the reasonably anticipated adverse effects of organic pollutants in the exit gas from a sewage sludge incinerator stack.

2.9 REQUIREMENTS MORE STRINGENT THAN OR IN ADDITION TO PART 503

2.9.1 PERMITTING AUTHORITY

The Part 503 requirements are National standards. When writing a permit, the permitting authority can impose more stringent or additional requirements as long as he can show that they are necessary to protect public health and the environment from any adverse effect of a pollutant in the sewage sludge. The permitting authority can use best professional judgment (BPJ) to develop more stringent conditions or to add limits for pollutants that are not regulated by Part 503. The justification for more stringent or additional requirements must be included in the permit's fact sheet.

2.9.2 STATE, POLITICAL SUBDIVISION, OR INTERSTATE AGENCY

A State, political subdivision, or interstate agency can impose more stringent or additional requirements without any justification. However, when a State assumes authorization of the Federal sewage sludge management program, the additional or more stringent requirements would not be considered part of the approved State program and would not be Federally enforceable, unless the State shows the more stringent or additional requirements are needed to protect public health and the environment.

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3. PART 503 AND THE PERMITTING PROCESS

QUICK REFERENCE INDEX

3.1 PERMIT APPLICATION

An estimated 16,000 POTWs and an additional 3,000 to 5,000 other treatment works treating domestic sewage are subject to the requirements of Part 503. Table 3-1 identifies the types of persons required to apply for a sewage sludge permit. Because of the large number of persons anticipated to be permitted, EPA has developed a phased approach to incorporate the Part 503 requirements into permits. This approach is outlined in EPA's February 19, 1993, amendments to the sewage sludge permit program regulations (58 *FR* 9404).

TABLE 3-1 PERSONS REQUIRED TO APPLY FOR A PERMIT

Persons Required To Apply For a Permit	Persons Not Required To Automatically Apply For A Permit
• All generators of a sewage sludge that is ultimately regulated by Part 503 • Industrial facilities that separately treat domestic sewage and generate a sewage sludge that is ultimately regulated by Part 503 • All surface disposal site owners/operators • All sewage sludge incinerator owners/operators • Any person who changes the quality of a sewage sludge that is ultimately regulated under Part 503 (e.g., sewage sludge blenders or composters)	• Industrial facilities that treat a combination of industrial wastewater and domestic sewage and generate sewage sludge* • Sewage sludge land appliers/haulers/transporters (who do not change the quality of the sewage sludge)* • Sewage sludge packagers/baggers (who do not change the quality of sewage sludge)* • Owners of property on which sewage sludge is land applied* • Domestic septage haulers/land appliers*

*EPA maintains the ability to request permit applications from these persons where necessary to protect public health and the environment

The first phase of permitting is focused on persons required to have or requesting site-specific pollutant limits (i.e., incinerators and some surface disposal sites). These persons had to submit sewage sludge application information within 180 days of publication of Part 503. For all other TWTDS that already have NPDES permits, the Part 503 requirements will be incorporated into their permits as they are site-specific limits and that do not have NPDES permits had to submit limited baseline data within 1 year after Part 503 was published, and then a complete permit application when requested by the permitting authority. EPA may develop other permitting priorities and maintains the ability to require permit applications from any person sooner than under the phased approach.

Parts 122 and 501 require that the following information be obtained in the application: general facility information, annual sewage sludge volume, other permits held or requested, a topographical map extending 1 mile beyond the TWTDS boundary, a narrative description of use or disposal practices, any sewage sludge monitoring data the applicant may have, and any other information requested by the permit writer. The permit applicant must identify its chosen use or disposal practices and submit information to enable the permitting authority to determine compliance with the standards or to verify site-specific pollutant limits where the applicant requests or is required to have them.

EPA has developed an interim application form to be used by all TWTDS. The form lists the information that is required for the different categories of sewage sludge users or disposers. It should be used until the promulgation of the new municipal application forms 2A and 2S. The interim application form is in Appendix F and additional copies can be obtained from EPA Regional sludge coordinators.

All sewage sludge permit applications must be sent to the EPA Regional office until an applicant's State sewage sludge management program has been approved by EPA. When renewing an NPDES application in an NPDES approved State, the effluent information must go to the State and the sewage sludge information must be sent to the EPA Region.

3.1.1 REVIEWING THE APPLICATION

The better the information received at the time of application, the easier it is to assemble an appropriate and accurate permit for a particular use or disposal practice. Therefore, the most important step of the permitting process is the review of the application information by the permit writer for completeness and accuracy. Experience in NPDES permit writing has shown that considerable correspondence is often required before an application is considered to be "complete" and "accurate" by the permit writer. Some offices employ checklists for the review of application forms to facilitate this process. As the permit writer gains experience in writing permits, she will be able to better detect omissions and errors in the application information.

At a minimum, the application information should address each of the requirements specified at §§122.21(c) and (d). When an information item is not applicable, "NA" should be used to show that the item has been considered. However, if information is missing for an item, the permit writer must contact the applicant to obtain a written response. Because an administrative record must be maintained in processing a permit application and hearings are possible, only minor items should be handled by telephone, and even these must be documented in writing. The preferred method is to return the application to the applicant for completion, or to request a new application after the applicant has been advised of the problem items. If changes or corrections to any application are extensive, the applicant may be required to submit a new application. An application is considered complete when the permitting authority is satisfied that all required materials have been submitted.

The permit writer also should review the application to ensure, to the best of his ability, that it is accurate. While it can be difficult to detect many inaccuracies from the application alone, a number of common mistakes can be readily detected. The permit writer should follow the same procedures for correcting inaccurate information as are used for obtaining missing information. The following are examples of accuracy reviews the permit writer may conduct for pollutant characterization data.

- Do the reported values correspond to any existing permit, previous application, or monitoring data?

- Do concentration values correspond with analytical detection levels? Were the correct analytical methods used?

The permit writer should examine a number of data elements to verify that the data submitted are accurate and representative of the quality of the sewage sludge. These include evaluations to ensure that:

- Samples of sewage sludge were collected so as to ensure a representative sample
- Samples were collected and transported using appropriate procedures
- All regulated parameters were analyzed
- Analytical methods specified in Part 503 were used
- Appropriate detection levels were documented
- Results were reported on a dry weight basis
- Chain of custody was documented from sample collection through analysis
- Appropriate QA/QC procedures were followed.

3.1.2 COLLECTING ADDITIONAL INFORMATION

The permit writer may use additional sources of information to develop the draft permit. For example, a review of any records existing on the TWTDS can provide information that may be used by the permit writer. Performing a site visit and reviewing supplemental information sources can also provide additional information and insight into operations at a TWTDS.

Background information on the TWTDS may be available in the existing NPDES permit file or in other permit program office files, such as Resource Conservation and Recovery Act (RCRA) and Clean Air Act files. Information that may be available includes any current permits at the Federal, State, and local levels; the fact sheets for the current permits; any existing pollutant monitoring or discharge monitoring reports (DMRs); compliance inspection reports; correspondence concerning compliance problems; information on changes in plant conditions; and communications with other agencies. Some of this information may be stored in various automated data tracking systems, such as the NPDES Permit Compliance System. The permit writer should use this information where available. The information found may be used to verify information provided in the application, to gain a more detailed understanding of the TWTDS's operations, or to determine the compliance status of the TWTDS for other programs, which may indicate whether enforceable special conditions in the sewage sludge permit are appropriate.

For a permit writer to gain a thorough understanding of complex TWTDS, an inspection visit can be invaluable. A site visit is important in cases where significant pollution control or treatment improvements are required or where frequent compliance problems have occurred. The site visit should include a review of sewage sludge treatment processes, including performance of the sewage sludge treatment units, and operation and maintenance practices. A site visit supports an evaluation of the adequacy of existing treatment practices and performance data and an assessment of the feasibility of improvements. Monitoring points, sampling methods, and analytical techniques should be evaluated to determine changes to monitoring requirements and to evaluate the quality of the data. In addition, raw material and product storage and loading areas, sewage sludge storage and disposal areas, land application sites, storm water management controls, and all process areas should be observed to determine the need for controls and for specific best management practices.

Aerial photographs are an excellent aid for conducting a site visit and may provide much of the needed information on the potential for contamination of surface runoff. Aerial photographs are useful in determining the effects on the surrounding environment. For example, changes in vegetation in areas that should be uniform may indicate a pollution problem and a change in the coloration of bodies of water may indicate the TWTDS's effects on the surface waters. Aerial photographs may be obtained from a variety of sources as identified in Table 3-2.

A great deal of information may be required to be submitted by the permit applicant. To ensure the completeness and accuracy of the data received, the permit writer may use a variety of other sources. Table 3-2 lists government agencies and organizations that may be contacted to obtain information including topographic maps, flood rate and boundary maps, storm water management facility design requirements, and air quality models that may support permit development efforts and can be used to verify or supplement the permit applicant's responses.

As mentioned above, additional sources of information that may be useful to the permit writer include other environmental permits, such as air or solid waste permits, and other sewage sludge management permits written for similar TWTDS. Supplemental data may be requested, as needed, from various State agencies or from the applicant. References used in developing this guidance document, as listed at the end of each chapter, are also good sources of information.

Finally, the permit writer may use secondary sources of information to obtain background data on sewage sludge use or disposal practices and their potential effects on public health and the environment. Use of these other sources may supplement information received from the applicant. The following is a list of information sources for sewage sludge.

- EPA's National Sewage Sludge Survey—More than 400 POTWs were surveyed for information on sewage sludge use or disposal practices and 200 were sampled for actual sewage sludge quality data. Copies of the analytical database and questionnaire database of this survey are available through the National Technical Information Service (NTIS) in Springfield, Virginia. Information on ordering these and other technical support documents is in Part XIV of the preamble to Part 503 (58 *FR* 9377).

- State solid waste management plans, individual solid waste/sludge management plans, and State application forms—This information can be obtained through the State NPDES permit office, solid waste program office, or health department.

- EPA Construction Grant Program information—This includes the NEEDS data base that describes all treatment processes used at POTWs and other basic information about their design and operation. The NEEDS data base is administered by the Municipal Support Division of the Office of Wastewater Management at EPA Headquarters.

TABLE 3-2 LIST OF GOVERNMENT AGENCIES AND ORGANIZATIONS THAT MAY BE CONTACTED FOR CERTAIN INFORMATION

Type of Information	Source
1. Topographical maps of the area being reviewed	U.S. Geological Survey (USGS).
2. Information on types of habitat, endangered species of plant, fish, and wildlife in the area being reviewed	Regional U.S. Fish and Wildlife Service (FWS).
3. Flood insurance rate maps (FIRMS) and flood boundary and floodway maps in the area being reviewed	U.S. Federal Emergency Management Agency (FEMA) Distribution Center, the U.S. Army Corps of Engineers, USGS, the U.S. Soil Conservation Service, the Bureau of Land Management, the Tennessee Valley Authority, or State and local agencies.
4. Information on 100-year flood and information to determine the potential of flooding in the area being reviewed	U.S. Water Resources Council, U.S. Army Corps of Engineers.
5. Information on the numerical models to aid in the prediction of flood hydrographs, flow parameters, the effect of obstructions on flow levels, the simulation of flood control structures, and sediment transport	Local U.S. Army Corps of Engineers District Office.
6. • Site-specific storm water management facility design requirements in the area being reviewed • Storm water permits.	• Local planning agencies, civil works departments, or local zoning boards (name and address of such local agencies can be found in the local directories) • NPDES permitting authority.
7. Location of wetlands in the area being reviewed	Local U.S. Army Corps of Engineers District Office and local planning and zoning commissions or agencies.
8. Seismic impact zones, fault zones, and seismic hazards in the area being reviewed	USGS, the Building Seismic Safety Council, the Colorado School of Mines, State Geological Surveys, Earthquake Information Center, the National Information Service for Earthquake Engineering, the National Institute of Science and Technology, the American Institute of Architects.
9. Copies of the computer software package, Geotechnical Analysis for Review of Dikes Stability, which details the basic technical concepts and operational procedures for the analysis of site hydraulic conditions, dike slope, foundation stability, dike settlement, and liquefaction potential of dike and foundation soils	EPA's Risk Reduction Engineering Laboratory.
10. EPA's approved air quality models	EPA's Office of Air Quality and Standards in Research Triangle Park, NC.
11. Aerial photographs of a site to aid in identifying the potential for surface runoff	Environmental Services Division (in some EPA Regions), the National Enforcement Investigation Center, EPA's Environmental Monitoring and Support Laboratory in Las Vegas, NV, the Environmental Photo Interpretation Laboratory in Vint Hill, VA, and private contractors.

- Pretreatment program information—This includes information on types and amount of industrial loadings to a POTW and past or present sewage sludge quality problems and can be found in the POTW's pretreatment program application, annual reports, and environmental audit reports. This information can be found in the State or EPA Regional NPDES permitting office.

- Basin plans and water quality management plans—These sources may be useful in identifying sensitive areas such as wetlands or drinking water aquifers.

- Local and State health extension agencies and university agricultural research departments—These sources may be useful for consultation on specific characteristics or problems having to do with sewage sludge management and potential impacts.

3.2 OVERVIEW OF THE PERMITTING PROCESS

An NPDES permit and the permit issuance process (including development of a fact sheet and public notice requirements), must follow the NPDES permitting regulations in Parts 122 and 124. Permits issued by States under Part 501 must contain similar conditions to those in NPDES permits. This section reviews appropriate conditions for a sewage sludge permit and highlights fact sheet requirements.

3.2.1 CORE PERMIT CONDITIONS

Generally, each permit issued to a TWTDS should contain:

- Specific pollutant limits applicable to sewage sludge quality

- General requirements, operational standards, and management practices

- Compliance monitoring requirements

- Reporting and recordkeeping requirements

- Standard permit conditions required by Part 122 or Part 501

- Any other conditions related to any aspect of sewage sludge management developed on a case-by-case basis where such conditions are necessary to protect public health and the environment.

As indicated above, each NPDES permit must contain the standard conditions included in every NPDES effluent permit. Previously, EPA modified some of these standard conditions to specifically include sewage sludge activities. For a sewage sludge-only permit, some of the NPDES standard conditions from § 122.41, which focus on discharges to waters of the United States, do not apply (e.g., upset and bypass).

3.2.2 FACT SHEET

The permit writer must develop a fact sheet for each Class I sludge management facility and for each permit that includes a land application plan, in accordance with the requirements in Parts 124 and 501. When a fact sheet is not required, a statement of basis must be prepared. A fact sheet must include:

- Any calculations or other necessary explanation of the derivation of specific standards for sewage sludge use or disposal, including a citation to the standard for sewage sludge use or disposal and reasons why they are applicable.
- A brief description of the TWTDS and when appropriate, a sketch or detailed description of the location of the regulated activity described in the application.
- For permits that include a sewage sludge land application plan under §501.15(a)(2)(ix), a brief description of how each of the required elements of the land application plan are addressed in the permit.
- The name and telephone number of a contact person.
- A description of the procedures for reaching a final decision on the draft permit.

4. LAND APPLICATION - PART 503 SUBPART B

QUICK REFERENCE INDEX

4.1 INTRODUCTION

This chapter provides guidance on implementation of the requirements for Part 503, Subpart B, which applies to the land application of sewage sludge. The permit writer should work with the permittee to determine which of the land application requirements apply to a particular situation. Chapter 2 defines sewage sludge and provides a detailed description of materials that are not regulated under Part 503.

The first step is to determine whether the use or disposal practice qualifies as land application. For purposes of Part 503, "land application" is the spreading or spraying of sewage sludge onto the surface of the land or the injection of sewage sludge beneath the surface of the land to condition the soil or to fertilize crops grown in the soil.

Sewage sludge may be applied to agricultural land (including pasture and range land), forests, and public contact sites, such as parks and golf courses. In these situations, the rate at which the sewage sludge is applied usually is based on the nitrogen requirements of the vegetation or crop grown in the soil.

Sewage sludge also may be applied to disturbed land in an effort to reclaim and vegetate the land. A reclamation site is an area that has been disturbed by activities such as strip mining, clear-cutting, severe erosion, or construction. The land is so disturbed that it no longer supports vegetation. Sewage sludge is applied to restore organic material in the soil and to provide nutrients for vegetation grown in the soil. In some cases, sewage sludge may be applied to a reclamation site at a rate that is higher than the rate needed to provide the nitrogen for the vegetation.

Other types of land on which sewage sludge may be applied are lawns and home garden. Sewage sludge usually is applied to lawns or home gardens in small amounts and is usually sold or given away in a bag or other container (i.e., receptacle that holds up to one metric ton of sewage sludge) for application to those types of land.

The permit writer also should determine whether bulk sewage sludge will be applied to the land or whether sewage sludge will be sold or given away in a bag or other container for land application. This will help the permit writer determine which of the Part 503 land application requirements apply to a particular situation.

Sewage sludge that meets certain requirements is frequently referred to as "exceptional quality" (see definition) although this term is not found in Part 503. If a generator or other preparer is able to demonstrate that a sewage sludge or a material derived from sewage sludge meets the criteria for "exceptional quality" sewage sludge, the sewage sludge is not subject to the general requirements and management practices in the land application subpart. In addition, whenever an exceptional quality sewage sludge is used to produce a material derived from the sewage sludge, the resulting material is not subject to the Part 503 requirements. The preparer of this resulting material does not have to independently demonstrate that the material meets the exceptional quality criteria as long as all of the sewage sludge from which the material was derived meets the exceptional

> **Exceptional Quality Criteria**
>
> Sewage sludge or material derived from sewage sludge that achieves the ceiling concentrations in §503.13(b)(1), the pollutant concentrations in §503.13(b)(3), one of the Class A pathogen reduction alternatives in §503.32(a), and one of the vector attraction reduction alternatives in §§503.33(b)(1) through (b)(8) or a vector attraction reduction method determined by the permitting authority to be equivalent, is referred to as exceptional quality sewage sludge.

quality criteria. Exceptional quality bulk sewage sludge is not subject to the Subpart B general requirements and management practices unless the permit writer can show that these requirements are necessary to protect public health and the environment. When the sewage sludge does not meet the exceptional quality criteria, the sewage sludge is subject to the Subpart B general requirements and management practices.

The treatment works generating the sewage sludge may not always be the person ultimately responsible for the land application of the sewage sludge. The sewage sludge may be transferred to another person who changes the quality or land applies the sewage sludge. When the generator provides the sewage sludge to another preparer, the permit writer must decide whether the generator or other preparer is responsible for the different requirements. This decision should be based on a thorough understanding of the type of sewage sludge treatment that occurs at each TWTDS. The permit writer may choose to put some requirements in both permits. Another option is to issue one permit to both entities as co-permittees.

Appliers who do not change sewage sludge quality will usually not be required to obtain a permit. When the applier is not the preparer, the permit writer may want to put the applier's requirements in the preparer's permit, to ensure compliance by the applier. Table 4-1 lists the specific Subpart B requirements that apply to a generator, another preparer, and an applier.

The remainder of this chapter discusses the Part 503 requirements for land application of bulk sewage sludge and for sewage sludge that is sold or given away in a bag or other container for application to the land. This chapter also discusses various scenarios for a land application standard. The alternative requirements for each of the seven elements of a Part 503 standard are combined in the scenarios to illustrate how those requirements are implemented.

4.2 SPECIAL DEFINITIONS

Section 503.9 contains general definitions applicable to more than one subpart in Part 503. In addition, §503.11 provides several definitions specifically applicable to land application. This section discusses some of the definitions in §503.11 and lists the remainder of the definitions in that section and some selected definitions from §503.9 for reference purposes.

Agronomic Rate

Statement of Regulation

§503.11(b) **Agronomic rate is the whole sewage sludge application rate (dry weight basis) designed: (1) to provide the amount of nitrogen needed by the food crop, feed crop, fiber crop, cover crop, or vegetation grown on the land and (2) to 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.**

The important aspect of this definition is that the agronomic rate is a rate that is designed to achieve certain results at a particular application site. For this reason, site-specific factors (e.g., soil type) must be considered when designing the agronomic rate.

Many pieces of information are used to design an agronomic rate. These include, among other things, the nitrogen concentration in the sewage sludge, estimates of available nitrogen from previous sewage

TABLE 4-1 SUBPART B REQUIREMENTS APPLICABLE TO GENERATORS, PREPARERS, OR APPLIERS

Generator or Preparer	Applier
General requirements 503.12(d) 503.12(f) 503.12(g) 503.12(i)	General requirements 503.12(a) 503.12(b) 503.12(e) 503.12(h) 503.12(j)
Pollutant limits 503.13(b)(1), (b)(3), or (b)(4)	Pollutant limits 503.13(b)(2)
Management practice 503.14(e)	Management practices 503.14(a) 503.14(b) 503.14(c) 503.14(d)
Operational standards 503.15(a) pathogens 503.33(b)(1-8) vector attraction reduction	Operational standards 503.32(b)(5) site restrictions for Class B sewage sludge 503.33(b)(9) vector attraction reduction 503.33(b)(10) vector attraction reduction
Monitoring 503.16(a)	
Recordkeeping 503.17(a)(1) exceptional quality sewage sludge 503.17(a)(2) exceptional quality sewage sludge derived material 503.17(a)(3)(i) sewage sludge subject to pollutant concentration limits, Class A, and vector attraction reduction in §503.33(b)(9) or §503.33(b)(10) 503.17(a)(4)(i) sewage sludge subject to pollutant concentration limits and Class B 503.17(a)(5)(i) sewage sludge subject to cumulative pollutant loading rates 503.17(a)(6) sewage sludge subject to annual pollutant loading rates	Recordkeeping 503.17(a)(3)(ii) sewage sludge subject to pollutant concentration limits, Class A, and vector attraction reduction in §503.33(b)(9) or §503.33(b)(10) 503.17(a)(4)(ii) sewage sludge subject to pollutant concentration limits and Class B 503.17(a)(5)(ii) sewage sludge subject to cumulative loading rates
Reporting 503.18	Reporting 503.18

sludge applications and/or legume residues, the realistic yield of the crop or vegetation grown in the soil, and the nitrogen requirement for the crop or vegetation.

Annual Pollutant Loading Rate

Statement of Regulation

§503.11(c) **Annual pollutant loading rate is the maximum amount of a pollutant that can be applied to a unit area of land during a 365 day period.**

An annual pollutant loading rate (APLR) limits the amount of a pollutant that can be applied to the land in sewage sludge each year. It does not limit the concentration of a pollutant in the sewage sludge. To ensure that none of the annual pollutant loading rates are exceeded, the annual whole sludge application rate that does not cause any of those rates to be exceeded must be determined using the procedure in Appendix A of Part 503. The APLR only applies to sewage sludge that does not meet the pollutant concentrations and is sold or given away in a bag or other container for application to the land.

Annual Whole Sludge Application Rate

Statement of Regulation

§503.11(d) **Annual whole sludge application rate is the maximum amount of sewage sludge (dry weight basis) that can be applied to a unit area of land during a 365 day period.**

The annual whole sludge application rate (AWSAR) is the amount of sewage sludge (i.e., tons per acre) applied to a hectare of the land in a year. In most cases, the AWSAR for bulk sewage sludge is limited to the agronomic rate for the application site. For sewage sludge sold or given away in a bag or other container, the AWSAR is the rate determined using the procedure in Appendix A of Part 503.

Bulk Sewage Sludge

Statement of Regulation

§503.11(e) **Bulk sewage sludge is sewage sludge that is not sold or given away in a bag or other container for application to the land.**

Bulk sewage sludge refers to sewage sludge that usually is applied to the land in large amounts. However, small amounts of sewage sludge (e.g., less than one metric ton) also can be bulk sewage sludge if the Part 503 land application requirements for bulk sewage sludge are met when the small amounts are land applied.

Cumulative Pollutant Loading Rate

Statement of Regulation

§503.11(f) **Cumulative pollutant loading rate is the maximum amount of an inorganic pollutant that can be applied to an area of land.**

This type of pollutant limit regulates the amount of a pollutant in sewage sludge that can be applied to a unit area of land rather than the concentration of the pollutant in the sewage sludge. This amount is not an annual amount, but the cumulative amount that can be applied to the land (i.e., for the life of the application site). Cumulative pollutant loading rates (CPLRs) only apply to bulk sewage sludge that is land applied because records have to be kept of the amount of each pollutant applied to a site in sewage sludge. It is impracticable to keep records of the amount of pollutants in sewage sludge sold or given away in a bag or other container that is applied to the land. CPLRs do not apply to sewage sludge that meets the pollutant concentrations.

Land Application

Statement of Regulation

§503.11(h) **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 soil so that the sewage sludge can either condition the soil or fertilize crops or vegetation grown in the soil.**

Land application refers to the application of sewage sludge to an area of land to take advantage of the soil conditioning properties or fertilizer value of the sewage sludge. Placement of sewage sludge on the land for other purposes is considered surface disposal of sewage sludge in Part 503.

Other Container

Statement of Regulation

§503.11(j) **Other 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.**

The definition of other container limits the amount of sewage sludge that can be sold or given away in a bag or other container to one metric ton or less. This definition is used because the assumptions made to develop some of the Part 503 requirements (e.g., annual pollutant loading rates) only are applicable to small amounts of sewage sludge applied to certain types of land (e.g., lawns and home gardens). Usually only sewage sludge that is sold or given away in a bag or other container is applied to those types of land. Note that amounts of sewage sludge less that one metric ton also can be classified as bulk sewage sludge as discussed above.

The remaining definitions from §503.11 and selected definitions from §503.9 are shown below for reference purposes.

Statement of Regulation

§503.11(a)	**Agricultural land is land on which a food crop, a feed crop, or a fiber crop is grown. This includes range land and land used as pasture.**
§503.9(a)	**Apply sewage sludge or sewage sludge applied to land means land application of sewage sludge.**
§503.9(d)	**Cover crop is a small grain crop, such as oats, wheat, or barley, not grown for harvest.**
§503.9(g)	**Domestic sewage is waste and wastewater from humans or household operations that is discharged to or otherwise enters a treatment works.**
§503.9(h)	**Dry weight basis means calculated on the basis of having been dried at 105 degrees Celsius until reaching a constant mass (i.e., essentially 100 percent solids content).**
§503.9(j)	**Feed crops are crops produces primarily for consumption by animals.**
§503.9(k)	**Fiber crops are crops such as flax and cotton.**
§503.9(l)	**Food crops are crops consumed by humans. This includes, but is not limited to, fruits, vegetables, and tobacco.**
§503.11(g)	**Forest is a tract of land thick with trees and underbrush.**
§503.11(i)	**Monthly average is the arithmetic mean of all measurements taken during the month.**
§503.11(k)	**Pasture is land on which animals feed directly on feed crops such as legumes, grasses, grain stubble, or stover.**
§503.11(l)	**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.**
§503.11(m)	**Range land is open land with indigenous vegetation.**
§503.11(n)	**Reclamation site is drastically disturbed land that is reclaimed using sewage sludge. This includes, but is not limited to, strip mines and construction sites.**
§503.9(bb)	**Wetlands means those areas that are inundated or saturated by surface water or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.**

4.3 GENERAL REQUIREMENTS

The application of sewage sludge to the land may involve several persons. Not all of these persons need to receive a permit, but all of them must comply with the appropriate Subpart B requirements. This section discusses the general requirements in the Part 503 land application subpart. They require persons preparing and applying sewage sludge to obtain information about the Part 503 land application requirements, to comply with the requirements, and to provide such information as necessary for other persons involved in preparing and land applying sewage sludge to comply with the requirements. The general requirements that apply to land application of bulk sewage sludge and to sewage sludge sold or given away in a bag or other container for application to the land are both discussed in this section. These general requirements do not normally apply to exceptional quality sewage sludge. However, the permit writer may apply any or all of these general requirements to bulk exceptional quality sewage sludge, if she can show that these requirements are necessary to protect public health and the environment from any reasonably anticipated adverse effect that may occur from any pollutant in the bulk sewage sludge.

4.3.1 BULK SEWAGE SLUDGE - PREPARER

Several of the Part 503 general requirements for land application apply to the person who prepares bulk sewage sludge. They are discussed below. Note that the person who prepares bulk sewage sludge is either the generator of the sewage sludge (e.g., a Federally owned treatment works) or a person who derives a material from sewage sludge (i.e., changes the quality of sewage sludge received from a generator).

Provide Concentration of Total Nitrogen in Sewage Sludge

<u>Statement of Regulation</u>

§503.12(d) **The person who prepares bulk sewage sludge that is applied to agricultural land, forest, a public contact site, or a reclamation site shall provide the person who applies the bulk sewage sludge written notification of the concentration of total nitrogen (as N on a dry weight basis) in the bulk sewage sludge.**

This general requirement requires that the person who prepares the sewage sludge (i.e., the generator of the sewage sludge or the person who derives a material from sewage sludge) provide the person who applies bulk sewage sludge to agricultural land, forest, a public contact site, or a reclamation site written notification of the total nitrogen concentration in the sewage sludge. The purpose of this requirement is to provide the land applier information needed by the applier to design the agronomic rate for the application site.

In addition to the total nitrogen concentration, the preparer should provide the applier the total Kjeldahl nitrogen, ammonia nitrogen, and nitrate nitrogen concentrations in the bulk sewage sludge. With that information and information about the application site (e.g., soil type and nitrogen in previous application of bulk sewage sludge), the applier can design the agronomic rate for the application site. This is discussed further in the section on land application management practices for bulk sewage sludge.

Note that this general requirement does not apply to sewage sludge that is sold or given away in a bag or other container for application to the land. In this situation, the guaranteed whole percentage of nitrogen in the sewage sludge is usually printed on a label or information sheet along with an application rate based on the nitrogen content of the sewage sludge. This provides the applier with information needed to ensure that the sewage sludge in not over-applied with respect to nitrogen.

Provide Information to the Person Who Applies Bulk Sewage Sludge

<u>Statement of Regulation</u>

§503.12(f) **When a person who prepares bulk sewage sludge provides the bulk sewage sludge to a person who applies the bulk sewage sludge to the land, the person who prepares the bulk sewage sludge shall provide the person who applies the sewage sludge notice and necessary information to comply with the requirements in this subpart.**

Under this general requirement, the person who prepares bulk sewage sludge is required to provide the person who applies the bulk sewage sludge to the land information needed to comply with the Part 503 requirements. This includes the nitrogen content of the sewage sludge, the concentration of the Part 503 pollutants in the sewage sludge, the class of pathogen reduction, whether vector attraction reduction is achieved through treatment, and the requirements for which the applier is responsible (e.g., management practices, vector attraction reduction if the sewage sludge is injected below the land surface or incorporated into the soil, and the Class B site restrictions).

The preparer also should notify the applier whether a record of the amount of each pollutant applied to the site in sewage sludge has to be kept because the sewage sludge is subject to the CPLR and whether the permitting authority in the state where the sewage sludge will be applied has been notified if that state is other than the state in which the sewage sludge is generated. In addition, the applier should be notified about the applicable Part 503 general requirements and recordkeeping requirements.

Provide Information to Another Person Who Prepares Sewage Sludge

<u>Statement of Regulation</u>

§503.12(g) **When a person who prepares sewage sludge provides the sewage sludge to another person who prepares the sewage sludge, the person who provides the sewage sludge shall provide the person who receives the sewage sludge notice and necessary information to comply with the requirements in this subpart.**

When a person receives sewage sludge from a preparer and then changes the quality of the sewage sludge, the second person also is a preparer because they derive a material from sewage sludge. This general requirement requires that the original preparer (the generator of the sewage sludge in most cases) provide the other preparer notice and necessary information to comply with the land application requirements.

The information that has to be provided to the new preparer is the applicable Part 503 requirements for land application, including general requirements, pollutant limits, management practices, operational standards for pathogens and vector attraction reduction, and the frequency of monitoring, recordkeeping, and reporting requirements. In addition, the original preparer should provide the new preparer the applicable general provisions in Subpart A of Part 503 (e.g., the requirement for a preparer in §503.7).

In this case, the notice and necessary information requirement in §503.12 (g) is the only requirement that applies to the original preparer because the quality of the original preparer's sewage sludge is changed by a subsequent preparer. The new preparer is now responsible for the Part 503 requirements if the derived material is applied to the land, including the requirement for a person who prepares sewage sludge in §503.7.

Interstate Transfer Notification Requirement

Statement of Regulation

§503.12(i) **Any person who prepares bulk sewage sludge that is applied to land in a State other than the State in which the bulk sewage sludge is prepared shall provide written notice, prior to the initial application of bulk sewage sludge to the land application site by the applier, to the permitting authority for the State in which the bulk sewage sludge is proposed to be applied. The notice shall include:**

(1) **The location, by either street address or latitude and longitude, of each land application site.**

(2) **The approximate time period bulk sewage sludge will be applied to the site.**

(3) **The name, address, telephone number, and National Pollutant Discharge Elimination System permit number (if appropriate) for the person who prepares the bulk sewage sludge.**

(4) **The name, address, telephone number, and National Pollutant Discharge Elimination System permit number (if appropriate) for the person who will apply the bulk sewage sludge.**

The purpose of this general requirement is to alert the permitting authority that bulk sewage sludge that is generated in one state will be land applied in another state. The permitting authority can then decide what action to take, if any.

This general requirement requires the person who prepares the bulk sewage sludge to notify the permitting authority in the state where the sewage sludge will be land applied if that state is different from the state in which the sewage sludge is generated. As part of the notification, the preparer must provide the location of the application site, the approximate time period bulk sewage sludge will be applied to the site, and the name and address of both the preparer and the applier.

4.3.2 BULK SEWAGE SLUDGE - APPLIER

In general, the permit writer will not issue a permit to persons involved in applying sewage sludge if these persons are not generating or preparing the sewage sludge. However, the permitting authority may designate the applier as a TWTDS if a permit is necessary to protect public health and the environment or to ensure compliance with Part 503. In some situations, such as when sewage sludge comes from another State, the permit writer might want to specify the information that the applier must obtain. The applier may be required to obtain all sampling data on pollutant concentrations in the sewage sludge and all data on pathogen and vector attraction reduction requirements from the preparer. Alternatively, the permit writer may require the applier to sample the sewage sludge received from the preparer to obtain the sewage sludge quality data. The following Part 503 general requirements must be met by the applier whether or not they are included in a permit.

Comply With the Part 503 Land Application Requirements

Statement of Regulation

§503.12(a) **No person shall apply sewage sludge to the land except in accordance with the requirements in this subpart.**

The first general requirement for the applier of bulk sewage sludge is that no person shall apply sewage sludge to the land except in accordance with the requirements in the land application subpart. This general requirement places the responsibility on the land applier to ensure that the requirements related to the land application site are met when the sewage sludge is actually land applied. These requirements include, but are not limited to, management practices, certain vector attraction reduction options, and the Class B site restrictions.

The land applier also should request information from the preparer that indicates that the treatment-related Part 503 land application requirements have been met, as appropriate. This includes pollutant concentrations in the sewage sludge, the class of pathogen reduction, and whether vector attraction reduction is achieved through treatment. The land applier needs this information to determine the requirements that he has to meet.

The person who applies bulk sewage sludge is also responsible for keeping certain records. These include the cumulative load of each inorganic pollutant applied to the land in sewage sludge if the CPLRs are applicable, whether the management practices are met, whether the sewage sludge is either injected below the land surface or incorporated into the soil for vector attraction reduction (as appropriate), whether the Class B site restrictions are met (as appropriate), and whether the requirement in §503.12(e) to obtain information has been met.

Do Not Exceed Any of the Cumulative Pollutant Loading Rates at a Land Application Site

Statement of Regulation

§503.12(b) **No person shall apply sewage sludge subject to the cumulative pollutant loading rates in §503.13(b)(2) to agricultural land, forest, a public contact site, or a reclamation site if any of the cumulative pollutant loading rates in §503.13(b)(2) has been reached.**

This general requirement addresses land application of bulk sewage sludge when the CPLRs are met. It does not apply if the pollutant concentration limits in Table 3 of §503.13 are met when sewage sludge is land applied.

Under this general requirement, no additional amount of bulk sewage sludge subject to the CPLRs can be applied to agricultural land, forest, a public contact site, or a reclamation site if any CPLRs have been reached at the application site. Records of the amount of each pollutant applied to a site since July 20, 1993, have to be kept to ensure that none of the CPLRs have been exceeded. If the amount of each pollutant applied to a site in bulk sewage sludge prior to July 20, 1993, is known, that amount can be subtracted from the CPLR for a pollutant to determine the additional amount of the pollutant that can be applied in sewage sludge. Note that bulk sewage sludge which meets the pollutant concentration limits can be applied to agricultural land, forest, a public contact site, or a reclamation site after a CPLR has been reached at the application site.

Under this general requirement, the land applier must keep a record of the amount of each Part 503 pollutant applied to an application site in bulk sewage sludge subject to the CPLRs. Those records must be kept indefinitely and must be made available to other persons who apply bulk sewage sludge to the same site. In this case, the records of the amount of each pollutant applied to the site are considered effluent data and cannot be withheld from other appliers.

Obtain Information Needed to Comply

Statement of Regulation

§503.12(e)(1) **The person who applies sewage sludge to the land shall obtain information needed to comply with the requirements in this subpart.**

§503.12(e)(2) **(i) Before bulk sewage sludge subject to the cumulative pollutant loading rates in §503.13(b)(2) is applied to the land, the person who proposes to apply the bulk sewage sludge shall contact the permitting authority for the State in which the bulk sewage sludge will be applied to determine whether bulk sewage sludge subject to the cumulative pollutant loading rates in §503.13(b)(2) has been applied to the site since July 20, 1993.**

(ii) If bulk sewage sludge subject to the cumulative pollutant loading rates in §503.13(b)(2) has not been applied to the site since July 20, 1993, the cumulative amount for each pollutant listed in Table 2 may be applied to the site in accordance with §503.13(a)(2)(i).

(iii) If bulk sewage sludge subject to the cumulative pollutant loading rates in §503.13(b)(2) has been applied to the site since July 20, 1993, and the cumulative amount of each pollutant applied to the site in the bulk sewage 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 §503.13(a)(2)(i).

(iv) If bulk sewage sludge subject to the cumulative pollutant loading rates in §503.13(b)(2) has been applied to the site since July 20, 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 in accordance with §503.13(a)(2)(i).

This general requirement requires the person who applies sewage sludge to the land to obtain information needed to comply with the requirements of this subpart. In most cases, the land applier gets the information from the preparer of the sewage sludge. This includes information on the applicable general requirements, the concentration of pollutants in the sewage sludge, the class of the sewage sludge with respect to pathogens, and whether vector attraction reduction was achieved through treatment of the sewage sludge. In addition, the applier should request information about the nitrogen concentration in the sewage sludge and which of the Part 503 requirements have to be met by the applier.

In the case where the CPLRs are met, the applier is responsible to determine the amount of each pollutant applied previously to the site in bulk sewage sludge. This is done by first contacting the permitting authority for the state where the application site is located to get the names of persons who applied bulk sewage sludge to the site under the CPLR concept since July 20, 1993. Next, the applier has to contact each of the previous appliers to get their records on the amount of each pollutant applied to the site in bulk sewage sludge. The current applier then subtracts the amounts applied previously from the CPLR to determine the additional amount of each pollutant the current applier could apply to the site.

When the records of the amounts of each pollutant applied previously to the land in bulk sewage sludge can not be found, additional amounts of sewage sludge can not be applied to that site under the CPLR concept. However, sewage sludge that meets the pollutant concentration limits can be applied to that site, assuming that all other applicable Part 503 requirements are met.

Provide Notice to the Owner or Leaseholder of the Land on Which Bulk Sewage Sludge Is Applied

Statement of Regulation

§503.12(h) **The person who applies bulk sewage sludge to the land shall provide the owner or lease holder of the land on which the bulk sewage sludge is applied notice and necessary information to comply with the requirements in this subpart.**

This general requirement requires the person who applies bulk sewage sludge to provide the owner or leaseholder of the land on which the bulk sewage sludge is applied notice and necessary information to comply with the Part 503 land application requirements. The purpose of this general requirement is to ensure the transfer of information about the Part 503 requirements to the appropriate persons.

The Part 503 land application requirements that may apply to the owner or lease holder of the land include the site restrictions for a Class B sewage sludge. These include a prohibition on harvesting certain types of crops and grazing animals for certain periods, and restricting public access for certain periods. This general requirement ensures that the owner or lease holder is notified about these restrictions. The land applier knows about the restrictions because the preparer of the sewage sludge provides the information to the applier.

In addition to the site restrictions for a Class B sewage sludge, the owner or lease holder of the land should know that sewage sludge is being applied to the land and that the appropriate Part 503 land application requirements have been met. This information also should be provided by the land applier.

Notify the Permitting Authority When the Cumulative Pollutant Loading Rates Are Met

Statement of Regulation

§503.12(j) **Any person who applies bulk sewage sludge subject to the cumulative pollutant loading rates in §503.13(b)(2) to the land shall provide written notice, prior to the initial application of bulk sewage sludge to a land application site by the applier, to the permitting authority for the State in which the bulk sewage sludge will be applied and the permitting authority shall retain and provide access to the notice. The notice shall include:**

(1) **The location, by either street address or latitude and longitude, of the land application site.**

(2) **The name, address, telephone number, and National Pollutant Discharge Elimination System permit number (if appropriate) of the person who will apply the bulk sewage sludge.**

This general requirement addresses the situation where more than one person applies bulk sewage sludge to a site under the CPLR concept. Without knowing who all the appliers are, there is no way to determine when any of the CPLRs are reached at a site.

Under this general requirement, the person who applies bulk sewage sludge to the land under the CPLRs must notify the permitting authority prior to the initial application of the bulk sewage sludge. The applier provides the permitting authority the location of the application site, the appropriate time bulk sewage sludge will be applied to the site, and the name and address of the land applier. Note that the preparer does not provide the permitting authority the amounts of the Part 503 pollutants applied to the site in bulk sewage sludge. This information is kept by the land applier. However, because the permit writer will normally issue a permit to the preparer but not to the applier, this notification requirement may be addressed in the preparer's permit.

This general requirement applies any time bulk sewage sludge is applied under the CPLR concept, whether the application site is within the state where the bulk sewage sludge is generated or out-of-state. Thus, the permitting authority should have a record of all persons who apply bulk sewage sludge to a particular site.

The permitting authority provides the names of previous appliers to a new applier when the new applier notifies the permitting authority prior to the initial application by the new applier. The new applier has to contact the previous appliers to obtain the amount of each of the Part 503 pollutants applied to the site in bulk sewage sludge by the previous appliers. The new applier uses that information to adjust the amount of each pollutant the new applier can apply to the site in bulk sewage sludge without causing any of the CPLRs to be exceeded.

This general requirement is very important to the implementation of the CPLR concept. As indicated above, without knowing the amount of each of the Part 503 pollutants applied previously in bulk sewage sludge, there is no way to know when any of the CPLRs are reached at a particular site.

4.3.3' SEWAGE SLUDGE SOLD OR GIVEN AWAY IN A BAG OR OTHER CONTAINER - PREPARER

Only one of the land application general requirements applies to a person who prepares sewage sludge that is sold or given away in a bag or other container for application to the land. It addresses the situation where the preparer of the sewage sludge provides the sewage to another person who prepares the sewage sludge (i.e., changes the quality of the sewage sludge).

Provide Sewage Sludge to Another Person Who Prepares the Sewage Sludge

Statement of Regulation

§503.12(g) **When a person who prepares sewage sludge provides the sewage sludge to another person who prepares the sewage sludge, the person who provides the sewage sludge shall provide the person who receives the sewage sludge notice and necessary information to comply with the requirements in this subpart.**

In this situation, the person who provides sewage sludge to another preparer must provide the person who prepares the sewage sludge notice and necessary information about the Part 503 requirements for sewage sludge that is sold or given away in a bag or other container. This includes information on the general provisions in subpart A of Part 503 (e.g., the provision in §503.7 for a preparer of sewage sludge) and the appropriate requirements in the land application subpart 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 original preparer's (i.e., most likely the generator of the sewage sludge) responsibilities under Part 503 are reduced in this situation. The original preparer only is required to provide notice and necessary information to the other person about the Part 503 land application requirements. The person who prepares the sewage sludge is responsible to ensure the applicable Part 503 land application requirements are met.

4.3.4 SEWAGE SLUDGE SOLD OR GIVEN AWAY IN A BAG OR OTHER CONTAINER - APPLIER

When sewage sludge is sold or given away in a bag or other container for application to the land, there are two general requirements that the applier has to meet. They include the requirements to apply the sewage sludge in accordance with Part 503 and to obtain information needed to comply with Part 503. Because it is unlikely that an applier of this type of sewage sludge would be designated as a TWTDS, these conditions would probably be placed in the preparer's permit.

These general requirements only apply when the APLRs in Table 4 of §503.13 are met. If the pollutant concentration limits in Table 3 of §503.13 are met when sewage sludge is sold or given away in a bag or other container, the general requirements do not apply.

Comply with the Part 503 Land Application Requirements

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

§503.12(a) **No person shall apply sewage sludge to the land except in accordance with the requirements in this subpart.**

This general requirement requires the person who applies the sewage sludge to the land to comply with the appropriate Part 503 land application requirements. In most cases, the applier in this situation is a home owner.

The Part 503 requirements that have to be met are the instructions on a label or information sheet, which is required when the APLRs are met. The label or information sheet includes the AWSAR (e.g., pounds of sewage sludge per 1,000 square feet) for the sewage sludge and a statement that the AWSAR can not be exceeded. The applier must follow the instructions on the label or information sheet.

Obtain Information Needed to Comply With Part 503

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

§503.12(e)(1) **The person who applies sewage sludge to the land shall obtain information needed to comply with the requirements in this subpart.**

Under this general requirement, the person who applies sewage sludge that is sold or given away in a bag or other container to the land is required to obtain information to comply with the Part 503 requirements. This is done by reading the instructions on the label or information sheet related to the Part 503 requirements and following those instructions.

4.4 POLLUTANT LIMITS

Subpart B of Part 503 contains pollutant limits for sewage sludge that is land applied. These limits, which include ceiling concentration limits, cumulative pollutant loading rates, pollutant concentration limits, and annual pollutant loading rates, are discussed in this section.

Statement of Regulation

§503.13 Pollutant limits

§503.13(a) Sewage sludge

§503.13(a)(1) Bulk sewage sludge or sewage sludge sold or given away in a bag or other container shall not be applied to the land if the concentration of any pollutant in the sewage sludge exceeds the ceiling concentration for the pollutant in Table 1 of §503.13.

§503.13(a)(2) If bulk sewage sludge is applied to agricultural land, forest, and public contact site, or a reclamation site, either:

(i) the cumulative loading rate for each pollutant shall not exceed the cumulative loading rate for the pollutant in Table 2 of §503.13; or

(ii) the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of §503.13.

§503.13(a)(3) If bulk sewage sludge is applied to a lawn or a home garden, the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of §503.13.

§503.13(a)(4) If sewage sludge is sold or given away in a bag or other container for application to the land, either:

(i) the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of §503.13; or

(ii) the product of the concentration of each pollutant in the sewage sludge and the annual whole sludge application rate for the sewage sludge shall not cause the annual pollutant loading rate for the pollutant in Table 4 of §503.13 to be exceeded. The procedure used to determine the annual whole sludge application rate is presented in Appendix A of this part.

4.4.1 CEILING CONCENTRATION LIMITS - ALL LAND APPLIED SEWAGE SLUDGES

Statement of Regulations

§503.13 Pollutant limits

TABLE 1 OF §503.13 – CEILING CONCENTRATIONS

Pollutant	Ceiling Concentration (milligrams per kilogram)*
Arsenic	75
Cadmium	85
Copper	4,300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7,500

*Dry weight basis

The ceiling concentration limits for sewage sludge that is land applied are presented above. They are expressed in milligrams of pollutant per kilogram of sewage sludge on a dry weight basis.

All sewage sludge that is land applied, both bulk sewage sludge and sewage sludge sold or given away in a bag or other container, has to meet the ceiling concentration limits. These limits are instantaneous values, which means that all samples of sewage sludge analyzed for the Part 503 pollutants have to meet the limits.

The ceiling concentration limits are the least stringent of the concentration value calculated using the CPLRs and assumed values for site life and AWSAR (see discussion below for the pollutant concentration limits), and the 99th percentile value for the pollutant from EPA's 1988 National Sewage Sludge Survey (NSSS). They prevent sewage sludges with high pollutant concentrations from being land applied.

After the ceiling concentration limits are met, one of two other groups of pollutant limits also have to be met when sewage sludge is land applied. These groups of limits are discussed below.

4.4.2 BULK SEWAGE SLUDGE

Cumulative Pollutant Loading Rates

Statement of Regulations

§503.13 Pollutant limits

TABLE 2 OF §503.13

Pollutant	Cumulative Pollutant Loading Rate (kg/ha)
Arsenic	41
Cadmium	39
Copper	1,500
Lead	300
Mercury	17
Molybdenum	*
Nickel	420
Selenium	100
Zinc	2,800

***The molybdenum limit was deleted on February 25, 1994 (59 *Federal Register* 9095). EPA plans to propose a new molybdenum limit in a subsequent amendment to Part 503.**

The Part 503 CPLRs are presented above. They limit the amount of a pollutant that can be applied to an area of land in bulk sewage sludge. The CPLRs are expressed in kilograms of pollutant per hectare of land for the life of the application site.

The CPLRs are based on the results of an exposure risk assessment during which 14 pathways of exposure were evaluated. The number of pathways evaluated for a pollutant varied depending on whether the pathway was appropriate for a pollutant (e.g., the vapor pathway was not evaluated for inorganic pollutants) and on the availability of information.

The result of a pathway analysis was either a CPLR or a pollutant concentration that was converted to a CPLR. The most stringent CPLR for all of the pathways evaluated is the CPLR for the pollutant in Table 2 of §503.13. Thus, a Part 503 CPLR protects public health and the environment from the reasonably anticipated adverse effect of the pollutant for all of the exposure pathways evaluated for a pollutant.

The other pollutant limits in subpart B (i.e., ceiling concentration limits, pollutant concentration limits, and annual pollutant loading rates) were developed using the CPLRs and some conservative assumptions. Because the CPLRs were used to develop the other limits, EPA concluded that the other limits also protect public health and the environment when sewage sludge is land applied.

When bulk sewage sludge that is applied to the land is subject to the CPLRs, records have to be kept of the amount of each pollutant applied to the land in the bulk sewage sludge. When any of the 10 CPLRs is reached at a land application site, an additional amount of bulk sewage sludge subject to the CPLRs can not be applied to the site. In most cases, not all of the CPLRs will be reached at a site at the same time. This provides an additional measure of protectiveness for the pollutants for which the CPLR is never reached at an application site.

A permit writer can estimate the amount of time that a specific site will be able to receive sewage sludge without exceeding the CPLRs if the AWSAR remains the same. Figure 4-1 shows the procedure to use to estimate site life and Figure 4-2 provides an example calculation.

Pollutant Concentration Limits

§503.13(b)(3) Pollutant concentrations

TABLE 3 OF §503.13 – POLLUTANT CONCENTRATIONS

Pollutant	Monthly Average Concentration (milligrams per kilogram)[1]
Arsenic	41
Cadmium	39
Copper	1,500
Lead	300
Mercury	17
Molybdenum	*
Nickel	420
Selenium	100
Zinc	2,800

[1]Dry weight basis

*The molybdenum limit was deleted on February 25, 1994 (59 *Federal Register* 9095). EPA plans to propose a new molybdenum limit in a subsequent amendment to Part 503.

The second group of pollutant limits that can be met when bulk sewage sludge is land applied is the pollutant concentration limits shown above. They limit the concentration of a pollutant in the bulk sewage sludge and are expressed in milligrams of pollutant per kilogram of sewage sludge on a dry weight basis.

The pollutant concentration limits were developed using the following approach. A pollutant concentration was calculated using an assumed site of 100 years and an assumed annual whole sludge application rate of 10 metric tons per hectare in equation (1) below.

$$\frac{CPLR}{100} = C \times 10 \times 0.001 \tag{1}$$

where:

CPLR = cumulative pollutant loading rate from Table 2 of §503.13 in kilograms per hectare
100 = assumed site life in years
C = pollutant concentration in milligrams-pollutant per kilogram-sewage sludge (dry weight basis)
10 = assumed annual whole sludge application rate in metric tons per hectare per 365-day period
0.001 = a conversion factor

Given: ***Steps 1 and 2 show the information to be obtained from the applicant for use in calculating the site life***

Step 1: The concentration of arsenic, cadmium, copper, lead, mercury, nickel, selenium, and zinc in the sewage sludge.

Step 2: The whole sludge application rate (SR).

Calculations: ***Steps 3 through 5 show the procedures, using the information gathered in Steps 1 and 2, to calculate the number of years sewage sludge could be applied to a site if the pollutant concentrations and SR remain the same.***

Step 3: Calculate a yearly pollutant loading rate (PL) for each inorganic pollutant using the equation below.

$$PL = C \times 0.001 \times SR$$

Where:

PL = Yearly pollutant loading rate for an inorganic pollutant in kilograms per hectare per 365-day period.

C = Measured pollutant concentration in the sewage sludge in milligrams per kilograms of total solids (dry weight basis).

SR = Whole sludge application rate in metric tons per hectare per 365-day period (dry weight basis).

0.001 = Conversion factor.

Step 4: Calculate the years an inorganic pollutant can be applied to the land by dividing the cumulative pollutant loading rate in Table 2 of §503.13 by the PL calculated in Step 3 of this procedure.

Step 5: Determine the lowest number of years calculated in Step 4 of this procedure. This is the period that sewage sludge can be applied to the land assuming no change in sludge quality or application rates, without causing any of the cumulative pollutant loading rates in Table 2 of §503.13 to be exceeded.

FIGURE 4-1 PROCEDURES TO CALCULATE SITE LIFE

Given: Steps 1 and 2 show the information obtained from the treatment works for use in calculating site life

Step 1: The pollutant concentrations in sewage sludge (dry weight basis) follow:

Pollutant	Measured Concentration (mg/kg)
Arsenic	10
Cadmium	7
Copper	741
Lead	134
Mercury	5
Nickel	42
Selenium	5
Zinc	1,201

Step 2: Whole sludge application rate is 10 metric tons per hectare per 365-day period.

Calculations:* *Steps 3 through 5 show the calculations, using the information gathered in Steps 1 and 2.

Step 3: Determine the yearly pollutant loading rates (PL) for the pollutants using the equation provided in Step 3 of Figure 4-1.

Pollutant	Measured Concentration (mg/kg)	PL (kg/ha/yr)
Arsenic	10	0.10
Cadmium	7	0.07
Copper	741	7.41
Lead	134	1.34
Mercury	5	0.05
Nickel	42	0.42
Selenium	5	0.05
Zinc	1,201	12.01

FIGURE 4-2 EXAMPLE CALCULATIONS FOR DETERMINING SITE LIFE

Step 4: Calculate the years an inorganic pollutant can be applied to the land by dividing the CPLR by PL.

Pollutant	CPLR* (kg/ha)	PL** (kg/ha/yr)	Years (CPLR/PL)
Arsenic	41	0.10	410
Cadmium	39	0.07	557
Copper	1,500	7.41	202
Lead	300	1.34	224
Mercury	17	0.05	340
Nickel	420	0.42	1,000
Selenium	100	0.05	2,000
Zinc	2,800	12.01	233

*From Table 2 of §503.13
**From Step 3

Step 5: Determine the lowest number of years calculated in Step 4.

For this example, the lowest number of years is 202 for copper. Sewage sludge with the inorganic pollutant concentrations given in Step 1 of this procedure can be applied to the land each year at a whole sludge application rate of 10 metric tons per hectare for a period of 202 years.

FIGURE 4-2 EXAMPLE CALCULATIONS FOR DETERMINING SITE LIFE (Continued)

Because the pollutant concentration limits were determined using the CPLRs, EPA concluded that those limits protect public health and the environment from the reasonably anticipated adverse effects of a pollutant when bulk sewage sludge is land applied.

The pollutant concentration limits are monthly averages. A monthly average is the arithmetic average of all measurements taken during the month. Thus, if two measurements are taken during the month (i.e., two representative samples are collected and analyzed during the month), the monthly average concentration for a pollutant is the sum of the two measurements divided by two. A monthly average concentration is not an instantaneous value if more than one measurement is taken during the month (i.e., it is the arithmetic average of all measurements taken during the month). Each measurement taken during the month must meet the ceiling concentration limit for a pollutant whereas the arithmetic average of the measurements taken during the month must meet the pollutant concentration limit for a pollutant.

When the pollutant concentration limits are met, records of the amount of each pollutant applied to a site in bulk sewage sludge do not have to be kept. Records of the concentration of the pollutant in sewage sludge do have to be kept, however.

4.4.3 SEWAGE SLUDGE SOLD OR GIVEN AWAY IN A BAG OR OTHER CONTAINER

Annual Pollutant Loading Rates

§503.13(b)(4) Annual pollutant loading rates

TABLE 4 OF §503.13 – ANNUAL POLLUTANT LOADING RATES

Pollutant	Annual Pollutant Loading Rate (kilograms per hectare per 365-day period)[1]
Arsenic	2.0
Cadmium	1.9
Copper	75
Lead	15
Mercury	0.85
Molybdenum	*
Nickel	21
Selenium	5.0
Zinc	140

[1]Dry weight basis

***The molybdenum limit was deleted on February 25, 1994 (59 *Federal Register* 9095). EPA plans to propose a new molybdenum limit in a subsequent amendment to Part 503.**

One group of pollutant limits for sewage sludge sold or given away in a bag or other container is the APLRs shown above. The APLRs limit the amount of sewage sludge that can be applied to an area of land and are expressed in kilograms of pollutant per hectare of land per 365-day period.

The APLRs were developed using the CPLRs in Table 2 of §503.13 and an assumed life for the application site. Sewage sludge that is sold or given away in a bag or other container is usually applied to a public contact site, a lawn, or a home garden. To calculate the APLRs, EPA assumed a site life of 20 years for those types of land. The Agency concluded that a 20-year site life is reasonable for a public contact site, a lawn, or a home garden.

The APLRs were calculated by dividing the CPLRs in Table 2 of §503.13 by 20. Because the CPLRs and a reasonable value for site life were used to calculate the APLRs, EPA concluded that the APLRs protect public health and the environment from the reasonably anticipated adverse effects of pollutants in sewage sludge when the sewage sludge is sold or given away in a bag or other container for application to the land.

The following equation is used to determine the annual whole sludge application rate (AWSAR) for a sewage sludge that does not cause any of the APLRs to be exceeded at the application site. An annual whole sludge application rate is calculated for each pollutant using the measured concentration for the pollutant in the sewage sludge and the APLR for the pollutant in Table 4 of §503.13.

$$AWSAR = \frac{APLR}{C \times .001}$$

Where:

AWSAR = annual whole sludge application rate in metric tons per hectare per 365-day period (dry weight basis)
APLR = annual pollutant loading rate from §503.13(b)(4) in kilograms per hectare per 365 days
C = concentration of pollutant in sewage sludge in milligrams per kilogram (dry weight basis)
.001 = conversion factor

The most stringent of the above annual whole sludge application rates is the rate that has to be included on a label or information sheet. The person who land applies the sewage sludge is expected to apply the sewage sludge at a rate that is equal to or less than the rate on the label or information sheet. Figure 4-3 provides an example calculation.

If the pollutant concentration increases for any particular pollutant, the permittee must recalculate and comply with a new AWSAR. The permittee should notify the permitting authority any time a change in pollutant concentrations causes a change in the AWSAR. To avoid frequent changes in the AWSAR, the permittee should use the maximum expected pollutant concentrations when determining the AWSAR.

Pollutant Concentration Limits

The second group of pollutant limits that can be met when sewage sludge is sold or given away in a bag or other container for application to the land are the pollutant concentration limits in Table 3 of §503.13. These limits are monthly average values and are expressed in milligrams of pollutant per kilogram of sewage sludge on a dry weight basis.

The pollutant concentration limits for sewage sludge sold or given away in a bag or other container for application to the land are the same as the pollutant concentration limits for bulk sewage sludge that is land applied. Thus, sewage sludge that meets the ceiling concentration limits and the pollutant concentration limits can be applied to the land in bulk or can be sold or given away in a bag or other container for application to the land if the other appropriate requirements are met.

Given: ***Step 1 shows the information to be gathered from the applicant and the annual pollutant loading rates***

Step 1: Measure the concentration of arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc in the sewage sludge.

Annual pollutant loading rates from Table 4 in § 503.13(b)(4) for land application and measured pollutant concentrations in the sewage sludge are provided:

Pollutant	Annual Pollutant Loading Rate* (kg/ha)	Concentration** (mg/kg)
Arsenic	2.0	10
Cadmium	1.9	7
Copper	75	741
Lead	15	134
Mercury	0.85	5
Nickel	21	42
Selenium	5	5
Zinc	140	1,201

*From Table 4 of § 503.13.
**Measured in the sewage sludge.

Calculations: ***Steps 2 and 3 show the procedures, using the information gathered in Step 1, to calculate the annual whole sludge application rate (AWSAR) that ensures annual pollutant loading rates are not exceeded.***

Step 2: Using the pollutant concentrations from Step 1 and the APLRs from Table 4 of the land application regulations, calculate the AWSAR using the equation below.

$$AWSAR = \frac{APLR}{C \times 0.001}$$

Where,

AWSAR = Annual whole sludge application rate in metric tons (mt) per hectare per 365-day period (dry weight basis).
APLR = Annual pollutant loading rate in kilograms per hectare per 365-day period.
C = Measured pollutant concentration in the sewage sludge in milligrams per kilograms of total solids (dry weight basis).
0.001 = Conversion factor.

ANNUAL WHOLE SLUDGE APPLICATION RATE (AWSAR)	
Pollutant	**(mt/ha/365-day period*)**
Arsenic	200
Cadmium	271
Copper	101
Lead	112
Mercury	170
Nickel	500
Selenium	1,000
Zinc	117

*Dry weight basis.

Step 3: Determine the AWSAR for the sewage sludge by selecting the lowest AWSAR from those calculated in Step 2.

The lowest Annual Whole Sludge Application Rate for the sewage sludge in this example is 101. If the sewage sludge is applied to land at a rate greater than 101 metric tons per hectare per 365-day period, the APLR for copper will be exceeded.

FIGURE 4-3 EXAMPLE CALCULATIONS FOR DETERMINING THE AWSAR

4.5 MANAGEMENT PRACTICES

4.5.1 BULK SEWAGE SLUDGE

Section 503.14 specifies four management practices for bulk sewage sludge that is applied to the land. These management practices provide an additional measure of protection, not considered in the risk assessment models used to develop the pollutant limits, for endangered species or critical habitat, surface water, wetlands, and ground water. The management practices do not normally apply to exceptional quality sewage sludge. However, the permit writer may apply any or all of the management practices to bulk exceptional quality sewage sludge if he can show that these requirements are necessary to protect public health and the environment from any reasonably anticipated adverse effect that may occur from any pollutant in the bulk sewage sludge.

Endangered Species or Critical Habitat Protection

Statement of Regulation

§503.14(a)	**Bulk sewage sludge shall not be applied to the land 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.**

Permitting Factors

Land application sites are often located in rural areas that either contain or are surrounded by a wide variety of plant, fish, and wildlife species, some of which may be endangered or threatened. The designated critical habitat is any place where a threatened or endangered species lives and grows during any stage in its life cycle. All threatened or endangered species of plants, fish, and wildlife are listed in 50 CFR § 17.11 and § 17.12. A copy of the lists with references to the original *Federal Register* listing notice can be obtained from the U.S. Department of Interior, Fish and Wildlife Service (FWS).

The permit writer may need to verify if any endangered or threatened species of plant, fish, or wildlife exist on or near the application site. In addition, an application site may be located in the migratory route of an endangered or threatened species of fish or wildlife and may become a temporary but critical habitat for such species. The permit writer can obtain such information or verify the information provided in the permit application by contacting the field office of the FWS. To provide the permit writer with the requested information, the FWS biologist may need specific data, such as the exact location (preferably in terms of latitude and longitude), the size of the site, location and size of any nearby body of water, and type and extent of vegetative cover.

If threatened or endangered species or their designated critical habitats are present in the areas proposed to receive the sewage sludge, the permit writer will need to determine whether the application of the sewage sludge to the land will likely cause an adverse effect upon the species or their habitats. An adverse effect would be the destruction or adverse modification of the critical habitat to the extent that the likelihood of survival and recovery of the species is diminished. Unfortunately, it may not be possible to predict the effects of the land application of sewage sludge on the species or habitat without site specific field studies. In some cases, it may be necessary to prohibit the application of sewage sludge on sites where threatened or endangered species or their critical habitats are present. However, it may be possible to allow the application of sewage sludge concurrent with field studies designed to measure the effects of this application on the species and their habitats. Best professional judgment should be used if specific management practices are necessary to protect the species and their habitat.

Permit Conditions

Section 503.14(a) only applies if endangered species of plant, fish, or wildlife are identified at an application site or if it is determined that the application site is located in the migratory path of any endangered or threatened species of wildlife. However, as a precautionary measure, the permit writer may include this management practice in the permit as it appears in Part 503.

If it is determined that the application site supports or is part of a critical habitat for a threatened or endangered species of plant, fish, or wildlife, the permit writer should consult with FWS personnel or other informed State or local agency personnel to determine and develop necessary permit conditions.[1] For example, if the application site is located within the migratory path of an endangered species, the permit writer could develop a permit condition prohibiting the application of bulk sewage sludge during the migration period.

Other conditions that the permit writer may include are the following:

- Buffer zones that provide an adequate distance from the critical habitat of the endangered species
- Requirements for increased frequency of monitoring and reporting in certain areas
- Requirements to conduct special studies to determine the impact on the endangered species or its critical habitat.

Application of Bulk Sewage Sludge to Flooded Land[2]

Statement of Regulation

§503.14(b) **Bulk sewage sludge shall not be applied to agricultural land, forest, a public contact site, or a reclamation site that is flooded, frozen or snow-covered so that the bulk sewage sludge enters a wetland or other waters of the United States, as defined in 40 CFR 122.2, except as provided in a permit issued pursuant to section 402 or 404 of the CWA.**

Permitting Factors

Generally, land is considered flooded when the soil at the surface of the land is saturated with water, regardless of whether water is visible on the ground. Such flooding conditions may be produced by heavy precipitation that occurs locally or at some distance from the site, the rise of any nearby surface

[1]FWS and EPA are in the process of developing consultation guidance for such permitting activities.

[2]Although §503.14(b) addresses application of sewage sludge to both flooded land and frozen or snow-covered land together, this manual discusses sewage sludge application under these two situations separately for ease of understanding.

water levels, the rise of the ground-water table to the surface of the land, the melting of snow and ice on the ground, or irrigation. Soil that is not well drained or not covered with grass or dense vegetation can easily become saturated during heavy rainfalls and can remain saturated for an extended period during rainy seasons. On the other hand, soil that is well drained and covered with thick vegetation can become saturated but generally does not remain saturated for more than a few days after a major rain shower.

The permit application (particularly the required topographic map) may provide information enabling the permit writer to determine if a designated site has potential to flood. In addition, the permit writer may wish to identify flood plains by contacting the local offices of the Army Corp of Engineers and the United States Geological Survey. Typically, these offices maintain data concerning lands that may be flooded in the event of precipitation. Particular attention should be paid to sites located adjacent to large water bodies because these have the greatest potential to flood.

Lands located in flood plains are obviously more likely to become completely or partially flooded and to remain flooded for an extended period. River floodplains are readily identifiable as the flat areas adjacent to the river's normal channel. Floodplains are also identified in the flood insurance rate maps (FIRMS); flood boundary and floodway maps are published by the U.S. Federal Emergency Management Agency (FEMA). Guidance in using FIRMS is provided in *How to Read a Flood Insurance Rate Map*, published by FEMA. FEMA also publishes *The National Flood Insurance Program Community Status Book*, which lists communities in the Emergency or Regular Flood Insurance Programs, including communities that may not be involved in the National Flood Insurance Program but that have FIRMS or floodway maps published. Maps and other FEMA publications may be obtained from the FEMA distribution center.

Areas not covered by FIRMS or floodway maps may be included in floodplain maps available through the U.S. Army Corps of Engineers, the U.S. Geological Survey, the U.S. Soil Conservation Service, the Bureau of Land Management, the Tennessee Valley Authority, and State and local agencies. Many of the river channels covered by these maps may have undergone modification for hydropower or flood control projects, and the floodplain boundaries represented may not be accurate or representative. To identify current river channel modifications and land use watersheds that could affect floodplain designation, it may be necessary to compare the floodplain map series to recent aerial photographs.

The rise of the ground-water table to the surface of the ground due to hydrogeological activities can also cause flooding of the land. Such flooding conditions are most likely to occur in the lands where the ground-water table is at the ground surface. Information on the seasonal changes of the water table in an area can be obtained from the U.S. Geological Survey. If the land regularly experiences upsurges of ground water and remains saturated for an extended period of time, it may be necessary to identify the approximate period(s) of the year that such upsurges occur.

Irrigation is a controlled way of saturating the soil. The application of bulk sewage sludge to an irrigated land may not be a concern when irrigation is occurring during dry weather. In some cases, however, land is flooded for an extended period to facilitate the crop or vegetation growth (e.g., rice fields, artificial reedbeds, or artificial wetlands).

The permit writer should evaluate a land application site for all of the above factors that could cause the land to become flooded and determine if there are conditions necessary to address in the permit. Different permit conditions may be needed depending on the location of the land and the extent of time during which the land generally remains flooded. For example, land located in a flood plain that is often flooded may require more specific permit conditions than land that is well drained and becomes saturated for only a short period during local or seasonal precipitations.

Permit Conditions

Where no potential for floods is noted, the permit writer may incorporate the management practice as it appears in Part 503. However, if the permit writer finds that potential for flooding exists, the permit writer may address those land application sites with specific management practices to ensure that sewage sludge does not enter waters of the United States. Some possible conditions include:

- Restricting the application of bulk sewage sludge to floodplains during periods that such land has the potential to flood.
- Restricting application of bulk sewage sludge during period(s) when the land is saturated.
- Prohibiting the application of bulk sewage sludge during period(s) when the land is flooded for irrigation.
- Require incorporation within a specific time period.

Application of Bulk Sewage Sludge to Frozen or Snow-Covered Land

Statement of Regulation

§503.14(b) **Bulk sewage sludge shall not be applied to agricultural land, forest, a public contact site, or a reclamation site that is flooded, frozen or snow-covered so that the bulk sewage sludge enters a wetland or other waters of the United States, as defined in 40 CFR 122.2, except as provided in a permit issued pursuant to Section 402 or 404 of the CWA.**

Permitting Factors

Many factors must be considered to determine if bulk sewage sludge applied to frozen or snow-covered land could enter surface waters or wetlands. When bulk sewage sludge is properly applied to land that is not frozen, it gradually loses its water content by seepage into the ground and evaporation. However, it retains most of its nutrients and inorganic pollutants. During precipitation, moist or dewatered sewage sludge incorporated into the soil increases the soil's ability to absorb moisture and, therefore, reduces runoff (Huddleston and Ronayne 1990). On the other hand, when sewage sludge is applied to frozen land, it lies frozen on the surface of the ground with little or no chance for its moisture content to seep into the ground. When sewage sludge freezes and thaws repeatedly, it loses most of its water content in a short period of time during thawing (EPA 1987, Martel 1991). For this reason and because sewage sludge will thaw before the frozen ground beneath it, there is a greater chance that the sewage sludge will be washed off by any significant rainfall into a nearby stream, river, lake, or wetland.

The application of bulk sewage sludge on snow-covered land has certain consequences. Generally, in flat areas with little rainfall during the thawing season, the snow melt occurs from bottom to top, leaving any sewage sludge applied to the surface of the snow intact (assuming that the sewage sludge was applied on the top of the last snow cover of the season). However, if the melting season is intermixed with precipitation, sewage sludge exposed on the surface of the snow can wash away and enter any nearby surface water or wetland.

This management practice is not a blanket prohibition of the application of bulk sewage sludge to frozen or snow-covered land. Rather, it is intended to restrict such application only if the bulk sewage sludge could enter surface waters or wetlands. For obvious reasons, the permit writer should not be concerned with this management practice in areas where the ambient air temperature is rarely below freezing or which seldom receive any significant snow precipitation. The permit writer should first determine whether the conditions for frozen or snow-covered land exist in the area where sewage sludge is applied (such information is available from the National Oceanic and Atmospheric Administration). If such conditions do exist, the permit writer should then determine whether thawing snow or water runoff might carry sewage sludge into nearby surface waters and should develop permit conditions to address this eventuality.

The permit writer should consider the following four factors when developing permit conditions for a land application practice that could involve frozen and snow-covered land: (1) the distance to surface waters or wetlands, (2) the topography of the land, (3) the average precipitation in the area of the land application site, and (4) the average length of time that land remains frozen. First, because runoff is sometimes unavoidable, even over well-drained soils, it is reasonable to assume that the closer a land application site is to surface waters or wetlands, the greater the chance is for sewage sludge to enter those water bodies. As a general rule, more care must be taken to develop or determine the necessary permit conditions where the site is close to water bodies than where a site is one half mile or more from any surface body of water. The permit writer will need data on the location of any surface waters or wetlands on or near the application site. The permit application and topographic map submitted as part of the permit application may provide this information. The U.S. Geological Survey quadrangle maps can also be used to determine the distance from the application site to water bodies.

The second factor that plays an important role in determining the potential for runoff to surface waters is topography. The slope of the land affects the amount and velocity of runoff. Hilly and steep terrains (slope of 6 percent or above) produce more runoff having the capability to transport larger particles (including sewage sludge) farther and faster (EPA 1983). Flat terrains (slope of less than 6 percent) generate less runoff and at lower velocity, with little or no capacity to carry larger particles a long distance (EPA 1983). Snow and ice deposited or accumulated on very hilly or steep terrain are not stable and often move and break apart during rainfall or thawing. Of special concern is frozen or snow-covered land that has a fairly steep uninterrupted slope (greater than 6 percent) leading to the edge of a body of water and that lacks adequate controls to protect the surface water from the avalanching effect of the snow and ice.

Third, information on average precipitation and general weather patterns is necessary to determine if the application of sewage sludge to land should be restricted under certain conditions. Generally, heavy snowfalls and freezing conditions followed by torrential rains of short duration produce large amounts of runoff that will increase the potential for the sewage sludge to be washed off the land and into nearby surface waters or wetlands. The information on average precipitation rates and weather patterns needed to determine the occurrence and duration (months of the year) of such conditions is available for most major cities from the following three publications of the National Oceanic and Atmospheric Administration:

- *Climatic Summary of United States*

- *Monthly Summary of Climatic Data*, which provides basic information on total precipitation, maximum and minimum temperatures, and relative humidity for each day of the month and for every weather station located in a given area

- *Local Climatological Data*, which provides an annual summary data for a relatively small number of major weather stations.

Analyzing meteorological data is important to determine if there may be conditions that could produce excessive surface runoff.

Fourth, the average length of time that land remains frozen in a 365-day period depends on the climatic conditions and weather patterns of the area. If the land remains frozen for most of a given year and only briefly thaws, the application of bulk sewage sludge becomes highly questionable. On the other hand, if the land stays frozen for only few days during a year or briefly freezes at night and thaws during the day in cold seasons, there may be little or no additional risk of sewage sludge entering nearby surface waters or wetlands.

Permit Conditions

Considering the above factors, the permit writer should use best professional judgment in determining the potential for sewage sludge to enter surface waters or wetlands when applied to frozen or snow-covered land. Where the risk is high, the permit writer should develop permit conditions or require the permittee to develop and implement specific management practices to minimize this possibility. If the permit writer determines that bulk sewage sludge has no potential to enter surface waters or wetlands from snow-covered or frozen land application areas, additional management requirements should not be necessary. As a general rule, there is little or no chance for sewage sludge to enter surface waters or wetlands when the land is flat and located in a temperate zone with moderate snow and freezing conditions and when the application site is very far from any surface waters or wetlands. As a precautionary measure, the permit writer may want to incorporate the related management practice verbatim from the Part 503 rule into the permit.

In locations where the land is not very flat (rolling hills with slopes of 6 to 12 percent), receives moderate amounts of snow and ice, and is fairly distant from any surface waters or wetlands, the permit writer may consider allowing the application of sewage sludge under certain conditions while the land is covered with snow (EPA 1983). As part of such permit conditions, the permit writer may require that the sewage sludge be applied only once to an area and at no time during or immediately before or after any rain event or that runoff controls, such as buffer zones or any other measure necessary, be required to prevent sewage sludge from entering surface waters.

In the areas where land is fairly steep (slope of greater than 12 but less than 15 percent) or where there is high probability that the sewage sludge applied on top of the frozen or snow-covered land will be washed off by rain and into the nearby surface waters or wetlands, the application of sewage sludge should generally be allowed only during the time when the ground is not snow-covered, frozen, or thawing (saturated) (EPA 1983). Alternatively, the permit writer may allow limited application of sewage sludge to such snow-covered ground as long as adequate runoff controls are employed to ensure no sewage sludge can enter surface waters.

Lands with uninterrupted steep slopes are normally close to either permanent or intermittent bodies of water. The application of sewage sludge to any land with a slope greater than 15 percent should be prohibited when covered with snow (EPA 1983). In addition, the application of sewage sludge to land that remains frozen for most of the year and only briefly thaws should be prohibited in most cases. Finally, if the permit writer determines that additional management practices may be appropriate for sites on or near wetlands, he or she may include conditions that limit sewage sludge application to times when lands are not frozen or snow-covered, prohibit sewage sludge application to sites with significant wetlands, create buffer zones around wetlands, or require diking around wetlands areas.

Distance to Surface Waters

Statement of Regulation

§503.14(c) **Bulk sewage sludge shall not be applied to agricultural land, forest, or a reclamation site that is 10 meters or less from waters of the United States, as defined in 40 CFR 122.2, unless otherwise specified by the permitting authority.**

Permitting Factors

While a properly constructed and maintained 10-meter setback provides adequate protection to water bodies in most cases, under certain conditions a wider buffer zone may be necessary. There are also situations where a smaller setback provides adequate protection but this must be approved by the permitting authority. The major factors in determining the appropriate size of the buffer zone or setback are: (1) slope of the land, (2) type of surface water being protected, (3) condition of the ground surface of the buffer, (4) rate of bulk sewage sludge application, (5) water content of the bulk sewage sludge, and (6) soil permeability.

Generally, steeper slopes produce more runoff with faster velocities thereby increasing the potential for surface water contamination. As a general rule, the 10-meter setback should be adequate if the slope is 6 percent or less. Land with slopes greater than 6 percent but less than 12 percent may require wider buffer zones, incorporation or injection of the biosolids, soil conservation methods (e.g., crop residue, vegetative cover), and/or other runoff controls. The application of sewage sludge to lands with slopes greater than 12 percent but less than 15 percent may require much wider buffer zones, in addition to runoff controls. The application of sewage sludge to lands located near surface waters with slopes greater than 15 percent should be prohibited except where the soil has very good permeability and the slope length is short and is only a small part of the entire application site (EPA 1983, Huddleston and Ronayne 1990). Sites which do not meet these criteria (e.g., reclamation sites) should be examined on a case-by-case basis. In addition, slope restrictions should not be imposed if flow patterns and proximity to surface water would preclude migration to such waters.

The type of surface water to be protected from sewage sludge contamination is the second major factor in determining if a wider buffer zone is necessary. For example, a setback wider than 10 meters may be necessary to protect a body of water used as a source of drinking water or a trout stream extremely sensitive to particulate matter and pollutants. Agricultural drainage ditches are examples of water bodies that may not require a full 10 meter setback.

The condition of the ground surface of the buffer is the third important factor in determining the size of the buffer zone. A buffer zone that is bare and has very low permeability provides almost no filtering, while a surface with thick vegetation provides filtration and slows down the runoff.

Liquid sewage sludge is more likely to be washed into the nearby waters than is dried or dewatered sewage sludge. In addition, if large quantities of sewage sludge are applied on slopes greater than 6 percent, it may be necessary for the permit writer to require injection of liquid sewage sludge into the soil or incorporation of dried or dewatered sewage sludge into the soil as soon as practicable after application, in addition to requiring other runoff controls and a setback wider than 10 meters. However, if the land is fairly steep (12 to 15 percent slope), the 10-meter setback is generally adequate for small quantities of liquid sewage sludge or dried or dewatered sewage sludge applied to the land as long as the sludge is immediately incorporated into the soil (EPA 1983, Huddleston and Ronayne 1990).

Permit Conditions

If the permit writer finds that adequate management practices are not in place to prevent sewage sludge from entering U.S. waters, additional management practices may be appropriate. Such practices may include developing buffer zones greater than 10 meters and marking the boundaries of these zones using flags, fences, or lines. Where the permit writer determines that bulk sewage sludge has no potential to enter waters of the United States, he should incorporate the 10-meter setback with no additional special conditions stipulated or a lesser setback if the permittee has submitted adequate information to verify that the smaller setback will provide adequate protection.

The permit writer may need to identify and specify, in the permit, the line from which the buffer zone distance must be measured. Generally, the setback should be measured from the top confining bank of the stream, river, creek, pond, or lake. If no bank is present it should be measured form the edge of the water body or any readily visible high water mark at the time the biosolids are applied.

Agronomic Application Rate

Statement of Regulation

§503.14(d) **Bulk sewage sludge shall be applied to agricultural land, forest, or a public contact site, or a reclamation site at a whole sludge application rate that is equal to or less than the agronomic rate for the bulk sewage sludge unless, in the case of a reclamation site, otherwise specified by the permitting authority.**

Sewage sludges typically contain plant nutrients (nitrogen, phosphorus, and potassium), although the amount of nutrients available from sewage sludge are normally lower than the amounts from most commercial fertilizers (Huddleston and Ronayne 1990, EPA 1976, EPA 1978). Nitrogen and phosphorus are the most prevalent nutrients found in sewage sludge, and are the nutrients most needed by plants.

Nitrate Contamination

Nitrogen exists in the soils and sewage sludge in three basic forms:

- Organic (C-NH2)—Carbon based compounds such as proteins, amino acids. This form is not available to plants and must be converted to inorganic nitrogen by soil microorganisms. Mineralization is the conversion of organic N to inorganic N in the form of ammonium. Mineralization rates vary for different types of sludge but most of the organic nitrogen is mineralized to inorganic N in the first year. All of the organic nitrogen is expected to have mineralized by the end of the third year after application.

- Inorganic (ammonium NH_4^+, nitrite NO_2, nitrate NO_3^-)—Plants use the nitrate and ammonium ions. The soil microbes and plants compete for this inorganic N. Rapidly growing soil microbes can immobilize or "tie up" the ammonium and nitrate in the soil by converting it to the organic form, and may temporarily deplete the available N in the soil for plant uptake. The positively charged ammonium ions are adsorbed by the clay and organic matter so that little of this form is leached. Nitrification is the process whereby soil microbes convert ammonium to nitrate. Nitrate is very mobile and readily leached. Nitrite is usually not present in significant concentrations.

- Gas (nitrogen, N_2, ammonia NH_3)—Nitrogen gas is present in the soil atmosphere (air) and a source of nitrogen for legumes that can convert this to ammonium (NH_4^+) which is then used by the plant. In anaerobic conditions, microorganisms can convert nitrate to nitrogen gas and nitrous oxide (N_2O); this process is called denitrification. Under alkaline conditions, ammonium ions lose a hydrogen ion and become ammonia which readily volatilizes (producing ammonia gas NH_3).

The nitrogen content of sewage sludge is usually reported as inorganic ammonium-nitrogen, inorganic nitrate-nitrogen, and either total Kjeldahl nitrogen (TKN) or total nitrogen. TKN represents the organic nitrogen and inorganic ammonium-nitrogen only. Total nitrogen, on the other hand, represents organic nitrogen and inorganic ammonium-nitrogen as well as nitrate-nitrogen. Because it is not possible to analytically test for total organic nitrogen, an estimate of the total amount of organic nitrogen in the sludge can be made based on the analytical results for TKN or total nitrogen. To determine the organic nitrogen, subtract the ammonium-nitrogen from the TKN, or subtract the sum of ammonium plus nitrate-nitrogen from the total nitrogen. The nutrient contents of sewage sludge are normally expressed either as percent of dry weight or as mg/kg dry weight. Specifically, the estimates may be made as follows:

Organic N = TKN - ammonium, or

Organic N = Total N - (ammonium + nitrate)

Plants can use only a portion of the total nitrogen in the sewage sludge. Some of the nitrate and ammonium is lost to the atmosphere by denitrification and volatilization, some of the organic nitrogen becomes available over time as the mineralization process converts the organic forms to ammonium and nitrate. Some of the nitrate is lost through leaching. The goal is to supply the necessary amount of nitrogen needed for the crops or vegetation to produce the desired harvest yield with no leaching of the nitrogen below the root zone. The rates of mineralization, plant uptake, volatilization and denitrification are dependent on many factors and will vary from site to site and at the same site.

Recognizing that sewage sludge, if applied at excessive rates, could deteriorate ground water through nitrate leaching, Part 503 requires that bulk sewage sludge be land applied at a rate that is equal to or less than the agronomic rate for the application site. The agronomic rate is the whole sludge application rate (dry weight basis) designed: (1) to provide the amount of nitrogen needed by the crop or vegetation grown on the land and (2) to 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. EPA requires that the agronomic rate not be exceeded when bulk sewage sludge is applied to agricultural or forest land, or a public contact site. If bulk sewage sludge is applied to a reclamation site, the permit writer may allow exceedances of the agronomic rate.

The agronomic rate is the ratio of the sewage sludge nitrogen used for the crop (dry weight per unit area) divided by the available nitrogen in the sludge (dry weight of nitrogen per dry weight of sludge):

$$\frac{\textit{Sludge N needed for crop}}{\textit{Available N in sludge}}$$

Factors Affecting Nitrogen Availability

Predicting how much sewage sludge can be applied to meet crop yield goals and minimize leaching below the root zone requires consideration of numerous factors. Some factors that influence the amount of sewage sludge that can be applied are:

- Total nitrogen content in sewage sludge and the concentrations (or percentage of the total nitrogen) of the various forms in the sewage sludge are influenced by the types of processing operations. Anaerobic digestion (30 days or longer) produces sewage sludge with high levels of ammonium but little nitrate (oxygen is required to proceed from ammonia to nitrate) and converts most of the readily available organic nitrogen to ammonium nitrogen. Aerobically digested sewage sludge has higher levels of nitrate than anaerobically digested sewage sludge. Dewatering reduces the levels of both nitrate and ammonium nitrogen.

- The mineralization rate is affected by how well the sewage sludge was stabilized. Poor stabilization results in more organic nitrogen for mineralization. Good stabilization converts organic nitrogen into readily available inorganic N leaving only that which is relatively inert and resistant to further mineralization (this sewage sludge may have a low mineralization rate).

- The mineralization rate is also influenced by soil temperature and moisture. Temperature affects the metabolic rate of microorganisms, thus mineralization rates are typically higher in the summer months than in the winter months.

- The amount of ammonium lost through volatilization to the atmosphere is affected by pH, application method, application rate, and soil moisture.

  - Soil/sewage sludge pH—Alkaline sewage sludges have greater volatilization losses than more acidic sewage sludges. The high concentration of hydrogen ions in an acid sewage sludge increases the level of ammonium ions in the liquid phase of the sewage sludge and consequently diminishes losses of ammonia.

  - Application method—The more thoroughly sewage sludge is mixed with soil after application, the lower the volatilization loss. Increasing the interaction of the ammonium ion with the cation exchange complex of the soil reduces the amount subject to volatilization. Volatilization loss is minimal with subsurface injection of sewage sludge. If sewage sludge is left on the soil surface, volatilization occurs rapidly with the greatest loss occurring within the first week. Incorporation of sewage sludge immediately after application can greatly reduce the loss.

  - Application rate—Greater amounts of sewage sludge applied increase the percentage of ammonium ions lost by volatilization, possibly because of the decrease in the number of ammonium ions in direct contact with the soil.

  - Soil moisture—If the soil is saturated before surface application of liquid sewage sludge, the volatilization rate will be greater due to the decrease in the rate of infiltration. Slowing or impeding infiltration increases the length of time the aqueous ammonium ion solution is exposed to drying conditions on the soil surface, thus increasing the volatilization losses from surface applied alkaline sewage sludges.

- The amount of nitrate lost to the atmosphere by denitrification is affected by factors that contribute to anaerobic conditions and by the metabolic rate of the denitrifying microorganisms. The factors are:

  - Soil moisture—Saturated soils have fewer pore spaces occupied by oxygen; thus creating anaerobic conditions that favor the growth of denitrifying microorganisms.

  - Soil type—The texture of soil, coarse (sandy) to fine (clay), affects porosity and capacity to store water and oxygen; thus influencing the prevalence of anaerobic conditions even when soil is not saturated.

  - Carbon source—An abundant source of readily oxidizable carbon will increase the denitrification rate.

  - Nitrate levels-Denitrification will occur rapidly where nitrate levels provide sufficient source of nitrogen for the microorganisms.

Procedures for Determining the Agronomic Rate

The site-specific variability of the above factors means that determining the agronomic rate should be done on a site-specific basis. Many State sewage sludge management programs have developed procedures based on the knowledge and experience gained in regulating sewage sludge land application. These procedures account for the local conditions that affect the agronomic rate. Permit writers who need assistance in reviewing agronomic rate calculations can contact the Cooperative Extension Service, the Soil Conservation Service, or independent agronomists specializing in soil evaluation and nutrient management. These agencies and individuals can provide information on crop nitrogen needs, soil nitrogen testing, mineralization rates, and volatilization and denitrification losses. Permit writers should rely on procedures developed by state sludge management programs to determine agronomic rates, unless they have reason to believe that those procedures are not accurate.

The worksheet in Figure 4-4 illustrates one approach for calculating the agronomic rate. This worksheet is provided as an example and is not intended to replace the procedures currently being used by regulatory authorities or agricultural extension services. Many of the factors included in this example are common to most procedures for calculating agronomic rate. Some of the less common factors are noted as optional on the worksheet.

At a minimum, all of these procedures consider the nitrogen requirement of the crop, and the nitrogen content of the sewage sludge. Most procedures address residual nitrogen either through site-specific soil nitrogen data (from soil monitoring) or estimates of the amount of residual nitrogen from previous sewage sludge applications. If appropriate, nitrogen losses and nitrogen available from sources other than the sewage sludge can be factored into the procedures for deriving the whole sewage sludge application rate.

The nitrogen requirements for specific crops also differ by region and are best obtained from either actual soil test recommendations or from the Cooperative Extension Service's fertilizer recommendations and guides available from the County's Cooperative Extension Service Agent, Land Grant University, the U.S. Department of Agriculture, or the State sewage sludge regulatory agency. Note that nitrogen fertilizer recommendations are not typically given for legumes because they fix their own nitrogen, so purchasing commercial fertilizer is not economical. Therefore, for these crops, nitrogen requirements should be obtained from crop nitrogen removal information.

Although EPA chose to focus on nitrate contamination of ground water when establishing the agronomic rate as a requirement in Subpart B, the nutrients from sewage sludge can also degrade surface water quality. Nutrient overenrichment of surface water bodies is a common problem. EPA's National Water Quality Inventory showed that nutrients were the leading cause of water quality declines in lakes, reservoirs, and estuaries and the second leading pollutant in rivers and streams (EPA 1990). Nitrogen and phosphorus pose serious threats to surface water quality. This is especially true of phosphorus, because phosphate ions have low solubility in most soils, so leaching losses are rare. Instead, phosphate availability for leaching decreases exponentially over time through precipitation reactions, adsorption on mineral surfaces, and retention by soil constituents. As a result, most of the off-site transport of phosphorus is associated with sediment erosion and becomes a surface water quality problem.

Appendix H includes information on nutrient planning that can help permit writers understand the many factors involve in nutrient management. While this information is not necessary for writing permits, it is useful in understanding all the factors involved in nutrient planning.

Example Design Worksheet 1—for the Agronomic Rate

Key to Symbols and Abbreviations

NH4+ - N	=	Ammonium nitrogen content of the sewage sludge obtained from analytical testing of the sewage sludge, kg/mt (dry weight basis).
Kv	=	Volatilization factor estimating ammonium nitrogen remaining after atmospheric losses.
Org-N	=	Organic nitrogen content of the sewage sludge obtained from analytical testing or determined by subtracting NH_4-N from TKN, kg/mt (dry weight basis).
NO_3-N	=	Nitrate nitrogen content of the sewage sludge obtained from analytical testing, kg/mt (dry weight basis)
F_{0-1}	=	Mineralization rate for the sewage sludge during the first year of application, in percent of organic nitrogen expressed as a fraction (e.g., 20% = 0.2).

Helpful Conversions

mg/kg	=	lb/ton × 500
kg/ha	=	lbs/acre × 1.12
kg/ha	=	tons/acre × 2242
mt/ha	=	tons/acre × 2.24

1. Total available nitrogen from sewage sludge.
   a. Ammonium nitrogen. ________ kg/mt
   Calculated with the following formula: analytical result for NH_4^+ - N (kg/mt) × Kv (Kv obtained from Table W-1)
   b. Mineralized organic nitrogen for first year of application. ________ kg/mt
   Calculated with the following formula: Org-N × F_{0-1} (F_{0-1} obtained from Table W-2)
   c. Nitrate nitrogen. ________ kg/mt
   Use analytical result for NO_3-N
   d. Total ________ kg/mt
2. Available nitrogen in the soil. ________ kg/ha
   (Use whichever is greater a or b)
   a. Soil test results of background nitrogen in soil
   b. Estimate of available nitrogen from previous sewage sludge applications *(From Worksheet 2)*
3. Nitrogen supplied from other sources **(optional, but recommended)**:
   a. Nitrogen from supplemental fertilizers **(if appropriate)** ________ kg/ha
   b. Nitrogen from irrigation water **(if appropriate)** ________ kg/ha
   c. Nitrogen from previous crop (unless #2 is based on soil testing) ________ kg/ha
   d. Other (if appropriate) (specify): ________________ ________ kg/ha
   e. Total (add a, b, c, d, if available). ________ kg/ha
4. Total nitrogen available from existing sources. ________ kg/ha
   Add 2 and 3e
5. Available nitrogen loss to denitrification **(optional)** *(check with regulatory authority before using this site-specific factor)* ________ kg/ha
6. Adjusted nitrogen available ________ kg/ha
   Subtract 5 from 4
7. Total nitrogen requirement of crop *(obtain information from agricultural extension agents or other agronomy professionals)* ________ kg/ha
8. Supplemental nitrogen needed from sewage sludge. ________ kg/ha
   Subtract 4 or 6 from 7
9. Agronomic loading rate. ________ mt/ha
   Divide 8 by 1

FIGURE 4-4 WORKSHEETS FOR DETERMINING AGRONOMIC RATE

Worksheet 2. Example Calculation for Available Mineralized Organic Nitrogen

The organic nitrogen in sewage sludge continues to decompose and release mineral nitrogen through the mineralization process for several years following its initial application. This residual nitrogen from the previously applied sewage sludge must be accounted for as part of the overall nutrient budget when determining the agronomic rate for sewage sludge. Residual nitrogen can be determined through soil analysis or calculated using the following procedure. These calculations must be done for each yearly sewage sludge application unless soil analysis is performed prior to land application (see example calculations).

Instructions: Complete a separate table for each year sewage sludge was land applied. Note that most do not calculate beyond the 3rd year because the values become negligible. Sum the values of mineralized Org-N (Column d) from each table for the particular calendar year you're trying to determine Org-N available. (See example below)

a. Year[1]	b. Starting Org-N[2] (kg/ha)	c. Mineralization Rate[3] (Exhibit W-2)	d. Mineralized Org-N[4] (kg/ha)	e. Org-N Remaining[5] (kg/ha)
0-1 (year sewage sludge was applied)				
1-2 (1st year after)				
2-3 (2nd year after)				

[1]Begin with year sewage sludge is applied and continue for 2 more years.
[2]In the first year, this equals the amount of Org-N initially applied. In subsequent years, it represents the amount of org-N remaining from the previous year (i.e., column e).
[3]The org-N content of the initially applied sewage sludge continues to be mineralized, at decreasing rates, for years after initial application. See Table W-2 for mineralization values.
[4]Multiply column b and column c.
[5]Subtract column d from column b.

Example

Assume anaerobically digested sewage sludge with a 3% org-N content (dry weight basis) was applied to the site at a rate of 5 mt/ha in 1986. The following year, 1987, 3 mt/ha of sewage sludge (same org-N content a 1986) was applied to the same site. It is now 1988 and you want to calculate the available nitrogen from previous sewage sludge applications.

In 1986, the org-N in the sewage sludge applied = (0.03) (5 mt/ha) (1,000 kg/mt) = 150 kg/ha.
In 1987, the org-N in the sewage sludge applied = (0.03) (3 mt/ha) (1,000 kg/mt) = 90 kg/ha.

Calculate the available nitrogen from 1986 and 1987 in the following manner (assume anaerobically digested sewage sludge).

a. Year*	b. Starting Org-N (kg/ha)	c. Mineralization Rate (Exhibit W-2)	d. Mineralized Org-N (kg/ha)	e. Org-N Remaining (kg/ha)
1986 Sewage Sludge				
0-1 (first application-1986)	**150**	**0.2**	**30**	**120**
1-2 (1987)	**120**	**0.1**	**12**	**108**
2-3 (1988)	**108**	**0.05**	**5.40**	**102.60**
1987 Sewage Sludge				
0-1 (first application-1987)	**90**	**0.2**	**18**	**72**
1-2 (1988)	**72**	**0.1**	**7.2**	**64.80**
2-3 (1989)	**64.8**	**0.05**	**3.24**	**61.56**

To determine the total mineralized organic nitrogen available in 1988 from the sewage sludge applied in 1986 and 1987, add the mineralized Org-N value in the 1988 row of column d of the table for the 1986 sewage sludge to the mineralized Org-N value in the 1988 row of column d of the table for the 1987 sewage sludge (i.e., 5.40 + 7.2 = 12.6 kg/ha).
Total mineralized Org-N available in 1988 from previous sewage sludge 12.6 kg/ha.

FIGURE 4-4 WORKSHEETS FOR DETERMINING AGRONOMIC RATE (Continued)

Table W-1 - Example Volatilization Factors (Kv)

If Sewage sludge Is:	Factor Kv Is:
Liquid and surface applied	.50
Liquid and injected into the soil	1.0
Dewatered and surface applied	.50*

*Use value obtained from State regulatory agencies if available.

Table W-2 - Example Mineralization Rates*

Time after sewage sludge application (Year)	Fraction of Org-N Mineralized from Unstabilized Primary and Waste Activated Sewage Sludge	Fraction of Org-N Mineralized from Aerobically Digested Sewage Sludge	Fraction of Org-N Mineralized from Anaerobically Digested Sewage Sludge	Fraction of Org-N Mineralized from Composted Sewage Sludge
0-1	.40	.30	.20	.10
1-2	.20	.15	.10	.05
2-3	.10	.08	.05	.03

*Fraction of Org-N present mineralized during the time interval shown.

Note: The volatilization factors and mineralization rate were obtained from the *Process Design Manual for the Land Application of Sewage Sludge* (EPA, 1983a). Many States have developed different values for volatilization and mineralization based on local research. Check with the State authority or local agricultural extension agent for additional guidance. If available, the permit writer should use state or locally derived values.

FIGURE 4-4 WORKSHEETS FOR DETERMINING AGRONOMIC RATE (Continued)

Permit Conditions

To incorporate the agronomic rate management practice in a permit the permit writer should require the permittee to determine the agronomic rate for his site at the time the sludge is to be applied and then calculate the appropriate whole sludge application rate. The permit writer should also specify how frequently these calculations should be done (e.g., annually or for each sewage sludge application).

Part 503 only dictates application of sewage sludge at or below the agronomic rate. If a permit writer believes nutrient management practices are necessary in certain situations to protect public health or the environment, she can incorporate other conditions into the permit. Nutrient management planning is the best way to protect water resources, regardless of land use; it is especially necessary in areas with a high potential for transport and in environmentally sensitive areas.

4.5.2 SEWAGE SLUDGE SOLD OR GIVEN AWAY IN A BAG OR OTHER CONTAINER

There is only one management practice that is applicable to sewage sludge that is sold or given away in a bag or other container for application to the land. It is the requirement for a label or information sheet to accompany the sewage sludge. As for bulk sewage sludge, the management practice does not apply to exceptional quality sewage sludge.

Label or Information Sheet Requirements

Statement of Regulation

§503.14(e) **Either a label shall be affixed to the bag or other container in which sewage sludge is sold or given away for application to the land, or an information sheet shall be provided to the person who receives sewage sludge sold or given away in an other container for application to the land. The label or information sheet shall contain the following information:**

(1) The name and address of the person who prepared the sewage sludge that is sold or given away in a bag or other container for application to the land.

(2) A statement that application of the sewage sludge to the land is prohibited except in accordance with the instructions on the label or information sheet.

(3) The annual whole sludge application rate for the sewage sludge that does not cause any of the annual pollutant loading rates in Table 4 of §503.13 to be exceeded.

Permitting Factors

The permit writer should determine if a label or an information sheet has been developed. If such a label or information sheet is already developed, the permit writer should first ensure that the minimum required information is provided, as listed in §503.14(e), then examine the content for accuracy and consistency with Part 503. The label or information sheet may contain other information, such as directions for use, nutrient and mineral content, or any other marketing language that the permittee may wish to add. If a label or information sheet is not provided, the permit writer should require the permittee to develop the label and describe procedures for distributing the label or the information sheet.

The label or the information sheet must contain an annual whole sludge application rate that does not cause the annual pollutant loading rates presented in §503.13(b)(4) to be exceeded. The label must present this information as part of the application instructions using clear, simple, and easy to understand terms. The application rate should be expressed in units that are easy to understand (e.g., pounds per acre or pounds per 100 square feet). Section 4.4 of this manual provides detailed instructions on calculating the annual whole sludge application rate.

4.6 OPERATIONAL STANDARDS

4.6.1 PATHOGENS

Part 503 provides for numerous alternatives for pathogen reduction and a permittee may choose to use any of the alternatives. The permit writer should not specify the pathogen alternative to be met. To verify that the permittee is using an appropriate alternative, the permit writer should consider the following:

- Final Use of Sewage Sludge—The permit writer must be certain what type of land is to be used by the permittee.

- Sewage Sludge Treatment Processes—The permit writer should identify which treatment processes the permittee employs. The permit writer should review any submitted sewage sludge quality data and evaluate any information regarding existing or proposed sewage sludge treatment processes to verify that the permittee is capable of meeting the pathogen requirements for the land application practice proposed. The permit writer should then identify which specific pathogen alternatives are:

  - Required by Part 503 for the type of land on which sewage sludge is applied

  - Possible given the permittee's sewage sludge treatment processes

Bulk sewage sludge applied to lawns or gardens or sewage sludge that is sold or given away in a bag or other container must be treated to reduce the risk of disease transmission to the public using the substance. Because it is not feasible to impose site restrictions in these situations, the sewage sludge used in this manner must meet the Class A pathogen reduction requirements. Because of the lower potential for public exposure and the ability to control public access once the sewage sludge is applied, bulk sewage sludge that is applied to agricultural land, forest, public contact sites, and reclamation sites does not have to be treated to achieve the highest reductions. In these cases, either Class A or Class B pathogen reduction requirements must be met. If the sewage sludge is Class B, site restrictions are imposed to prevent exposure to the sewage sludge. The different alternatives for achieving pathogen reduction are discussed in Chapter 8. Table 4-2 indicates which of the pathogen alternatives in Subpart D apply to bulk sewage sludge and to sewage sludge sold or given away in a bag or other container. Table 4-3 lists the alternatives that the preparer must meet and those that the applier must meet.

TABLE 4-2 PATHOGEN AND VECTOR ATTRACTION REDUCTION REQUIREMENTS FOR APPLICATION OF SEWAGE SLUDGE TO DIFFERENT TYPES OF LAND

Sewage Sludge	Regulatory Requirements
• Exceptional quality sewage sludge • Material meeting exceptional quality criteria • Bulk sewage sludge or material derived from bulk sewage sludge applied to a lawn or a home garden • Sewage sludge sold or given away in a bag or a other container	Pathogens—Class A: one in §503.32(a) Vectors—one in §§503.33(b)(1) through 503.33(b)(8) or equivalent as determined by the permitting authority
• Bulk sewage sludge applied to: - Agricultural land - Forest - Public contact site - Reclamation site	Pathogens—Class A or Class B: one in §503.32(a) or §503.32(b) Vectors—one in §§503.33(b)(1) through 503.33(b)(10) or equivalent to one in §§503.33(b)(1) through 503.33(b)(8)

TABLE 4-3 PATHOGEN AND VECTOR ATTRACTION REDUCTION REQUIREMENTS FOR LAND APPLICATION

PATHOGEN AND VECTOR ATTRACTION REDUCTION REQUIREMENTS FOR PREPARERS OF SEWAGE SLUDGE	
Class A Pathogen Reduction	**Vector Attraction Reduction**
Alternative 1 Time and temperature Alternative 2 pH, temperature and time Alternative 3 One-time demonstration correlating pathogen levels and operating parameters Alternative 4 Concentrations of enteric viruses and helminth ova Alternative 5 Processes to Further Reduce Pathogens (PFRP) 1. Composting 2. Heat drying 3. Heat treatment 4. Thermophilic aerobic digestion 5. Beta ray irradiation 6. Gamma ray irradiation 7. Pasteurization Alternative 6 Equivalent to PFRP In addition all six alternatives include pathogen levels for fecal coliform or *Salmonella*	Option 1 38 percent volatile solids reduction Option 2 Lab demonstration of volatile solids reduction anaerobically Option 3 Lab demonstration of volatile solids reduction aerobically Option 4 SOUR ≤ 1.5 mg O_2/hour/g total solids Option 5 Aerobic process for 14 days at > 40°C Option 6 pH to ≥ 12 and retain at 11.5 Option 7 ≥ 75 percent solids for stabilized solids Option 8 ≥ 90 percent solids for unstabilized solids
Class B Pathogen Reduction	
Alternative 1 Density of fecal coliform Alternative 2 Processes to Significantly Reduce Pathogens (PSRP) 1. Aerobic digestion 2. Air drying 3. Anaerobic digestion 4. Composting 5. Lime stabilization	
PATHOGEN AND VECTOR ATTRACTION REDUCTION REQUIREMENTS FOR APPLIERS OF SEWAGE SLUDGE	
Class B Pathogen Reduction	**Vector Attraction Reduction**
Alternative 3 Equivalent to PSRP Class B Sludge Site Restrictions	Option 9 Injection below land surface Option 10 Incorporation into soil

§ 503.32(b)(5) Site Restrictions

(i) Food crops with harvested parts above ground but touching the sewage sludge/soil mixture shall not be harvested for 14 months after application.

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

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

(iv) Food/feed/fiber crops shall not be harvested for 30 days after application.

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

(vi) Turf grown where sewage sludge is applied shall not be harvested for 1 year after application when the harvested turf is placed on land with a high potential for public exposure or on 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.

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

4.6.2 VECTOR ATTRACTION REDUCTION

Part 503 provides for numerous options for vector attraction reduction and a permittee may choose to use any of the options. The permit writer should not specify the option that has to be met. To verify that the permittee is using an appropriate option, the permit writer should consider the following:

- Final Use of Sewage Sludge—The permit writer must be certain what type of land is to be used by the permittee.

- Sewage Sludge Treatment Processes—The permit writer should identify which treatment processes the permittee employs. The permit writer should review any submitted sewage sludge quality data and evaluate any information regarding existing or proposed sewage sludge treatment processes to verify that the permittee is capable of meeting the vector attraction reduction requirements for the land application practice proposed. The permit writer should then identify which specific vector attraction reduction options are:

  - Required by Part 503 for the type of land on which sewage sludge is applied

  - Possible given the permittee's sewage sludge treatment processes.

One of the first 10 vector attraction reduction requirements in §503.33(b) must be met when bulk sewage sludge is applied to agricultural land, forest, public contact sites, and reclamation sites. It is not feasible to inject or incorporate bulk sewage sludge applied to lawns or home gardens or sewage sludge that is sold or given away in a bag or other container. Therefore, one of the first 8 vector attraction reduction requirements in §503.33(b) must be met for these sewage sludges. The different options for achieving vector attraction reduction are discussed in Chapter 8. The proposed amendments to Part 503 (60 *FR* 54771) will allow use of an alternative vector reduction attraction method that the permitting authority determines is equivalent to one of the first eight methods in §503.33(b). Table 4-2 indicates which of the vector attraction reduction requirements in Subpart D apply to bulk sewage sludge and to sewage sludge sold or given away in a bag or other container. Table 4-3 lists the options that the preparer must meet and those that the applier must meet.

4.7 FREQUENCY OF MONITORING REQUIREMENTS

The permit writer will often impose the sewage sludge monitoring requirements on the generator and should require the generator to share the analytical results with appliers or other preparers who may need sewage sludge quality information to comply with Part 503 when land applying the sewage sludge, preparing the sewage sludge for land application, or preparing the sewage sludge for sale or give away in a bag or other container. The permit writer will frequently encounter circumstances where a subsequent preparer must monitor the sewage sludge quality. Any time a preparer of sewage sludge receives sewage sludge from a generator and then changes the quality of the sewage sludge, the preparer is required to monitor the quality of the sewage sludge. Sewage sludge monitoring requirements should be imposed on a preparer that accepts sewage sludge from multiple generators and mixes or otherwise handles the sewage sludge. Sewage sludge that has been treated to reduce pathogens and vector attraction and then stored for several months or longer may need to be resampled and reanalyzed for *Salmonella* or fecal coliform prior to being applied to the land.

In developing permit conditions for monitoring sewage sludge applied to the land, the permit writer should consider including the following:

- Parameters to be monitored
- Monitoring frequencies
- Monitoring locations
- Sampling types and preservation protocol
- Analytical methods.

In addition, the permit writer may find that including a provision that specifies that QA/QC procedures must be followed will ensure that the results of the monitoring program are reliable and precise. The following subsections briefly highlight each of the above-listed monitoring issues that should be addressed in the permit.

4.7.1 PARAMETERS TO BE MONITORED

Section 503.16 requires monitoring of sewage sludge for pollutant concentrations, pathogen densities, and vector attraction reduction. Parameters that must be monitored are listed in Table 4-4. Because the pollutant concentrations in sewage sludge must be recorded on a dry weight basis, the percent solids content of the sewage sludge must be determined each time monitoring is performed. The monitoring requirements for pathogens and vector attraction reduction are discussed in more detail in Chapter 8 of this manual. The permit writer will need to select the appropriate monitoring requirements and establish permit conditions specific to the pathogen and vector attraction reduction requirements met by the permittee.

4.7.2 MONITORING FREQUENCY

The frequency of monitoring is typically established through individual permits on a case-by-case basis. However, to enhance the self-implementation of the regulation, monitoring frequencies have been established in Part 503 for pollutants, pathogen density requirements, and the vector attraction reduction requirements in §§503.33(b)(1)-(4) and (b)(6)-(8). The monitoring frequencies established by §503.16 for land application are shown in Table 4-5. However, the permit writer has the discretion to require more frequent monitoring than established by Part 503. Additionally, §503.16(a)(2) gives the permit writer discretion to reduce the pollutant monitoring frequency if, after 2 years, the variability of pollutant concentrations is low and compliance is demonstrated so that a reduction in frequency appears appropriate. If the permittee is using pathogen Class A alternative 3, the permit writer can reduce the monitoring frequency for enteric viruses and viable helminth ova after 2 years.

For a generator or other preparer who land applies sewage sludge, the monitoring frequency is based on the amount of sludge land applied in a given 365-day period. If the sewage sludge is sold or given away in a bag or other container for land application, the monitoring frequency is based on the amount of sewage sludge received in a given 365-day period by the person who prepares the sewage sludge for sale or give away, not on the amount of sewage sludge actually sold or the amount of sewage sludge product (e.g., compost) produced. Whenever possible, the permit writer should specify the 365-day period and

TABLE 4-4 PARAMETERS TO MONITOR IN LAND APPLIED SEWAGE SLUDGE

Parameters To Be Monitored		
Pollutants[a]	**Pathogens**	**Vector Attraction Reduction**
Arsenic	Fecal coliform or *Salmonella*	Percent volatile solids reduction[c]
Cadmium	Enteric viruses[b]	Specific oxygen uptake rate[d]
Copper	Helminth ova[b]	pH[e]
Lead		Percent solids[f]
Mercury		
Molybdenum		
Nickel		
Selenium		
Zinc		

[a]Percent solids of sewage sludge must be monitored to report pollutant concentrations on a dry weight basis
[b]Class A options 3 and 4
[c]Vector attraction reduction options 1, 2, and 3
[d]Vector attraction reduction option 4
[e]Vector attraction reduction option 6
[f]Vector attraction reduction options 7 and 8.

TABLE 4-5 FREQUENCY OF MONITORING - LAND APPLICATION

Amount of Sewage Sludge[a] (metric tons per 365-day period)	Frequency[b]
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)

[a]Either the amount of bulk sewage sludge applied to the land or the amount of sewage sludge received by a person who prepares the sewage sludge that is sold or given away in a bag or other container for application to the land (on a dry weight basis).
[b]After the sewage sludge is monitored for 2 years at the above frequency, the permitting authority may reduce the frequency of monitoring for pollutant concentrations and for the pathogen density requirements in §§503.32(a)(5)(ii) and (a)(5)(iii).

Source: §503.16

the corresponding monitoring frequency. The permit writer should also specify that if the amount of sewage sludge to be land applied during the 365-day period is going to exceed the amount on which the monitoring frequency was based, then the permittee must increase the monitoring frequency to that required for the amount of sewage sludge to be land applied. For example, if the permittee is expected to apply between 200 and 750 metric tons per year during the 5-year permit period, the permit writer could specify two monitoring frequencies. Alternatively, the permit writer could simply apply the more frequent of the two monitoring frequencies for the entire 5-year permit period.

The permit writer should consider increasing the monitoring frequency beyond the frequency required by §503.16 in cases where the permit writer has noted the following:

- Concentrations of pollutants vary significantly between measurements
- Concentrations of pollutants are close to the ceiling concentrations
- A trend indicating worsening sewage sludge quality
- A lack of historical data on sewage sludge quality
- Other criteria that the permit writer believes substantiate an increased monitoring frequency.

The permit writer also has the discretion to reduce the monitoring frequency after 2 years of monitoring at the frequency specified in Table 4-5. In deciding whether to reduce the frequency of monitoring, the permit writer should consider the following:

- Variability of the pollutant concentrations—The frequency of monitoring should not be reduced where sewage sludge quality varies significantly such that compliance with applicable numeric limits may be in question.
- Trends in pollutant concentrations—Preparers with data indicating an increase in pollutant concentrations over the 2-year time period should not be granted a reduction in monitoring.
- The magnitude of the pollutant concentrations—If all sampling data reveal that the concentrations of pollutants are significantly below pollutant limitations, a reduction in monitoring may be appropriate.

The frequency of monitoring in Table 4-5 assumes that sewage sludge is land applied continuously throughout a 365-day period. Often, sewage sludge is stored before it is land applied. This could affect how frequently samples of the sewage sludge are collected and analyzed.

Part 503 requires that samples of sewage sludge that are collected and analyzed be representative of the sewage sludge that is used or disposed. Each time a sample is collected, no matter how frequently samples are collected, it should be a representative sample. Collecting a representative sample of sewage sludge that is stored before use or disposal may be more difficult than collecting a representative sample of sewage sludge that is used or disposed continuously. For example, samples of the sewage sludge at different locations in a storage pile and at various depths may have to be collected and then composited to obtain a representative sample of the stored sewage sludge. When sewage sludge is used or disposed continuously, a single grab sample may be appropriate. Whatever the situation, samples of sewage sludge analyzed to show compliance with Part 503 must be representative of the sewage sludge that is used or disposed.

The frequency of monitoring may vary when sewage sludge is stored before use or disposal depending on the parameters for which the sewage sludge samples are analyzed. This is illustrated below for pollutants. The frequency of monitoring for pathogen densities and vector attraction reduction is discussed in chapter 8.

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 land applied. Also assume that the frequency of monitoring required by Part 503 is once per month.

Two approaches can be used for the frequency of monitoring for pollutants in this example. In the first approach, a representative sample of the sewage sludge could be collected and analyzed every month to show compliance with the Part 503 pollutant limits. Every sample would have to meet the ceiling concentration limits in Table 1 of §503.13. If the TWTDS is attempting to meet the pollutant concentration limits, the monthly average pollutant concentrations in the samples collected during a month would have to meet the pollutant concentration limits in Table 3 of §503.13.

If the TWTDS is attempting to meet cumulative pollutant loading rates in Table 2 of §503.13, the pollutant concentrations in the samples analyzed each month would be averaged. That average then would be used along with the annual whole sludge application rate for the sewage sludge to calculate the amount of each inorganic pollutant in the sewage sludge that is used or disposed.

In the second approach, a representative sample of the stored sewage sludge would be collected and analyzed just prior to when the sewage sludge is land applied. This sample would be representative of the entire amount of sewage sludge that is stored. It would have to meet the ceiling concentration limits in Table 1 of §503.13. It would also have to either meet the monthly average pollutant concentration limits in Table 3 of §503.13 or the measured pollutant concentrations in the representative sample would be used to calculate the amount of each pollutant in the sewage sludge applied to a site, under the CPLR concept.

The above two approaches may result in a different number of samples that are analyzed. In both cases, however, 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.

4.7.3 MONITORING POINTS

Representative sampling is one of the most important aspects of monitoring. To obtain a representative sample of sewage sludge, the sample must be taken from the correct location and represent the entire amount of sewage sludge. In some situations, the location of the sampling point may have a dramatic effect on the monitoring results. It is important that samples be collected from a location representative of the final sewage sludge that is land applied. Because the pollutant limits pertain to the quality of the final sewage sludge applied to the land, samples must be collected after the last treatment process. Samples should be taken at the same point and in the same manner each time monitoring is performed. The sampling location should be safe and accessible.

The permit writer should determine how specific the description of the sampling location should be, depending on the following considerations:

- The variability of the sewage sludge at different points
- The ability to obtain a well-mixed sample.

For example, if a commercial preparer or applier receives sewage sludge from several different generators on a batch basis, the ability to mix the sewage sludge to get a sample representative of all the sewage sludges may be difficult. The permit writer may then want to specify the exact location where the sample is to be taken to obtain the most representative sample. If the sewage sludge separates easily between its liquid and solids fraction, then the permit writer may want to specify where the sample should be taken to ensure a well-mixed homogeneous sample.

EPA has developed three guidance manuals and a video that provide more detail on proper sample collection for sewage sludge:

- *Control of Pathogens and Vector Attraction in Sewage Sludge* (EPA 1992e)
- *POTW Sludge Sampling and Analysis Guidance Document* (EPA 1989a)
- *Sampling Procedures and Protocols for the National Sewage Sludge Survey* (EPA 1989b)
- *Sludge Sampling Video* (EPA 1992d).

4.7.4 SAMPLE COLLECTION AND PRESERVATION PROTOCOL

Also important in ensuring representative samples of sewage sludge are the methods for sample collection and preservation. The sampling technique varies depending on whether the sewage sludge is flowing through pipes, moving on a conveyor, or stored in a pile or bin. Sewage sludge that flows through pipes or moves on a conveyor should be sampled at equal intervals during the time the unit operates in a day. When sampling from piles or bins, core samples should be taken from at least four points in the pile or bin.

The permit writer should consider whether it is more appropriate to specify that the permittee collect a single grab sample or composite samples. With sewage sludge, as with wastewater, grab samples are instantaneous samples where an amount of sewage sludge is collected all at one time. Composite samples are a series of grab samples combined to make a single sample to be analyzed. Composite samples can be made from a series of grab samples collected from several points in the cross-section of the entire sewage sludge amount, or they can be a series of grab samples collected at regular time intervals.

In determining whether to specify that a sample be collected using a single grab sample or composite sampling method, the permit writer may evaluate factors such as:

- How well the sewage sludge is mixed
- Whether the sample is collected from a single batch of sewage sludge or from a stock pile made up of several batches
- Whether the composition of the sewage sludge varies over time.

In general, compositing several samples may provide a more representative sample than collecting one grab sample. Therefore, in most situations, composite samples should be required. Sewage sludge is most often used or disposed in a solid form and may be treated in batch processes. Sewage sludge characteristics may also vary over time. For these reasons, the quality may vary from day to day or even within the sewage sludge volume itself due to the inability to completely mix sewage sludges that have high solids contents.

Appropriate preservation techniques ensure that a sample remains representative for the period it is held prior to being analyzed. For field and laboratory preservation of sewage sludge samples, cooling to 4 degrees Celsius is, in most cases, the most appropriate method due to the inability to mix high solid sewage sludges with other preservatives. The permit writer should consider specifying this preservation method in the permit because it differs from the more common wastewater practices.

4.7.5 ANALYTICAL METHODS

All analyses performed to show compliance with the monitoring requirements must be conducted using the methods specified in Part 503. Methods to analyze specific parameters in sewage sludge are specified in §503.8 and shown in Table 4-6. The permit writer should identify the method needed for each analysis in the permit or incorporate the method by referencing the regulatory citation. In addition to listing the analytical methods specified by Part 503 for the regulated pollutants and pathogens, Table 4-6 lists suggested analytical methods for the various nitrogen forms and other soil characteristics. Other methods developed by States may be more applicable for soils in a specific area.

4.7.6 QUALITY ASSURANCE/QUALITY CONTROL(QA/QC)

A QA program is used to achieve a desired quality for activities, such as sample collection, laboratory analysis, data validation and reporting, documentation, and recordkeeping. A QA program will typically address the following major areas:

- Proper collection procedures, equipment, preservation methods, and chain-of-custody procedures to ensure representative samples
- Proper sample preparation procedures, instruments, equipment, and methodologies used for the analysis of samples
- Proper procedures and schedules for calibration and maintenance of equipment and instruments associated with the collection and analysis of samples
- Proper recordkeeping to produce accurate and complete records and reports, when required.

QC, which is part of the QA program, relates to the routine use of established procedures and policies during sample collection and analysis. The objective of QC procedures is to ultimately control both the accuracy and the precision of all analytical measurements. QC for sample collection includes the use of duplicate and spiked samples and sample blanks. QC of analytical procedures includes the use of spiked and split samples, proper calibration protocols, and appropriate analytical methods and procedures. While QA/QC is standard practice for most laboratories, the permit writer may determine that specificity in the permit will ensure more reliable data. This may be appropriate in cases where the sewage sludge is variable or where past permit history suggests that the permittee's self-monitoring program is questionable.

TABLE 4-6 ANALYTICAL METHODS

METHODS FOR THE ANALYSIS OF SEWAGE SLUDGE PART 503			
Pollutant	**Analytical Method**	**Maximum Holding Time, Sample Preservation, Sample Container, Sample Preparation**	**Comments**
Arsenic	AA Furnace SW-846 Method 7060 AA Gaseous Hydride SW-846 Method 7061 Inductively Coupled Plasma SW-846 Method 6010	6 months Plastic or glass container Samples need to be digested prior to analysis.	All samples must be digested using SW-846 Method 3050 or 3051 prior to analysis by any of the procedures indicated. The AA Direct Aspiration analyses are applicable at moderate concentration levels in clean complex matrix systems. AA Furnace methods can increase sensitivity if matrix effects are not severe. Inductively Coupled Plasma (ICP) methods are applicable over a broad linear range and are especially sensitive for refractory elements. Detection limits for ICP methods are generally higher than for AA Furnace methods.
Cadmium	AA Direct Aspiration SW-846 Method 7130 AA Furnace SW-846 Method 7131 Inductively Coupled Plasma SW-846 Method 6010		
Copper	AA Direct Aspiration SW-846 Method 7210 AA Furnace SW-846 Method 7211 Inductively Coupled Plasma SW-846 Method 6010		
Lead	AA Direct Aspiration SW-846 Method 7420 AA Furnace SW-846 7421 Inductively Coupled Plasma SW-846 Method 6010		

TABLE 4-6 ANALYTICAL METHODS (Continued)

METHODS FOR THE ANALYSIS OF SEWAGE SLUDGE PART 503			
Pollutant	**Analytical Method**	**Maximum Holding Time, Sample Preservation, Sample Container, Sample Preparation**	**Comments**
Mercury	Cold Vapor (manual) SW-846 Method 7470 SW-846 Method 7471	28 days Cool to 4°C Plastic or glass container	SW-846 Method 7470 applies to mercury in liquid wastes. SW-846 Method 7471 applies to mercury in solid or semisolid wastes. The digestion procedure is contained in the analytical method.
Molybdenum	AA Direct Aspiration SW-846 Method 7480 AA Furnace SW-846 Method 7481 Inductively Coupled Plasma SW-846 Method 6010	6 months Plastic or glass container Samples need to be digested prior to analysis.	All samples must be digested using SW-846 Method 3050 or 3051 prior to analysis by any of the procedures indicated. The AA Direct Aspiration analyses are applicable at moderate concentration levels in clean complex matrix systems. AA Furnace methods can increase sensitivity if matrix effects are not severe. Inductively Coupled Plasma (ICP) methods are applicable over a broad linear range and are especially sensitive for refractory elements. Detection limits for ICP methods are generally higher than for AA Furnace methods.
Nickel	AA Direct Aspiration SW-846 Method 7520 Inductively Coupled Plasma SW-846 Method 6010		
Selenium	AA Furnace SW-846 Method 7740 or 7951 Inductively Coupled Plasma SW-846 Method 6010 AA Gaseous Hydride SW-846 Method 7741		
Zinc	AA Direct Aspiration SW-846 Method 7950 Inductively Coupled Plasma SW-846 Method 6010		

TABLE 4-6 ANALYTICAL METHODS (Continued)

METHODS FOR THE ANALYSIS OF SEWAGE SLUDGE PART 503			
Pollutant	**Analytical Method**	**Maximum Holding Time, Sample Preservation, Sample Container, Sample Preparation**	**Comments**
Total Solids, Volatile Solids, Fixed Solids	Gravimetric SM-2540 G	7 days Cool to 4°C Plastic or glass container	Recommended procedure for solid and semisolid samples.
Fecal Coliform	SM-9221 E (MPN) SM-9222 D (membrane filter)	24 hours Cool to 4°C Plastic or glass container	Both procedures are very temperature sensitive. Samples must be analyzed within holding times.
Salmonella	SM-9260 D.1 Kenner, B.A. and H.A. Clark	24 hours Plastic or glass container	Large sample volumes are needed due to the low concentration of *Salmonella* in wastewater. Also, due to the large number of *Salmonella* species, more than one procedure may be necessary to adequately determine the *Salmonella's* presence.
Enteric Viruses	ASTM-Method D 4994-89	2 hours at up to 25°C or 48 hours at 2 to 10°C Plastic or glass container	Concentration of the sample is necessary due to the presumably low numbers of viruses in the sample.
Helminth Ova	Yanko, W.A.		See reference list.
Specific Oxygen Uptake Rate	SM-2710 B	Perform as soon as possible Plastic or glass container	Quite sensitive to sample temperature variation and lag time between sample collection and test initiation. Replicate samples are suggested.
Percent Volatile Solids Reduction	ERT		See reference list.

TABLE 4-6 ANALYTICAL METHODS (Continued)

METHODS FOR THE ANALYSIS OF NITROGEN IN SEWAGE SLUDGE			
Pollutant	**Analytical Method**	**Maximum Holding Time, Sample Preservation, Sample Container, Sample Preparation**	**Comments**
Total Kjeldahl Nitrogen (TKN)	SM-4500-N_{org} EPA-351.3	28 days Cool to 4°C Plastic or glass container	Total kjeldahl nitrogen is the sum of organic and ammonia nitrogen in a sample. Sample digestion and distillation are required and are included or referenced in the method.
Ammonia Nitrogen (NH_3-N)	SM-4500-NH_3	28 days Cool to 4°C Plastic or glass container	All samples must be digested using procedure SM-4500-NH_3 B prior to analysis by one of the specific analysis procedures listed.
Nitrate Nitrogen (NO_3-N)	SM-4500-NO_3^- SW-846 Method 9200	28 days Cool to 4°C Plastic or glass container	Nitrite nitrogen is the fully oxidized state of nitrogen. Organics may interfere with the method.

TABLE 4-6 ANALYTICAL METHODS (Continued)

SOIL ANALYTICAL METHODS			
Soil Chemical Property	**Analytical Method**	**Extraction and/or Digestion Procedure**	**Comments**
pH	EPA-9045 SM-4500-H^+	1:1 soil/water	A soil pH at or above 6.5 minimizes metal uptake by crops.
Cation Exchange Capacity (CEC)	Sodium Acetate EPA-9081 Ammonium Acetate EPA-9080	Extract with 1N NaOAc (sodium acetate)	Needed to determine the soil's ability to attenuate heavy metal cations. The cation exchange capacity can be determined by summing the soil test results of the individual cations.
Plant Available Nitrogen	N-Ammonia Distillation, Nesslerization SM-4500-NH_3 A,B,C N-Nitrate Electrode Method SM-4500-NO_3^- A,D	Ammonium and Nitrate Extract with 2N KCl	Inorganic nitrogen (NH_4^+,NO_3^-) is readily available for plant uptake
Plant Available Phosphorous	SM-4500-P A,B,C,D,E	a) Extract with 0.03N NH_4F + HCl b) Extract with dilute HCl + H_2SO_4 c) Extract with 0.5M $NaHCO_3$ d) Extract with water	
Background Metal Analysis	Metals should be analyzed as per appropriate methods prescribed in *Standard Methods for the Examination of Water and Wastewater 17th Edition* and *SW-846*.	Metal samples must be digested prior to analysis.	

TABLE 4-6 ANALYTICAL METHODS (Continued)

References

EPA - *Methods for Chemical Analysis of Water and Wastes*, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory-Cincinnati (EMSL-CI), EPA-600/4-79-020, March 1983.

SM - *Standard Methods For The Examination of Water and Wastewater*, 18th Edition. American Public Health Association, Washington, D.C., 1992.

SW-846 - *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, U.S. Environmental Protection Agency, November 1986.

ASTM - *Annual Book of Standards - Water*, American Society for Testing and Materials, Phila., PA, 1991.

ASTM[1] - "Standard Practice for Recovery of Viruses from Wastewater Sludge," *Annual Book of ASTM Standards*, Section 11, Water and Environmental Technology, 1992.

USGS - Fishman, M. J., et al, "Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments," U.S. Dept. of the Interior, Techniques of Water Resource Investigations of the U.S. Geological Survey, Denver, CO, 1989.

KC - Kenner, B.A. and H.A. Clark, "Determination and Enumeration of *Salmonella* and *Pseudomonas aeruginosa*," J. Water Pollution Control Federation, 46(9):2163-2171, 1974.

Yanko - Yanko, W.A., *Occurrence of Pathogens in Distribution and Marketing Municipal Sludges*, EPA 600/1-87-014, 1987. NTIS PB 88-154273/AS, National Technical Information Service, Springfield, Virginia.

ERT - *Environmental Regulations and Technology - Control of Pathogens and Vectors in Sewage Sludge*, U.S. Environmental Protection Agency, Cincinnati, OH, EPA-625/R-92/013, 1992.

4.8 RECORDKEEPING REQUIREMENTS

Records must be kept to demonstrate that the Part 503 requirements are being met. Part 503 requires specific information be kept to show compliance with pollutant concentrations and loadings, pathogen reduction requirements, vector attraction reduction requirements, and management practices. These records must be retained for 5 years, except for specific cumulative pollutant loading information which must be kept indefinitely. The recordkeeping requirements for land application of sewage sludge are shown in Table 4-7. This table identifies the minimum requirements for which records must be kept, who must keep the records, and how long they must be retained. The requirements differ depending on the pollutant limits that are met. The generator, other preparer, and land applier may each be required to keep records.

TABLE 4-7 MINIMUM REQUIRED RECORDS FOR LAND APPLICATION

(A) Exceptional Quality Sewage Sludge and Exceptional Quality Material Derived from Sewage Sludge That Did Not Meet Exceptional Quality Criteria [§503.17(a)(1) and §503.17(a)(2)]
If sewage sludge or a material derived from sewage sludge applied to the land meets the ceiling concentrations in §503.13(b)(1), the pollutant concentrations in §503.13(b)(3), the Class A pathogen requirements in §503.32(a), and one of the vector attraction requirements in §§503.33(b)(1) through 503.33(b)(8), or an equivalent vector attraction reduction requirement as determined by the permitting authority; the person who prepares the sewage sludge or the person who derives the material that meets those requirements shall develop the following information and shall retain the information for a period of 5 years: (i) The concentration of each pollutant listed in Table 3 of §503.13 in the sewage sludge or derived material. (ii) A certification that the information submitted to determine compliance with the pathogen and vector attraction reduction requirement is accurate. (iii) A description of how the Class A pathogen requirements in §503.32(a) are met (refer to Chapter 6). (iv) A description of how one of the vector attraction requirements in §§503.33(b)(1) through 503.33(b)(8), or an equivalent vector attraction reduction requirement as determined by the permitting authority, is met (refer to Chapter 6).
(B) Material Derived from Sewage Sludge That Meets Exceptional Quality Criteria [§§503.10(d) and (g)]
None

TABLE 4-7 MINIMUM REQUIRED RECORDS FOR LAND APPLICATION (Continued)

(C) Bulk Sewage Sludge Meeting Pollutant Concentrations, Class A Pathogen Reduction Requirements, and Vector Attraction Reduction Alternative 9 or 10 [§503.17(a)(3)]

If the pollutant concentrations in §503.13(b)(3), the Class A pathogen requirements in §503.32(a), and the vector attraction reduction requirements in either §503.33(b)(9) or §503.33(b)(10) are met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site:

(i) The person who prepares the bulk sewage sludge shall develop the following information and shall retain the information for 5 years.

- (A) The concentration of each pollutant listed in Table 3 of §503.13 in the bulk sewage sludge.
- (B) A certification that the information submitted to determine compliance with the pathogen requirements is accurate.
- (C) A description of how the pathogen requirements in §503.32(a) are met.

(ii) The person who applies the bulk sewage sludge shall develop the following information and shall retain the information for 5 years.

- (A) A certification that the information submitted to determine compliance with the management practices and vector attraction reduction requirements is accurate.
- (B) A description of how the management practices in §503.14 are met for each site on which bulk sewage sludge is applied.
- (C) A description of how the vector attraction reduction requirements in either §503.33(b)(9) or §503.33(b)(10) are met for each site on which bulk sewage sludge is applied.

TABLE 4-7 MINIMUM REQUIRED RECORDS FOR LAND APPLICATION (Continued)

(D) Bulk Sewage Sludge Meeting Pollutant Concentrations and Class B Pathogen Reduction Requirements [§503.17(a)(4)]

If the requirements in §503.13(b)(3) and §503.32(b) are met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site:

(i) The person who prepares the bulk sewage sludge for application to the land shall develop the following information and shall retain the information for 5 years.

(A) The concentration of each pollutant listed of Table 3 of §503.13 in the bulk sewage sludge.

(B) A certification that the information submitted to determine compliance with the pathogen and vector attraction reduction requirements (if applicable) is accurate.

(C) A description of how the pathogen requirements in §503.32(b) are met.

(D) When one of the vector attraction reduction requirements in §§503.33(b)(1) through 503.33(b)(8), or an equivalent vector attraction reduction requirement as determined by the permitting authority is met, a description of how the vector attraction requirement is met.

(ii) The person who applies the bulk sewage sludge to the land shall develop the following information and shall retain the information for a period of 5 years.

(A) A certification that the information submitted to determine compliance with the management practices, the site restrictions, and the vector attraction reduction requirements (if applicable) is accurate.

(B) A description of how the management practices in §503.14 are met for each site on which bulk sewage sludge is applied.

(C) A description of how the site restrictions in §503.32(b)(5) are met.

(D) A description of how the vector attraction reduction requirements in either §§503.33(b)(9) or (b)(10) are met, if one of these alternatives is used.

(E) The date bulk sewage sludge is applied to each site.

TABLE 4-7 MINIMUM REQUIRED RECORDS FOR LAND APPLICATION (Continued)

(E) Bulk Sewage Sludge Subject to Cumulative Pollutant Loading Rates [§503.17(a)(5)]

If the requirements in §503.13(a)(2)(i) are met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site:

(i) The person who prepares the bulk sewage sludge shall develop the following information and shall retain the information for 5 years.

(A) The concentration of each pollutant listed in Table 1 of §503.13 in the bulk sewage sludge.

(B) A certification that the information submitted to determine compliance with the pathogen requirements and the vector attraction reduction requirements (if applicable) is accurate.

(C) A description of how the pathogen requirements in either §503.32(a) or §503.32(b) are met.

(D) When one of the vector attraction requirements in §§503.33(b)(1) through 503.33(b)(8), or an equivalent vector attraction reduction requirement as determined by the permitting authority is met, a description of how the vector attraction requirement is met.

(ii) The person who applies the bulk sewage sludge shall develop the following information, retain the information in §§503.17(a)(5)(ii)(A) through 503.17(a)(5)(ii)(G) indefinitely, and retain the information in §§503.17(a)(5)(ii)(H) through 503.17(a)(5)(ii)(M) for 5 years.

(A) The location, by either street address or latitude and longitude, of each site on which bulk sewage sludge is applied.

(B) The number of hectares in each site on which bulk sewage sludge is applied.

(C) The date bulk sewage sludge is applied to each site.

(D) The cumulative amount of each pollutant (i.e., kilograms) listed in Table 2 of §503.13 in the bulk sewage sludge applied to each site, including the amount in §503.12(e)(2)(iii).

(E) The amount of sewage sludge (i.e., metric tons) applied to each site.

(F) A certification that the information submitted to determine compliance with the requirement to obtain information is accurate.

TABLE 4-7 MINIMUM REQUIRED RECORDS FOR LAND APPLICATION (Continued)

(E) Bulk Sewage Sludge Subject to Cumulative Pollutant Loading Rates (Continued)

(G) A description of how the requirements to obtain information in §503.12(e)(2) are met.

(H) A certification that the information submitted to determine compliance with the management requirements is accurate.

(I) A description of how the management practices in §503.14 are met for each site on which bulk sewage sludge is applied.

(J) If the bulk sewage sludge meets the Class B pathogen requirements in §503.32(b), a certification that the information submitted to determine compliance with the site restrictions is accurate.

(K) A description of how the site restrictions in §503.32(b)(5) are met for each site on which Class B bulk sewage sludge is applied.

(L) If the vector attraction reduction requirements in either §§503.33(b)(9) or 503.33(b)(10) are met, a certification statement that the information submitted to determine compliance with the vector attraction reduction requirements is accurate.

(M) If the vector attraction reduction requirements in either §§503.33(b)(9) or 503.33(b)(10) are met, a description of how the requirements are met.

(F) Sewage Sludge Sold or Given Away in a Bag or Other Container Subject to Annual Pollutant Loading Rates [§503.17(a)(6)]

If the requirements in §503.13(a)(4)(ii) are met when sewage sludge is sold or given away in a bag or other container for application to the land, the person who prepares the sewage sludge for sale or give away in a bag or other container shall develop the following information and shall retain the information for 5 years:

(i) The annual whole sewage sludge application rate for the sewage sludge that does not cause the annual pollutant loading rates in Table 4 of §503.13 to be exceeded.

(ii) The concentration of each pollutant listed in Table 4 of §503.13 in the sewage sludge.

(iii) A certification that the information submitted to determine compliance with the pathogen and vector attraction reduction requirements is accurate.

(iv) A description of how the Class A pathogen requirements in §503.32(a) are met.

(v) A description of how one of the vector attraction requirements in §§503.33(b)(1) through 503.33(b)(8), or an equivalent vector attraction reduction requirement as determined by the permitting authority is met.

The permit writer is obligated to include the minimum appropriate recordkeeping conditions in each permit. Additionally, the permit writer may specify that other records be obtained or developed and maintained by the permittee to determine compliance with permit conditions. The following technical guidance provides examples of specific records the permit writer may want to specify that the permittee retain.

4.8.1 DOCUMENTATION FOR POLLUTANT CONCENTRATIONS

At a minimum, the person who prepares the sewage sludge for application to the land must keep sampling and analysis results. This documentation should include:

- Sampling records, including the date and time of sample collection, sample location, sample type, sample volume, name of person collecting the sample, type of sample container, method of field preservation, and sampling QC.

- Analytical records, including date and time of analysis, name of analyst, analytical methods, laboratory bench sheets with raw data and calculations used to determine results, analytical QC, and analytical results.

4.8.2 DOCUMENTATION FOR PATHOGEN AND VECTOR ATTRACTION REDUCTION

Records must be maintained of certifications made by the preparer and the land applier that the pathogen reduction requirements and vector attraction reduction requirements were met and a description of how the requirements were met. Permit conditions should specify the required certification statement to be used by the permittee. These certifications must be signed by a responsible individual. If the permit is an NPDES permit, there may already be language in the standard conditions defining the person who must sign all records and reports. If not, then the NPDES language in §122.22 may be used.

The description of how the pathogen and vector attraction reduction requirements were met should be supported by analytical results documenting pathogen density, logs documenting operational parameters for sewage sludge treatment units, and records describing site restrictions to properly demonstrate compliance with the provisions. Further discussion of the suggested monitoring and recordkeeping requirements and supporting documentation is provided in Chapter 8.

4.8.3 DOCUMENTATION TO SHOW COMPLIANCE WITH MANAGEMENT PRACTICES

Persons who land apply bulk sewage sludge are required to certify that they are meeting the management practices in §503.14 and to describe how the management practices are met unless they are land applying a sewage sludge that meets the exceptional quality criteria. If non-exceptional quality sewage sludge is prepared for sale or give away in a bag or other container, the preparer must meet the management practice requiring a label. The permit writer, at a minimum, can specify that the certification and description be maintained. After review of the permittee's application package and/or a field visit to application sites or in response to public concern, the permit writer may determine that more specific requirements are necessary to ensure compliance with the management practices. If the permit writer decides that more specific information is needed to determine compliance with the management practices, the permit writer must establish permit conditions that identify specific information, additional reports, or records that must be kept by the permittee. The following discussions for each management practice provide examples of specific information that may be requested to demonstrate compliance with the management practices.

Endangered Species or Critical Habitat Protection

Some of the following documentation may be necessary to demonstrate that the application site has been evaluated for potential effects on threatened or endangered species of plant, fish, or wildlife or their designated critical habitat and that necessary protective measures have been identified and implemented:

- The general proximity of the nearest critical habitat, including migration routes for threatened or endangered species to the application site
- A list of endangered or threatened species in the area or documentation that none exist
- If there are endangered or threatened species, a determination from the FWS or appropriate State or local agency that the land application activity will not adversely affect the survival of the species or its critical habitat
- If the above determination indicates that adverse impacts can be avoided if specific measures are taken, records containing documentation of the measures and how they have been met.

Application of Sewage Sludge to Flooded, Frozen, or Snow-Covered Land

Some of the following information may be needed to prove that it was highly unlikely for the sewage sludge applied to the flooded, frozen, or snow-covered land to have entered any surface waters or wetlands:

- A copy of any permit issued pursuant to either Section 402 or 404 of the CWA for allowing application of sewage sludge near wetlands
- A description of the general climatic conditions and the records of the average daily temperature and amount of snowfall in the area of the application site
- The average uninterrupted slope of the land application site and the distance of nearby surface waters or wetlands from the boundary of the application site
- A description of the run-off controls used at the site to prevent any sewage sludge from entering nearby surface waters or wetlands
- Records of the average daily amounts of precipitation in the area and a description of how land application of sewage sludge is avoided during periods of high rainfall
- The average depth to the ground water and records of the periods and extent of any flooding caused by ground water upsurges
- The types of crops grown and a brief description of any irrigation method used and typical periods when irrigation occurs.

Distance to Surface Waters

Some of the following records may be appropriate to document that an adequate buffer zone is maintained to prevent sewage sludge from entering adjacent surface water bodies:

- A log book entry for each application site describing the slope of the land application site, the distance between the boundary of the land application site and nearest surface water body, or documentation that surface water (which includes wetlands and intermittent stream beds) does not exist near the land application site

- If there is surface water near the land application site: the approximate length of each water body frontage; width, length, and slope of the protective buffer zone provided for that water body; and description of the vegetative cover of the buffer zone

- A log entry documenting the condition of any buffer zone, including its width and vegetative cover

- Site maps submitted at the time each site is identified, showing location of any surface waters with buffer zones clearly identified.

Agronomic Application Rate

The following documentation should be kept on file to demonstrate compliance with the agronomic rate requirement:

- The original calculations used to determine the whole sludge application rate, including all assumptions and sources of background information, and data for the variables used in the calculation, such as:

  - Nitrogen required by the crop or vegetation (available from Land Grant Universities, local extension agents, and Soil Conservation Service representatives)

  - Values for the nitrogen content (organic nitrogen, ammonia nitrogen, and nitrate-nitrogen) of the sewage sludge

  - Values for nitrogen content of supplemental fertilizers, if applicable

  - Values for nitrogen available from sewage sludge applied in previous years, if applicable

  - Nitrogen available from crop residue, if applicable

- The actual quantity of sewage sludge (dry weight basis) applied to the land application site

- The type of vegetation actually grown on the land and the annual nitrogen requirement for the vegetation or the annual whole sludge application rate authorized by the permitting authority

- The amount of supplemental fertilizer actually applied to the land, if known, and the nitrogen content of the fertilizer.

Label or Information Sheet

Preparers of sewage sludge subject to annual pollutant loading rates are required to keep a copy of a label or information sheet for at least 5 years. Part 503 requires that each label or information sheet contain at least the following:

- The name and address of the person who prepared the sewage sludge for sale or give away in a bag or other container for application to the land
- A statement that prohibits the application of the sewage sludge to the land except in accordance with the instruction on the label or information sheet
- The annual whole sludge application rate (AWSAR) for the sewage sludge that does not cause the annual pollutant loading rates to be exceeded.

The permit writer should specify that each time the quality of the sewage sludge changes enough to affect the AWSAR, the new label or information sheet be kept in the records.

4.9 REPORTING REQUIREMENTS

Statement of Regulation

§503.18(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 10,000 people or more shall submit the following information to the permitting authority:**

(1) **The information in 503.17(a), except the information in 503.17(a)(3)(ii), 503.17(a)(4)(ii) and in 503.17(a)(5)(ii), for the appropriate requirements on February 19 of each year.**

(2) **The information in 503.17(a)(5)(ii)(A) through 503.17(a)(5)(ii)(G) on February 19 of each year when 90 percent or more of any of the cumulative pollutant loading rates in Table 2 of §503.13 is reached at a site.**

As was described in the previous section, virtually all persons involved in the preparation of sewage sludge for land application or in the land application itself are required to keep records. However, only a subset of persons that are required to keep records are then required to report under §503.18.

The reporting requirements in §503.18 apply to the following persons:

- Class I sludge management facilities
- POTWs with a flow rate equal to or greater than 1 mgd
- POTWs serving a population of 10,000 or greater.

TWTDS that are not automatically required to report can be designated as a Class 1 sludge management facility by the Regional Administrator. These TWTDS, which could include compost processes and pelletization processes, would then be subject to the reporting requirements.

At a minimum, §503.18 specifies that certain persons report annually the information that they are required to develop and retain under the recordkeeping requirements. The permit writer should develop permit conditions that specifically identify the information that must be reported, the dates by which the information must be received, and the address to which the report must be submitted. The following technical guidance addresses these issues.

The permit writer is expected to set forth conditions requiring persons to meet the minimum reporting requirements. At a minimum, this includes the results of sewage sludge analyses for pollutant concentrations and a certification and description of how the pathogen reduction requirement was met. If the person used one of the treatment related vector attraction reduction alternatives [§§503.33(b)(1) through (8)], then the report must include a certification and description of how the vector attraction reduction requirement was met. In addition, if the sewage sludge prepared by the reporting person is land applied under the cumulative pollutant loading rates, that person is required to report site-specific information when the cumulative loading of any pollutant reaches 90 percent of the cumulative pollutant loading rate for that pollutant at that site.

When the preparer is instructed to report the results of sewage sludge analyses for pollutant concentrations or for pathogen density, he/she should be required to include the following information to improve the reliability of the report:

- Units for reported concentrations
- Dry weight concentrations
- Number of samples collected during the monitoring period
- Number of excursions during the monitoring period
- Sample collection techniques
- Analytical methods.

Whenever possible, the permittee should identify the specific elements to be contained in the description of how the pathogen and vector attraction reduction requirements were met. Refer to Chapter 8 for a detailed discussion of appropriate elements for each pathogen reduction and vector attraction reduction alternative. The permit writer may require that additional information be reported over the minimum requirements to determine the compliance status. In the case where additional information is to be reported, the permit writer must specifically require that information in the permit.

The permit writer will need to consider whether yearly reporting requirements are sufficient depending on site-specific conditions. He may want to require some reports to be submitted at a more frequent interval than the yearly reporting requirement. For example, if the permit writer has imposed quarterly monitoring requirements for pollutants in the permit, it may be appropriate to require quarterly reporting of the concentrations or pollutant loadings to determine compliance with the pollutant limits and to respond to noncompliance in a timely manner. In addition, several situations may warrant the inclusion of more frequent reporting, such as:

- Where sewage sludge data show significant variations in quality or where sewage sludge data indicate a trend toward poorer quality sewage sludge. In these cases, more frequent reporting may assist regulatory officials in addressing problems before violations of land application requirements occur. Additionally, the permit writer may have more advanced warning of the need to reopen a permit to address these situations.

- Where a compliance schedule was specified.

The permit writer should instruct the permittee to submit reports to the Water Compliance Chief at the appropriate EPA Regional office or to the appropriate State counterpart in an approved State. The permit should require that the reports be signed by an authorized representative. If the permit is an NPDES permit, the standard conditions may already contain language defining the authorized representative. If not, then the regulatory language found in §122.22 may be included to clearly identify the authorized representative.

4.10 SCENARIOS FOR A LAND APPLICATION STANDARD

This section discusses different scenarios for a land application standard for bulk sewage sludge and for sewage sludge that is sold or given away in a bag or other container for application to the land. Each scenario contains the appropriate 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).

Each of the scenarios is discussed in terms of whether the sewage sludge is classified as Exceptional Quality (EQ). This concept is discussed below.

Two approaches are taken in Part 503 to protect public health and the environment from the reasonably anticipated adverse effect of pollutants in sewage sludge when the sewage sludge is applied to the land. In one approach, sewage sludge is treated to meet the Part 503 requirements for pollutants, pathogens, and vector attraction reduction. Because those requirements are met through treatment, controls are not needed at the application site either to ensure any of the Part 503 requirements are met (e.g., injection of the sewage sludge below the land surface to reduce the attraction of vectors) or to prevent exposure to the sewage sludge.

Under the other approach, the Part 503 requirements are met through a combination of treatment of the sewage sludge and restrictions on the application site. In this case, control of the application site must be maintained to ensure that activities are performed at the site to meet a Part 503 requirement or that certain site restrictions are met. In both approaches, public health and the environment are protected, but through different means (i.e., treatment as opposed to a combination of treatment and restrictions on exposure).

During the development of Part 503, EPA received several comments that encouraged the Agency to use the treatment approach to identify sewage sludges that are equivalent to other types of fertilizers. Because the Part 503 requirements for pollutants, pathogens, and vector attraction reduction would be met through treatment, no controls would be needed at the application site. Thus, the sewage sludge could be treated like other fertilizers (i.e., generally, no site controls are imposed when other fertilizers are land applied).

In response to the comments, EPA modified the applicability section in subpart B of the final Part 503. Sections 503.10 (b) and (c) indicate that if bulk sewage sludge or a bulk material derived from bulk sewage sludge meets the ceiling concentration limits in Table 1 of §503.13, the pollutant concentration limits in Table 3 of §503.13, one of the Class A pathogen alternatives in §503.32(a), and one of the vector attraction reduction options in §§503.33 (b)(1) through (b)(8), or an equivalent vector attraction reduction option as determined by the permitting authority, the bulk sewage sludge or bulk material derived from bulk sewage sludge is not subject to the general requirements in §503.12 or the management practices in §503.14 when the bulk sewage sludge is land applied.

A bulk sewage sludge or bulk material derived from sewage sludge that meets the above requirements is known as exceptional quality (EQ). This term is used so that the above quality requirement do not have to be repeated each time they are discussed. The term exceptional quality is not used in the Part 503 regulation.

The term exceptional quality identifies a sewage sludge for which the Part 503 land application requirements are met by treating the sewage sludge. A non-EQ sewage sludge is a sewage sludge for which the Part 503 requirements are met through a combination of treatment and restrictions on exposure to the sewage sludge after it is land applied. Public health and the environment are protected when either EQ or non-EQ sewage sludge is land applied.

Sewage sludge that is sold or given away in a bag or other container for application to the land and that meets the above three quality requirements also is considered EQ. Thus, an EQ sewage sludge can be applied to agricultural land (including pasture and range land), forest, a public contact site, a reclamation site, a lawn, or a home garden and not be subject to the Part 503 land application general requirements and management practices.

In the case of bulk EQ sewage sludge or a bulk EQ material derived from sewage sludge, the EPA Regional Administrator or the State Director in the case where a State has an approved sludge management program can require that the Part 503 land application general requirements and management practices be met when the bulk EQ sewage sludge or bulk EQ material is land applied (see §§503.10(b)(2) and (c)(2)). In this case, the EPA Regional Administrator or State Director has to show that the general requirements and management practices are needed to protect public health and the environment from the reasonably anticipated adverse effect that may occur from any pollutant in the bulk sewage sludge or bulk material. This provision does not apply to sewage sludge that is sold or given away in a bag or other container for application to the land.

EPA concluded that a sewage sludge that meets the treatment-related Part 503 requirements for pollutants, pathogens, and vector attraction reduction has value and, thus, most likely will not be land applied inappropriately (e.g., at a rate that is greater than the agronomic rate for the site). For this reason and because control over an application site is not needed to ensure that any of the Part 503 requirements for pollutants, pathogens, and vector attraction reduction are met, the Agency also concluded that an EQ sewage sludge should be handled like other types of fertilizers with respect to application requirements.

The scenarios presented in this section are defined in terms of whether the sewage sludge is EQ. For example, the first scenario is for an EQ sewage sludge and the third scenario is for bulk sewage sludge that is non-EQ because the Class B pathogen requirements are met.

4.10.1 SCENARIO 1 - EXCEPTIONAL QUALITY (EQ) SEWAGE SLUDGE

For this scenario, the ceiling concentration limits, the pollutant concentration limits, one of the Class A pathogen requirements, and one of the first eight vector attraction reduction options (or an equivalent option) are met. When all of those requirements are met, the sewage sludge can be applied to agricultural land (including pasture and range land), forest, a public contact site, a reclamation site, a lawn, or a home garden without being subject to the Part 503 land application general requirements and management practices. It also can be sold or given away in a bag or other container for application to the land without being subject to the land application general requirements and management practices.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 1

General requirements:	None
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Pollutant concentration limits in Table 3 of §503.13
Management practices:	None
Operational standard (pathogens):	One of the Class A alternatives in §503.32(a)
Operational standard (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) through (b)(8) or an option determined to be equivalent by the permitting authority
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in either §503.17(a)(1) or §503.17(a)(2)
Reporting:	Requirements in §503.18(a)(1)

4.10.2 SCENARIO 2 - BULK SEWAGE SLUDGE THAT IS NON-EQ BECAUSE OF VECTOR ATTRACTION REDUCTION

In this scenario, the ceiling and pollutant concentration limits, the Class A pathogen requirements, and either vector attraction reduction option 9 (injection) or 10 (incorporation) are met. Control over the application site has to be maintained to ensure that the vector attraction reduction option is met. When the requirements in this scenario are met, bulk sewage sludge can be applied to agricultural land, forest, a public contact site, or a reclamation site. It can not be applied to a lawn or a home garden because vector attraction reduction options 9 and 10 are not feasible for a lawn or home garden.

This scenario does not apply to sewage sludge sold or given away in a bag or other container for application to the land. One of the treatment related vector attraction reduction options (i.e., Options 1 through 8) has to be met in this case.

ELEMENTS OF A PART 503 STANDARD - SCENARIO 2	
General requirements:	Requirements in §§503.12(a), (d), (e)(1), (f), (g), (h), and (i)
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Pollutant concentration limits in Table 3 of §503.13
Management practices:	Requirements in §§503.14(a) through (d)
Operational standard (pathogens):	One of the Class A pathogen alternatives in §503.32(a)
Operational standard (vector attraction reduction):	Either the vector attraction reduction option in §§503.33(b)(9) or (b)(10)
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(3)
Reporting:	Requirements in §503.18(a)(1)

4.10.3 SCENARIO 3 - BULK SEWAGE SLUDGE THAT IS NON-EQ BECAUSE OF PATHOGEN REDUCTION

In this scenario, the ceiling and pollutant concentration limits, one of the Class B pathogen alternatives, and one of the first eight vector attraction reduction options (or an equivalent option) are met. Because the Class B pathogen requirements are met, restrictions are imposed on the application site to prevent exposure to the bulk sewage sludge for certain periods. Bulk sewage sludge that meets the requirements in this scenario can be applied to agricultural land, forest, a public contact site, or a reclamation site, but not to a lawn or home garden. It is not feasible to impose the Class B site restrictions on a lawn or a home garden.

This scenario does not apply to sewage sludge sold or given away in a bag or other container for application to the land. When sewage sludge is sold or given away in a bag or other container for application to the land one of the Class A pathogen alternatives has to be met.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 3	
General requirements:	Requirements in §§503.12(a), (d), (e)(1), (f), (g), (h), and (i).
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Pollutant concentration limits in Table 3 of §503.13
Management practices:	Requirements in §§503.14(a) through (d)
Operational standard (pathogens):	One of the Class B alternatives in §503.32(b) and the site restrictions in §503.32(b)(5)
Operational standard (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) through (b)(8) or an option determined to be equivalent by the permitting authority
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(4)
Reporting:	Requirements in §503.18(a)(1)

4.10.4 SCENARIO 4 - BULK SEWAGE SLUDGE THAT IS NON-EQ BECAUSE OF POLLUTANT CONCENTRATIONS

In this scenario, the ceiling concentration limits, the CPLRs, one of the Class A pathogen alternatives, and one of the first eight vector attraction reduction options are met. Because the bulk sewage sludge is subject to the CPLRs, records have to be kept of the amount of each pollutant applied to the land in bulk sewage sludge. When the requirements in this scenario are met, bulk sewage sludge can be applied to agricultural land, forest, a public contact site, or a reclamation site. It can not be applied to a lawn or a home garden because it is not feasible to keep records of the amount of each pollutant applied to a lawn or home garden in bulk sewage sludge.

This scenario does not apply to sewage sludge sold or given away in a bag or other container for application to the land. In this case, the locations of the many application sites are not known. Thus, records of the amount of each pollutant applied to a site in sewage sludge can not be kept.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 4	
General requirements:	Requirements in §§503.12(a), (b), (d), (e)(1), (e)(2), (f), (g), (h), (i), and (j)
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Cumulative pollutant loading rates in Table 2 of §503.13
Management practices:	Requirements in §§503.14(a) through (d)
Operational standard (pathogens):	One of the Class A pathogen alternatives in §503.32(a)
Operational standard (vector attraction reduction):	One of the vector attraction reduction options in §§503.33 (b)(1) through (b)(8) or an option determined to be equivalent by the permitting authority
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(5)
Reporting:	Requirements in §§503.18(a)(1) and (a)(2)

4.10.5 SCENARIO 5 - BULK SEWAGE SLUDGE THAT IS NON-EQ BECAUSE OF VECTOR ATTRACTION REDUCTION AND PATHOGEN REDUCTION

In this scenario, the ceiling concentration limits in Table 1 of §503.13, the pollutant concentration limits in Table 3 of §503.13, one of the Class B pathogen alternatives in §503.32(b), and either the vector attraction reduction option in §§503.33(b)(9) or (b)(10) are met. Control over the application site must be maintained to ensure that the Class B site restrictions and the vector attraction reduction option are met at the site. When the Part 503 requirements in this scenario are met, bulk sewage sludge can be applied to agricultural land, forest, a public contact site, or a reclamation site, but not to a lawn or home garden.

This scenario does not apply to sewage sludge sold or given away in a bag or other container for application to the land. Control over the application site is not maintained when sewage sludge is sold or given away in a bag or other container.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 5	
General requirements:	Requirements in §§503.12(a), (d), (e)(1), (f), (g), (h), and (i)
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Pollutant concentration limits in Table 3 of §503.13
Management practices:	Requirements in §§503.14(a) through (d)
Operational standard (pathogens):	One of the Class B pathogen alternatives in §503.32(b) and the Class B site restrictions in §503.32(b)(5)
Operational standard (vector attraction reduction):	Either the requirements in §§503.33(b)(9) or (b)(10)
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(4)
Reporting:	Requirements in §503.18(a)(1)

4.10.6 SCENARIO 6 - BULK SEWAGE SLUDGE THAT IS NON-EQ BECAUSE OF VECTOR ATTRACTION REDUCTION AND POLLUTANT CONCENTRATIONS

In this scenario, the ceiling concentration limits in Table 1 of §503.13, the CPLRs in Table 2 of §503.13, one of the Class A pathogen alternatives, and the vector attraction reduction option in either §§503.33(b)(9) or (b)(10) are met. Because the CPLRs and either vector attraction reduction option 9 or 10 are met, control over the application site has to be maintained so that records of the amount of each pollutant applied to the land in bulk sewage sludge can be maintained and so that vector attraction reduction can be achieved. When the requirements in this scenario are met, bulk sewage sludge can be applied to agricultural land, forest, a public contact site, or a reclamation site, but not to a lawn or home garden.

This scenario does not apply to sewage sludge sold or given away in a bag or other container for application to the land. Control over the application site is not maintained when sewage sludge is sold or given away in a bag or other container.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 6	
General requirements:	Requirements in §§503.12(a), (b), (d), (e)(1), (e)(2), (f), (g), (h), (i), and (j)
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Cumulative pollutant loading rates in Table 2 of §503.13
Management practices:	Requirements in §§503.14(a) through (d)
Operational standard (pathogens):	One of the Class A pathogens in §503.32(a)
Operational standard (vector attraction reduction):	Either the requirements in §§503.33(b)(9) or (b)(10)
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(5)
Reporting:	Requirements in §§503.18(a)(1) and (a)(2)

4.10.7 SCENARIO 7 - BULK SEWAGE SLUDGE THAT IS NON-EQ FOR PATHOGEN REDUCTION AND POLLUTANT CONCENTRATIONS

In this scenario, the ceiling concentration limits in Table 1 of §503.13, the CPLRs in Table 2 of §503.13, one of the Class B pathogen alternatives, the Class B site restrictions, and one of the first eight vector attraction reduction options (or an equivalent option) are met. Control over the application site has to be maintained to ensure that records of the amount of each pollutant applied to the site in bulk sewage sludge are kept and to ensure that the Class B site restrictions are met. When the Part 503 requirements in this scenario are met, bulk sewage sludge can be applied to agricultural land, forest, a public contact site, or a reclamation, but not to a lawn or home garden.

This scenario does not apply to sewage sludge sold or given away in a bag or other container for application to the land. When sewage sludge is sold or given away in a bag or other container for application to the land, control over the application site is not maintained. Thus, there is no way to implement the site related requirements in this scenario.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 7	
General requirements:	Requirements in §§503.12(a), (b), (d), (e)(1), (e)(2), (f), (g), (h), (i), and (j)
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Cumulative pollutant loading rates in Table 2 of §503.13
Management practices:	Requirements in §§503.14(a) through (d)
Operational standard (pathogens):	One of the Class B pathogen alternatives in §503.31(b) and the Class B site restrictions in §503.13(b)(5)
Operational standard (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) through (b)(8) or an option determined to be equivalent by the permitting authority
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(5)
Reporting:	Requirements in §§503.18(a)(1) and (a)(2)

4.10.8 SCENARIO 8 - BULK SEWAGE SLUDGE THAT IS NON-EQ FOR VECTOR ATTRACTION REDUCTION, PATHOGEN REDUCTION, AND POLLUTANT CONCENTRATIONS

In this scenario, none of the requirements for an EQ sewage sludge are met. Instead, the ceiling concentration limits, the CPLRs, the Class B pathogen requirements, the Class B site restrictions, and either vector attraction reduction option 9 or 10 are met. Control over the application site has to be maintained to ensure that records of the amount of each pollutant applied to the site in sewage sludge are kept; to ensure that the Class B site restrictions are met; and to ensure that either vector attraction reduction option 9 or 10 is met. When the requirements in this scenario are met, bulk sewage sludge can be applied to agricultural land, forest, a public contact site, or a reclamation site, but not to a lawn or a home garden.

This scenario does not apply to sewage sludge sold or given away in a bag or other container for application to the land. The requirements related to the application site can not be implemented when sewage sludge is sold or given away in a bag or other container because control over the application site is not maintained.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 8	
General requirements:	Requirements in §§503.12(a), (b), (d), (e)(1), (e)(2), (f), (g), (h), (i), and (j)
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Cumulative pollutant loading rates in Table 2 of §503.13
Management practices:	Requirements in §§503.14(a) through (d)
Operational standard (pathogens):	One of the Class B pathogen alternatives in §503.32(b) and the Class B site restrictions in §503.32(b)(5)
Operational standard (vector attraction reduction):	The vector attraction reduction option in either §§503.33(b)(9) or (b)(10)
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(5)
Reporting:	Requirements in §§503.18(a)(1) and (a)(2)

4.10.9 SCENARIO 9 - SEWAGE SLUDGE SOLD OR GIVEN AWAY IN A BAG OR OTHER CONTAINER FOR APPLICATION TO THE LAND THAT IS NON-EQ BECAUSE OF POLLUTANT CONCENTRATIONS

In this scenario, the ceiling concentration limits, the APLRs, one of the Class A pathogen alternatives, and one of the first eight vector attraction reduction options (or an equivalent option) are met. Control over the application site is not maintained in this scenario. When the requirements in this scenario are met, sewage sludge can be applied to any type of land but most likely will be applied to a public contact site, a lawn, or a home garden.

This scenario does not apply to bulk sewage sludge that is land applied. It only applies to amounts up to one metric ton that are sold or given away in a bag or other container (e.g., a bucket, a box, a carton, or a vehicle or trailer with a load capacity of one metric ton or less). EPA assumed that small amounts of sewage sludge would be applied to a site for 20 years in developing the annual pollutant loading rates that are part of this scenario.

The only difference between this scenario and Scenario 1 for sewage sludge sold or given away in a bag or other container for application to the land is the pollutant limits. For Scenario 1, the ceiling concentration limits and pollutant concentration limits are met. In this scenario, the ceiling concentration limits and APLRs are met.

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 9	
General requirements:	Requirements in §§503.12(a), (e)(1), and (g)
Pollutant limits:	Ceiling concentration limits in Table 1 of §503.13
	Annual pollutant loading rates in Table 4 of §503.13
Management practice:	Requirements in §503.14(e)
Operational standard (pathogen):	One of the Class A pathogen alternatives in §503.32(a)
Operational standard (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) through (b)(8) or an option determined to be equivalent by the permitting authority
Frequency of monitoring:	Requirements in §503.16(a)
Recordkeeping:	Requirements in §503.17(a)(6)
Reporting:	Requirements in §503.18(a)

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5. SURFACE DISPOSAL - PART 503 SUBPART C

QUICK REFERENCE INDEX

5.1 INTRODUCTION

This chapter provides guidance on implementation of the requirements for surface disposal contained in Part 503, Subpart C. It is presumed that the permit writer has established that the sewage sludge being disposed is regulated by Part 503. Chapter 2 provides a detailed discussion of sewage sludge that is and is not regulated by Part 503.

Major challenges in determining whether this subpart is applicable to a particular facility include:

- Distinguishing surface disposal from land application
- Distinguishing surface disposal from treatment
- Distinguishing surface disposal from storage.

A surface disposal site is defined as an area of land that contains one or more active sewage sludge units. An active sewage sludge unit is an area of land on which sewage sludge is placed for disposal. Land does not include waters of the United States, as defined in § 122.2. Examples of sewage sludge surface disposal practices include sewage sludge-only landfills (monofills), sewage sludge piles, and lagoons designed for the final disposal of sewage sludge.

Surface disposal differs from land application in that it principally uses the land as final disposal, instead of using the sewage sludge to enhance the productivity of the land. Surface disposal occurs when sewage sludge is applied at rates in excess of the agronomic rate needed by vegetation grown on the site (and the site is not a reclamation site).

However, some surface disposal practices, where the sewage sludge is applied on the surface of the land, may be very similar to land application practices. For example, a surface disposal site where sewage sludge is applied and a food, feed, or fiber crop is grown or animals are grazed may appear to be a land application site. However, the site is a surface disposal site if it is for the final disposal of sewage sludge. In these situations, management practices must be implemented to control activities such as growing of crops or animal grazing.

The storage or treatment of sewage sludge (other than treatment to reduce pathogen levels and vector attraction characteristics) is not regulated by Part 503. If sewage sludge is placed on an area of land for either treatment or storage, § 503.20(c) makes clear that neither the land nor the sewage sludge placed on that land for treatment or storage is subject to the requirements in Subpart C. Lagoons, in particular, are frequently used to dewater or stabilize the sewage sludge, as well as for storage. Storage of sewage sludge is the placement of sewage sludge on land on which it remains for 2 years or less. The most obvious indicator that the land-based activity is treatment or storage is whether the treatment works has designated a subsequent sewage sludge use or disposal practice. Unless a final use or disposal practice has been identified for the sewage sludge, the permit writer should permit the land-based activity as final disposal or require that the permittee develop a final use or disposal plan for its sewage sludge.

Statement of Regulation

§503.20(b) **This subpart does not apply to sewage sludge stored on the land or to the land on which sewage sludge is stored. It also does not apply to sewage sludge that remains on the land for longer than 2 years when the person who prepares the sewage sludge demonstrates that the land on which the sewage sludge remains is not an active sewage sludge unit. The demonstration shall include the following information, which shall be retained by the person who prepares the sewage sludge for the period that the sewage sludge remains on the land:**

(1) **The name and address of the person who prepares the sewage sludge.**

(2) **The name and address of the person who either owns the land or leases the land.**

(3) **The location, by either street address or latitude and longitude, of the land.**

(4) **An explanation of why sewage sludge needs to remain on the land for longer than 2 years prior to final use or disposal.**

(5) **The approximate time period when the sewage sludge will be used or disposed.**

§503.20(c) **This subpart does not apply to sewage sludge stored or treated on the land or to land on which sewage sludge is treated.**

Another factor used to distinguish between storage and final disposal is the length of time that the sewage sludge remains on the land. Sewage sludge that remains on the land for periods greater than 2 years is being disposed unless the person who prepares the sewage sludge establishes through written justification a basis for leaving the sewage sludge on the land for longer than 2 years according to §503.20(b). The permit writer should evaluate each situation with regard to protection of public health and the environment and the reasonableness of a particular activity in determining whether it should be regarded as final disposal. Treatment works that generate small quantities of sewage sludge may reasonably stockpile sewage sludge for a period of time before use or disposal. Even some large treatment works may stockpile sewage sludge for periods when they unexpectedly lose access to their use or disposal practice. In contrast, there are a number of treatment works that indefinitely stockpile sewage sludge under conditions that should be considered disposal. It is common in some areas to construct sewage sludge "storage" lagoons with a 15-year capacity to postpone final disposal. These lagoons are constructed similarly to a surface disposal site and poses the same threat to human health and the environment, particularly ground water, as a surface disposal site and therefore should be regulated as such.

Some provisions of Subpart C apply to the sewage sludge, some to the location or siting of the surface disposal site and others to the operation of the surface disposal site. Not all of the management practices, frequency of monitoring, and recordkeeping requirements apply to every surface disposal site. For example, some apply only to sites with a liner and leachate collection system; others apply only to sites on which a cover is placed over sewage sludge.

When the preparer is not the owner/operator of the surface disposal site, the permit writer must decide how to allocate the permit requirements. Most of the general requirements and management practices apply to the site owner/operator. Requirements for pathogen and vector attraction reduction should be allocated according to whether they are met by the preparer, the owner/operator, or both. The pollutant limits may be placed in both permits; when they are based on site conditions the preparer's permit might contain a condition to meet the pollutant limits that are imposed on the owner/operator.

5.2 SPECIAL DEFINITIONS

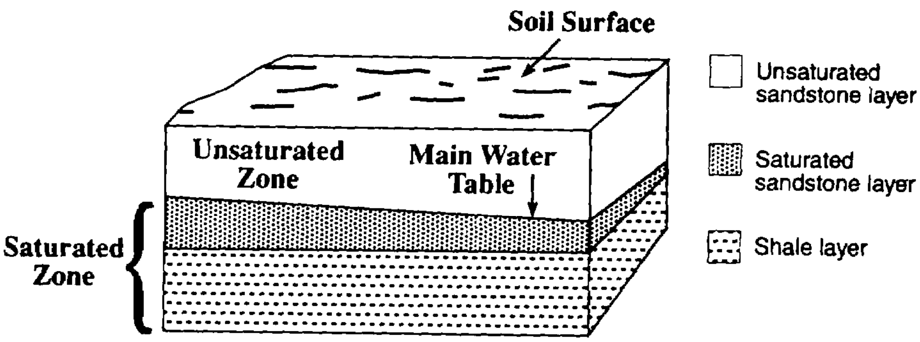
Section 503.21 contains definitions related specifically to surface disposal of sewage sludge. This section of the guidance manual briefly explains some of the terms in §503.21 applicable to surface disposal of sewage sludge and lists the remaining definitions in §503.21. This section also provides selected definitions from §503.9 (general definitions for the Part 503 rule) for reference purposes.

Aquifer

Statement of Regulation

§503.21(b) **Aquifer is a geologic formation, group of geologic formations, or a portion of a geologic formation capable of yielding ground water to wells or springs.**

An aquifer is a saturated permeable geologic unit that can transmit significant quantities of water under normal hydraulic gradients. An aquifer is typically described as being either confined, unconfined, or perched. In a confined aquifer, the permeable water-bearing and transporting material lies between two layers of less-permeable confining material referred to as aquitards. An unconfined aquifer will have an aquitard as its lower boundary and the water table as its upper limit. A perched aquifer is a phenomenon where a less permeable formation existing in the unsaturated zone above the water table acts as a lower aquitard. Water percolating down toward the water table is intercepted and collected, forming an isolated saturated zone and perched water table.



AQUIFER

Cover

Statement of Regulation

§503.21(d) **Cover is soil or other material used to cover sewage sludge placed on an active sewage sludge unit.**

Cover is the placement of earthen material over the sewage sludge once it has been placed in an active sewage sludge unit. Cover is placed over the sewage sludge to reduce vector attraction characteristics, to contain pathogens, and/or to mitigate odor problems. Virtually any soil is considered suitable cover material if it accomplishes the desired objectives; very coarse soils; however, may be inappropriate if the moisture content of the sewage sludge is so high that the soil sinks into the sewage sludge rather than mounding over the surface.

Other materials may be used as alternatives to soil cover material. The permit writer may require a demonstration (similar to that required for municipal solid waste landfills by the Part 258 regulations) that the alternate material is suitable. Suggested methods for the applicant to demonstrate alternative cover suitability are: (1) side-by-side comparison test of soil cover and alternative material; (2) full-scale demonstration; or (3) short-term full scale tests. Alternatives to soil cover include foams, polymer-bonded paper applied in a slurry/spray form, removable and reusable geotextiles, tarps, wood chips, and amended soils. Alternatives may be used provided they control disease vectors and odors without presenting a threat to human health and the environment (EPA 1992a).

A daily cover, applied at the end of the operating day, is one of the vector attraction reduction options allowed under §503.25(b).

Liner

Statement of Regulation

§503.21(j) **Liner is soil or synthetic material that has a hydraulic conductivity of 1 × 10^{-7} centimeters per second or less.**

A liner is an impediment used to retard the downward movement of liquid. The liner must have a hydraulic conductivity (the rate at which liquid moves through the liner) of 1 × 10^{-7} (one ten-millionth) centimeters per second or less. There are three general types of liners: soil, flexible membrane and composite. A soil liner is usually composed of compacted clay. Flexible membrane liners (or geomembranes) are generally polymeric materials, such as plastics and synthetic rubbers. Composite liners are flexible membrane liners overlying a compacted low-permeability soil layer.

Appendix B describes the types of liners that are commonly used and how the permit writer may determine if a site has a liner that meets the above hydraulic conductivity requirement and would appropriately be classified as a liner under Part 503.

Qualified Ground-Water Scientist

Statement of Regulation

§503.21(l) **Qualified ground-water scientist is an individual with a baccalaureate or post-graduate degree in the natural sciences or engineering who has sufficient training and experience in ground-water hydrology and related fields, as may be demonstrated by State registration, professional certification, or completion of accredited university programs, to make sound professional judgments regarding ground-water monitoring, pollutant fate and transport, and corrective action.**

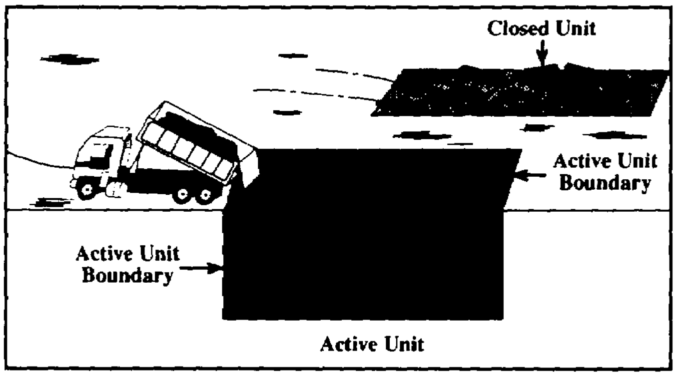
The qualifications of a ground-water scientist are defined in Part 503 to ensure that professionals with appropriate qualifications and judgment capabilities are used. The ground-water scientist must have an education and background that allows him or her to evaluate ground-water flow, ground-water monitoring systems, and ground-water monitoring technologies and methods. The ground-water scientist must be able to solve solute transport problems and evaluate ground water remediation techniques. The most appropriate education includes undergraduate or graduate studies in hydrogeology, ground-water hydrology, engineering hydrology, water resource engineering, geotechnical engineering, geology, or ground-water modeling. Although a ground-water scientist's education may vary from this list, the individual's education should be through an accredited institution. Some States have certification programs for ground-water scientists (EPA 1992a).

Sewage Sludge Unit

Statement of Regulation

§503.21(n) **Sewage sludge unit is land on which only sewage sludge is placed for final disposal. This does not include land on which sewage sludge is either stored or treated. Land does not include waters of the United States as defined in 40 CFR 122.2.**

A sewage sludge unit is usually a confined area of land within the surface disposal site used for the disposal of sewage sludge (including a material derived from sewage sludge). Some units will be lined and employ leachate collection systems. Numerous types of structures fall within the definition of sewage sludge unit, including excavated trenches or fill areas of varying dimensions and area fill mounds that may actually be located in depressions on the surface of the land.



The remaining definitions from §503.21 and selected definitions from §503.9 are shown below for reference purposes.

Statement of Regulation

§503.21(a) **Active sewage sludge unit is a sewage sludge unit that has not closed.**

§503.9(b) **Base flood is a flood that has a one percent chance of occurring in any given year (i.e., a flood with a magnitude equalled once in 100 years).**

§503.21(c) **Contaminate an aquifer means to introduce a substance that causes the maximum contaminant level for nitrate in 40 CFR 141.11 to be exceeded in ground water or that causes the existing concentration of nitrate in ground water to increase when the existing concentration of nitrate in the ground water exceeds the maximum contaminant level for nitrate in 40 CFR 141.11.**

§503.9(d) **Cover crop is a small grain crop, such as oats, wheat, or barley, not grown for harvest.**

Statement of Regulations

§503.21(e)	Displacement is the relative movement of any two sides of a fault measured in any direction.
§503.21(f)	Fault is a fracture or zone of fractures in any materials along which strata on one side are displaced with respect to strata on the other side.
§503.9(j)	Feed crops are crops produced primarily for consumption by animals.
§503.9(k)	Fiber crops are crops such as flax and cotton.
§503.21(g)	Final cover is the last layer of soil or other material placed on a sewage sludge unit at closure.
§503.9(l)	Food crops are crops consumed by humans. This includes, but is not limited to, fruits, vegetables, and tobacco.
§503.9(m)	Ground water is water below the land surface in the saturated zone.
§503.21(h)	Holocene time is the most recent epoch of the Quaternary period, extending from the end of the Pleistocene epoch to the present.
§503.21(i)	Leachate collection system is a system or device installed immediately above a liner that is designed, constructed, maintained, and operated to collect and remove leachate from a sewage sludge unit.
§503.21(k)	Lower explosive limit for methane gas is the lowest percentage of methane gas in air, by volume, that propagates a flame at 25 degrees Celsius and atmospheric pressure.
§503.9(s)	Place sewage sludge or sewage sludge placed means disposal of sewage sludge on a surface disposal site.
§503.9(v)	Runoff is rainwater, leachate, or other liquid that drains overland on any part of a land surface and runs off of the land surface.
§503.21(m)	Seismic impact zone is an area that has a 10 percent or greater probability that the horizontal ground level acceleration of the rock in the area exceeds 0.10 gravity once in 250 years.
§503.9(y)	Store or storage of sewage sludge is the placement of sewage sludge on land on which the sewage sludge remains for 2 years or less. This does not include the placement of sewage sludge on land for treatment.
§503.21(p)	Surface disposal site is an area of land that contains one or more active sewage sludge units.
§503.21(q)	Unstable area is land subject to natural or human-induced forces that may damage the structural components of an active sewage sludge unit. This includes, but is not limited to, land on which the soils are subject to mass movement.
§503.9(bb)	Wetlands means those areas that are inundated or saturated by surface water or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

5.3 GENERAL REQUIREMENTS

Section 503.22 CFR outlines four general requirements for placing sewage sludge on an active sewage sludge unit. First, sewage sludge cannot be placed on an active sewage sludge unit unless the requirements of Subpart C are met. Second, the active sewage sludge unit cannot be located within 60 meters of a fault, in an unstable area, or in a wetland. Third, the owner/operator of an active sewage sludge unit must submit a written closure and post-closure plan to the permitting authority 180 days before the unit is due to close. Finally, the owner of a surface disposal site must provide written notification to the subsequent owner of the site that sewage sludge was placed on the land. The following sections discuss each of these requirements.

5.3.1 COMPLY WITH THE PART 503 SURFACE DISPOSAL REQUIREMENTS

<u>Statement of Regulation</u>

§503.22(a)	**No person shall place sewage sludge on an active sewage sludge unit unless the requirements in this subpart are met.**

The first general requirement is that no person shall place sewage sludge on an active sewage sludge unit except in accordance with the requirements in the surface disposal subpart. This general requirement places the responsibility on the person who places sewage sludge on an active sewage sludge unit to ensure that the requirements related to the surface disposal are met when the sewage sludge is actually placed on the unit.

The person who places sewage sludge on the land could be either the preparer or the owner/operator of the surface disposal site. If the person who places the sewage sludge is not the preparer, she should request information from the preparer that indicates that the treatment-related Part 503 surface disposal requirements have been met, as appropriate. This includes pollutant concentrations in the sewage sludge, and whether pathogen reduction and vector attraction reduction is achieved through treatment.

5.3.2 LOCATION OF ACTIVE SEWAGE SLUDGE UNIT WITHIN 60 METERS OF A FAULT, IN AN UNSTABLE AREA, OR IN A WETLAND

<u>Statement of Regulation</u>

§503.22(b)	**An active sewage sludge unit located within 60 meters of a fault that has displacement in Holocene time; located in an unstable area; or located in a wetland, except as provided in a permit issued pursuant to section 402 or 404 of the CWA, shall close by March 22, 1994, unless, in the case of an active sewage sludge unit located within 60 meters of a fault that has displacement in Holocene time, otherwise specified by the permitting authority.**

The permit writer should refer to Section 5.5 to determine whether the active sewage sludge unit is located in any of the three prohibited or restricted areas identified above. The specific sections that address these requirements are:

- Fault areas—Section 5.5.4
- Unstable areas—Section 5.5.5
- Wetlands—Section 5.5.6.

The permit writer should develop specific permit conditions to require an active sewage sludge unit to close if he has determined that one of the following situations exists:

- The site is located within 60 meters of a fault with displacement in Holocene time (i.e., last 11,000 years) and has not been adequately designed to withstand seismic impacts
- The site is located in an unstable area
- The site is located in a wetland without a Section 402 or 404 permit.

Part 503 requires active sewage sludge units located as described above to close by March 22, 1994. Therefore, all such active sewage sludge units are in non-compliance unless, for those within 60 meters of a fault with displacement in Holocene time, they have requested and received permission to remain open from the permitting authority. If the permit writer believes that an active sewage sludge unit falls into one of the categories that requires closure, she will need to ask the owner/operator why it has not closed and discuss possible enforcement actions. This will include development of a compliance schedule that addresses closure activities and time frames.

5.3.3 WRITTEN CLOSURE AND POST-CLOSURE PLAN

Statement of Regulation

§503.22(c) **The owner/operator of an active sewage sludge unit shall submit a written closure and post closure plan to the permitting authority 180 days prior to the date that the active sewage sludge unit closes. The plan shall describe how the sewage sludge unit will be closed and, at a minimum, shall include:**

(1) A discussion of how the leachate collection system will be operated and maintained for 3 years after the sewage sludge unit closes if the sewage sludge unit has a liner and leachate collection system.

(2) A description of the system used to monitor for methane gas in the air in any structures within the surface disposal site and in the air at the property line of the surface disposal site, as required in 503.24(j)(2).

(3) A discussion of how public access to the surface disposal site will be restricted for 3 years after the last sewage sludge unit in the surface disposal site closes.

The Part 503 rule requires that a closure and post-closure plan be submitted to the permitting authority 180 days prior to closure of a unit. The plan, at a minimum, must address the three items specified in §503.22(c):

- Operation and maintenance of the leachate collection system if the unit has a liner and leachate collection system
- Methane gas monitoring if a final cover is placed on the unit
- Public access restriction to the site.

The permit writer has the authority and discretion during the development of permit conditions to elaborate on the Federal requirements and to include additional requirements if needed. For example, the regulation uses general language in specifying what the closure and post-closure plan must cover - i.e., how the leachate collection system will be operated and maintained, the system used to monitor for methane gas, and how public access will be restricted. The permit writer may develop more specific permit conditions that detail what the discussion or description must contain. Table 5-1 is an example outline of a closure and post-closure plan.

The closure and post-closure plan also should discuss post-closure activities - i.e., operating and maintaining the systems that prevent or monitor releases from the unit and monitoring activities that will be conducted throughout the 3-year period following the unit's closure. The plan should provide the following specific information:

- Name, address, and telephone number of a person to contact about the site
- Description of land use after closure, including any use restrictions
- Schedule or frequency at which post-closure activities are conducted
- Procedure for verifying that post-closure was provided in accordance with the plan
- Inspection and routine maintenance schedules (e.g., site visits, vegetation control)
- Personnel responsible for post-closure activities (e.g., company, title, responsibilities)
- Procedures for non-scheduled repairs
- Contingency plans (EPA 1992a).

Operation and Maintenance of the Leachate Collection System

Leachate can contaminate ground water, surface water, and soil if it is not controlled. If the active sewage sludge unit has a liner and leachate collection system, the closure/post-closure plan must describe how the leachate collection system will be operated and maintained for 3 years after closure. The owner/operator must comply with all NPDES and other applicable requirements for leachate collection and disposal. The closure and post-closure plan should furnish specific information on the operating schedule, leachate management plan, and the leachate removal schedule. Section 5.5.8 provides additional details on the operation and maintenance of the leachate collection system.

TABLE 5-1 SAMPLE CLOSURE AND POST-CLOSURE PLAN OUTLINE

Owner/Operator Name:
Mailing Address:
Telephone Number:
Site Location Address:

I. ACTIVE SEWAGE SLUDGE UNIT CONDITIONS

A. General information
   1. Size of active sewage sludge unit (hectares or acres)
   2. Description of liner, if applicable
   3. Description of leachate collection system, if applicable
   4. Copy of NPDES permit if there are discharges to U.S. waters

B. Schedule of final closure (milestone chart)
   1. Final date of sewage sludge accepted
   2. Date all on-site disposal completed
   3. Date final cover completed, if applicable
   4. Final date vegetation planted or other material placed
   5. Final date closure completed
   6. Total time required to close the active sewage sludge unit

II. DISPOSING OF SEWAGE SLUDGE

A. Total amount of sewage sludge to be disposed of on the active sewage sludge unit (m^3 or yd^3)

B. Description of procedures for disposing of sewage sludge
   1. Size of surface disposal site, number of active sewage sludge units and size of units necessary for disposing of sewage sludge (include site map of disposal area)
   2. Design and construction of active sewage sludge units

III. COVER AND VEGETATION

A. Final cover, if applicable
   1. Total area to be covered (m^2 or yd^2)
   2. Characteristics of final cover
      a. Type(s) of material(s)
      b. Depth of material(s)
      c. Total amount of material(s) required
   3. Final cover design
      a. Slope of cover
      b. Length of run of slope
      c. Type of drainage and diversion structures

B. Vegetation (if vegetation is to be planted)
   1. Total area requiring vegetation (hectares or acres)

C. Erosion Control (if vegetation is not to be planted)
   1. Procedures and materials for controlling cover erosion
   2. Justification for procedures and materials used

TABLE 5-1 SAMPLE CLOSURE AND POST-CLOSURE PLAN OUTLINE (Continued)

IV. GROUND-WATER MONITORING, IF APPLICABLE

- A. Analyses required
  1. Number of ground-water samples to be collected
  2. Ground-water monitoring schedule (e.g., quarterly, semi-annually)
  3. Details of ground-water monitoring program
- B. Maintenance of ground-water monitoring equipment

V. COLLECTION, REMOVAL AND TREATMENT OF LEACHATE

- A. Description of leachate collection system (i.e., pumping and collecting procedures), if applicable
  1. Description of the leachate sampling and analysis plan
  2. Estimated volume of leachate collected per month
- B. Description of leachate treatment process, if on-site
  1. Design objectives
  2. Materials and equipment required
- C. Disposal of leachate
  1. If discharged to surface waters, include copy of NPDES permit
  2. If hauled off site, provide final destination
- D. Maintenance of equipment
  1. Repairs and replacements required
  2. Regular maintenance required over the duration of closure and post-closure periods

VI. METHANE MONITORING, IF APPLICABLE

- A. Monitoring requirements
  1. Monitoring locations
  2. Frequency of analyses
- B. Maintenance of monitoring equipment
- C. Planned response to exceedences of limits

VII. MAINTENANCE ACTIVITIES

- A. Surface disposal site inspections
  1. List all structures, areas, and monitoring systems to be inspected
  2. Frequency of inspections for each
- B. Planned responses to probable occurrences (including those listed below)
  1. Loss of containment integrity
  2. Severe storm erosion
  3. Drainage failure
- C. Maintaining cover and/or vegetation
  1. Cover maintenance activities and schedule
  2. Mowing schedule
  3. Reseeding and mulching schedule
  4. Soil replacement
     - a. Labor requirements
     - b. Soil requirements
  5. Fertilizing schedule
  6. Sprinkling schedule
  7. Rodent and insect control program

TABLE 5-1 SAMPLE CLOSURE AND POST-CLOSURE PLAN OUTLINE (Continued)

D. Controlling erosion
  1. Maintenance program for drainage and diversion system
  2. Activities required to repair expected erosive damage
  3. Replacement cover soil, if applicable
     a. Amount to be stored on site during the post-closure period
     b. Specification of alternative sources of cover soil, if applicable (i.e., off-site purchase agreement or on-site excavation)

VIII. INSTALLATION OR MAINTENANCE OF THE FENCE, IF APPLICABLE

A. If a fence already exists, describe required maintenance at closure to ensure it is in good condition
B. If fence is to be installed, specify:
  1. Area to be enclosed
  2. Type of materials used
  3. Dimensions of fence
C. Security and public access practices planned for the post-closure period
  1. Description of security system
  2. Maintenance schedule

IX. CLOSURE SCHEDULE

A. Schedule for closure procedures
B. Schedule of periodic inspections

Methane Gas Monitoring System

Methane gas is a byproduct of the anaerobic decomposition of organic matter and is explosive within a certain concentration range in air. Consequently, Part 503 requires continuous monitoring of air for methane gas at sites where the sewage sludge is covered. Additionally, air must be monitored for methane for a period of 3 years after closure, if a final cover is placed on an active sewage sludge unit at closure. At sites where methane monitoring is required, air must be monitored inside structures at the site and at the site boundary to prevent the accumulation of methane gas to levels that could cause hazards such as explosions, fires, and asphyxiation.

To provide for adequate monitoring of methane for 3 years after an active sewage sludge unit closes, the closure and post-closure plan should specifically describe the monitoring equipment. Data must be collected continuously and must be retained for 5 years. Section 5.5.9 furnishes additional information on methane monitoring and collection systems.

Public Access Restriction

Part 503 restricts public access to a closed sewage sludge unit to prevent:

- Possible exposure to methane
- Direct contact with, or ingestion of, the sewage sludge or sewage sludge-soil mixture
- Traffic that could damage the final cover.

Section 5.5.11 provides examples of proper public access control that should be described in the closure plan.

Final Cover

If a final cover is placed on an active sewage sludge unit that is to be closed, the cover should be designed to:

- Control volatilization of pollutants
- Account for settling or subsidence in the unit
- Resist erosion
- Control runoff and prevent other damage to the cover.

The closure plan should describe how the final cover accommodates settlement and subsidence, caused by decomposition and consolidation of the sewage sludge, which can impair the integrity of the final cover system (EPA 1992a). The plan should include erosion control to prevent surface water and precipitation from damaging the cover if soil is removed from the cover or the cover system is somehow degraded. Erosion control should be designed to minimize the amount of water that flows across the cover and, thus, minimize damage to the unit's physical structure, prevent discharges of pollutants in solution or suspension in the runoff, and limit downward percolation of water through the sewage sludge that creates leachate.

When the final cover is installed, repairs and maintenance may be necessary for the cover to continue functioning properly. The permit writer should seek information on landfill closure technology, design, and maintenance procedures relevant to sewage sludge unit closure. He may use this information to develop permit conditions that meet the requirements for closing an active sewage sludge unit.

5.3.4 NOTIFICATION TO SUBSEQUENT OWNER

Statement of Regulation

§503.22(d) **The owner of a surface disposal site shall provide written notification to the subsequent owner of the site that sewage sludge was placed on the land.**

This section addresses the two issues that the permit writer will encounter in implementing this requirement: (1) identifying the type(s) of information that need to be provided to the subsequent owner of surface disposal sites; and (2) determining an appropriate mechanism for ensuring that this information is passed on to the subsequent owner. According to Part 503, a subsequent owner must be provided with a written notification stating that the land has been used for surface disposal of sewage sludge. The notice should describe the sewage sludge disposal activities as well as provide specific details about the design and operations of the site.

The permit writer should consider requiring the following information in the notification statement:

- Name(s) and address(es) of the former owner(s) and operator(s) of the surface disposal site
- Map of the surface disposal site clearly showing the geographical location of sewage sludge units as well as a depth profile of the former sewage sludge units at the surface disposal site
- Estimate of the total amount of sewage sludge that has been disposed in each sewage sludge unit at the surface disposal site
- Results of methane gas monitoring (if conducted)
- Type of liner and leachate collection system installed, if appropriate, and leachate volume and characteristics
- Copy of any written closure and post-closure plan.

5.4 POLLUTANT LIMITS

Sewage sludge placed in an active sewage sludge unit that is not equipped with a liner and a leachate collection system must meet pollutant limits for three metals: arsenic, chromium, and nickel. The specific pollutant limits to apply depend on the distance between the active sewage sludge unit boundary and the surface disposal site property line.

No pollutant limits pertain to sewage sludge placed in a unit that is equipped with a liner and leachate collection system because the liner retards the movement of pollutants in sewage sludge into the ground water. Owners/operators of sites that have liners and leachate collection systems must demonstrate that the liner meets the specifications in §503.21(j). If the liners are substandard, then the sewage sludge placed in these units must meet the pollutant concentrations for unlined units. Appendix B contains information to assist in evaluating whether a liner was designed, installed, and continues to maintain a hydraulic conductivity of 10^{-7} centimeters per second.

The permit writer also may determine that the conditions of the active sewage sludge unit warrant the development of site-specific limits. In this case, the permit writer may use the permittee's site-specific data and the Tables in Appendix E to calculate site-specific sewage sludge pollutant limits.

The permit writer needs the following information to determine the appropriate pollutant limits applicable to the sewage sludge placed on an active sewage sludge unit:

- Information on the liner and leachate collection system - in developing the specific pollutant limits for sewage sludge placed in these units, it was assumed that the liner would achieve a minimum level of protection by slowing the passage of leachate through the liner to a rate of less than 10^{-7} centimeters per second. If a liner does not meet this specification, then the unit is considered unlined for purposes of assigning pollutant limits to the sewage sludge placed in the unit.
- Distance between unit boundary and the site property line - the distance of 150 meters was one of the assumptions used when developing the Part 503 pollutant limits. If the unit boundary is closer to the property line, the potential for ground water contamination may be increased due to proximity to a well; therefore, the pollutant limits needs to be reduced.

Step 1: Initially, the permit writer should review the permit application and determine whether the permittee has requested site-specific pollutant limits. Refer to Section 5.4.3 for further instructions for the use of site-specific limits. If site specific limits are not requested or appropriate, continue to the next step.

Step 2: Determine whether the active sewage sludge unit has a liner and leachate collection system. If it does, no pollutant limits apply. If the unit does not have both a liner and a leachate collection system, or if the liner does not meet the hydraulic conductivity specification, continue to the next step.

Step 3: For an active unit without a liner and leachate collection system, identify the distance from the unit boundary to the site property line. If the unit boundary is located 150 meters or further from the site property line, apply the pollutant limits listed in Table 1 of § 503.23. Refer to Section 5.4.1 for further instructions on how to apply these limits.

Step 4: If this distance is less than 150 meters, apply the pollutant concentration limits listed in Table 2 of § 503.23 for the appropriate actual distance. Refer to Section 5.4.2 for further instruction on how to apply these limits.

In addition, the permit writer must recognize that a surface disposal site may have several different types of active sewage sludge units and that the sewage sludge placed on site may be subject to different pollutant limits depending on the active sewage sludge unit in which it is placed. In such situations, the permit writer will have to designate different pollutant limits and monitoring and recordkeeping requirements for each active sewage sludge unit.

5.4.1 AN ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM WITH A UNIT BOUNDARY TO SITE PROPERTY LINE DISTANCE OF 150 METERS OR MORE

Statement of Regulation

§503.23 **Pollutant limits (other than domestic septage)**

§503.23(a) **Active sewage sludge unit without a liner and leachate collection system**

§503.23(a)(1) **Except as provided in §503.23(a)(2) and (b), the concentration of each pollutant listed in Table 1 of §503.23 in sewage sludge placed on an active sewage sludge unit shall not exceed the concentration for the pollutant in Table 1 of §503.23.**

TABLE 1 OF §503.23 -- POLLUTANT CONCENTRATIONS - ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM

Pollutant	Concentration (milligrams per kilogram*)
Arsenic	73
Chromium	600
Nickel	420

*Dry weight basis

The permit writer applies the pollutant concentrations in Table 1 of §503.23 when the following conditions exist:

- The active sewage sludge unit does not have a liner and leachate collection system or has a liner that fails to meet specified hydraulic conductivity criteria
- The unit boundary is 150 meters or more from the property line of the surface disposal site.

The permit should contain the pollutants and pollutant limits that appear in §503.23(a)(1). These limits should be expressed as the maximum pollutant concentrations not to be exceeded. These limits should also be expressed on a dry weight basis. The metric units (mg/kg) should be included in the permit, but English units also can be used. Conversion factors are provided in Appendix A.

5.4.2 AN ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM WITH A UNIT BOUNDARY TO SITE PROPERTY LINE DISTANCE OF LESS THAN 150 METERS

Statement of Regulation

§503.23 **Pollutant limits (other than domestic septage)**

§503.23(a) **Active sewage sludge unit without a liner and leachate collection system**

§503.23(a)(2) **Except as provided in §503.23(b), the concentration of each pollutant listed in Table 1 of §503.23 in sewage sludge placed on an active sewage sludge unit whose boundary is less than 150 meters from the property line of the surface disposal site shall not exceed the concentration determined using the following procedure.**

(i) The actual distance from the active sewage sludge unit boundary to the property line of the surface disposal site shall be determined.

(ii) The concentration of each pollutant listed in Table 2 of §503.23 in the sewage sludge shall not exceed the concentration in Table 2 of §503.23 that corresponds to the actual distance in §503.23(a)(2)(i).

TABLE 2 OF §503.23 – POLLUTANT CONCENTRATIONS - ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM THAT HAS A UNIT BOUNDARY TO PROPERTY LINE DISTANCE LESS THAN 150 METERS

Unit boundary to property line distance (meters)	Pollutant concentration* Arsenic (mg/kg)	Chromium (mg/kg)	Nickel (mg/kg)
0 to less than 25	30	200	210
25 to less than 50	34	220	240
50 to less than 75	39	260	270
75 to less than 100	46	300	320
100 to less than 125	53	360	390
125 to less than 150	62	450	420

*Dry weight basis

The risk assessment methodology used in developing pollutant limits for sewage sludge placed in an unlined active sewage sludge unit assumed that the boundary of each unit would be at least 150 meters from the site property line of the surface disposal site. Sewage sludge placed in an active sewage sludge unit located closer than 150 meters from the site property line must meet more stringent pollutant limits to ensure protection of ground water.

To determine the appropriate pollutant limits for an active unit without a liner and leachate collection system with a boundary that is less than 150 meters from the disposal site property line, the permit writer must know the actual distance from the active sewage sludge unit boundary to the property line of the surface disposal site. This distance should be the shortest distance measured between any point on the unit boundary to any point located on the property line of the surface disposal site.

The permit writer should use the actual distance from the sewage sludge unit boundary to the property line of the site and read the corresponding pollutant limits for arsenic, chromium, and nickel from Table 2 of § 503.23. This procedure is illustrated in the worksheet in Figure 5-1. The permit writer can determine the applicable limits by using this worksheet and following the example provided in the figure.

The permit should include the pollutant limits that appear in § 503.23(a)(2) for the actual distance from the unit boundary to the site property line. These limits should be expressed as the maximum pollutant concentrations not to be exceeded. These limits should be expressed on a dry weight basis using the metric units (mg/kg), but English units can also be used. Conversion factors are provided in Appendix A.

5.4.3 SITE-SPECIFIC POLLUTANT LIMITS

Statement of Regulation

§503.23	**Pollutant limits (other than domestic septage)**
§503.23(b)	**Active sewage sludge unit without a liner and leachate collection system - site-specific limits**
§503.23(b)(1)	**At the time of permit application, the owner/operator of a surface disposal site may request site-specific pollutant limits in accordance with §503.23(b)(2) 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 §503.23 and when the permitting authority determines that site-specific pollutant limits are appropriate for the active sewage sludge unit.**
§503.23(b)(2)	**The concentration of each pollutant listed in Table 1 of §503.23 in sewage sludge placed on an active sewage sludge unit without a liner and leachate collection system 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.**

Site-specific pollutant limits can be developed for active sewage sludge units without liners and leachate collection systems. If the owner/operator of a surface disposal site requests site-specific pollutant limits, the permit writer will need to determine if such a request is valid and if site-specific pollutant limits are appropriate. Thereafter, he should use the information in Appendix E to determine the site-specific pollutant concentration limits. To determine whether a request for site-specific pollutant limits is valid, the permit writer should request current information on specific site parameters and compare this information to the values used in developing the pollutant limits in § 503.23(a).

The permit writer should follow these steps to determine the appropriate pollutant concentration limits to apply to an active sewage sludge unit that does not have a liner and leachate collection system or to a unit whose liner fails to meet the hydraulic conductivity requirements:

Step 1: Obtain the actual distance from the active sewage sludge unit boundary to the site property line.

Step 2: Review the columns in the table below to locate the range containing the distance obtained in Step 1.

Step 3: Incorporate the pollutant limits provided in the appropriate column into the permit for the surface disposal site.

POLLUTANT CONCENTRATIONS FOR AN ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM
(milligrams per kilogram*)

Pollutants	≥150	<150-≥125	<125-≥100	<100-≥75	<75-≥50	<50-≥25	<25-≥0
Arsenic	73	62	53	46	39	34	30
Chromium	600	450	360	300	260	220	200
Nickel	420	420	390	320	270	240	210
*Dry weight basis							

For example, to obtain the pollutant limits for an active sewage sludge unit whose boundary is located 88 meters from the site property line, the permit writer would review the above table to identify the distance range, <100 to ≥75 meters. The following pollutant limits would be included in the permit:

Arsenic 46 mg/kg
Chromium 300 mg/kg
Nickel 320 mg/kg

FIGURE 5-1 WORKSHEET FOR CALCULATING POLLUTANT LIMITS FOR ACTIVE SEWAGE SLUDGE UNITS WITHOUT LINERS AND LEACHATE COLLECTION SYSTEMS

The permit writer should consult Appendix E to determine if the site-specific parameter values are substantially different from those used in developing the §503.23(a) pollutant limits. Before proceeding with the site-specific assessment, the permit writer should review all available sewage sludge pollutant concentration data. The site-specific limits issued in the permit must be the lower of either the values derived from the site-specific tables or the existing concentration of the pollutant in the sewage sludge.

5.5 MANAGEMENT PRACTICES

5.5.1 ENDANGERED SPECIES OR CRITICAL HABITAT PROTECTION

<u>Statement of Regulation</u>

§503.24(a) **Sewage sludge shall not be placed on an active sewage sludge unit 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.**

Permitting Factors

Active sewage sludge units are often located in rural areas that either contain or are surrounded by a wide variety of plant, fish, and wildlife species, some of which may be endangered or threatened. The designated critical habitat is any place where a threatened or endangered species lives and grows during any stage in its life cycle. All threatened or endangered species of plants, fish, and wildlife are listed in 50 CFR §§ 17.11 and 17.12. A copy of the lists with references to the original *Federal Register* listing notice can be obtained from the U.S. Department of Interior, Fish and Wildlife Service (FWS).

The permit writer may need to verify if any endangered or threatened species of plant, fish, or wildlife exist on or near the active sewage sludge unit. In addition, a surface disposal site may be located in the migratory route of an endangered or threatened species of fish or wildlife and may become a temporary but critical habitat for such species. The permit writer can obtain such information or verify the information provided in the permit application by contacting the field office of the FWS. To provide the permit writer with the requested information, the FWS biologist may need specific data, such as the exact location (preferably in terms of latitude and longitude), the size of the site, location and size of any nearby body of water, and type and extent of vegetative cover.

If threatened or endangered species or their designated critical habitats are present in the areas proposed to receive the sewage sludge, the permit writer will need to determine whether the placement of the sewage sludge on the active sewage sludge unit will likely cause an adverse effect upon the species or their habitats. An adverse effect would be the destruction or adverse modification of the critical habitat to the extent that the likelihood of survival and recovery of the species is diminished. Unfortunately, it may not be possible to predict the effects of the placement of sewage sludge on the species or habitat without site specific field studies. In some cases, it may be necessary to prohibit the application of sewage sludge on sites where threatened or endangered species or their critical habitats are present. However, it may be possible to allow the placement of sewage sludge concurrent with field studies designed to measure the effects on the species and their habitats. EPA policy or best professional judgment (BPJ) should be used if specific management practices are necessary to protect the species and their habitat.

Permit Conditions

Section 503.24(a) only applies if endangered species of plant, fish, or wildlife are identified within or near an active sewage sludge unit or if it is determined that the unit is located in the migratory path of any endangered or threatened species of wildlife. However, as a precautionary measure, the permit writer may include this management practice in the permit as it appears in Part 503.

If it is determined that the active sewage sludge unit supports or is part of a critical habitat for a threatened or endangered species of plant, fish, or wildlife, the permit writer should consult with FWS personnel or other informed State or local agency personnel to determine and develop necessary permit conditions.[1] For example, if the unit is located within the migratory path of an endangered species, the permit writer could develop a permit condition prohibiting the application of bulk sewage sludge during the migration period.

Other conditions that the permit writer may include are the following:

- Buffer zones that provide an adequate distance from the critical habitat of the endangered species
- Requirements for increased monitoring and reporting in certain areas
- Requirements to conduct special studies to determine the impact on the endangered species or its critical habitat.

5.5.2 BASE FLOOD FLOW RESTRICTIONS

Statement of Regulation

§503.24(b) An active sewage sludge unit shall not restrict the flow of a base flood.

Permitting Factors

The siting of active sewage sludge units on areas subject to flooding requires special considerations to ensure that the flow of floodwaters is not restricted. Restricting the flow of a base flood can increase the velocity of the flow downstream of the site, reduce the temporary storage capacity of the flood plain, or increase the level of the flood waters.

Base flood is a flood that has a one percent chance of occurring in any given year (i.e., a flood with a magnitude equalled once in 100 years). [§503.9(b)]

An active sewage sludge unit located in the base flood area that affects the flow of the base flood and flood water storage capacity of the flood plain is acceptable, unless the effect is large enough to cause higher flood levels and greater flood damage. If the owner/operator of the active sewage sludge unit can demonstrate that the active sewage sludge unit will not pose unacceptable threats of higher flood levels

[1] FWS and EPA are in the process of developing consultation guidance for such permitting activities.

and flood velocity, the requirements of this provision are met. If this demonstration can not be made, the owner/operator must close the active sewage sludge units located in the 100-year flood plain. Closure must be performed in accordance with the closure and post-closure plan required by §503.22(c).

Restriction of the flow of a base flood is defined as the raising of flood levels by one foot or more due to the presence of an obstruction.

The permit writer should first determine whether the active sewage sludge unit is located within an area that is likely to be inundated during the 100-year base flood (i.e., within the 100-year flood plain). River flood plains are readily identifiable as the flat areas adjacent to the river's normal channel. The 100-year flood plains are identified in the flood insurance rate maps (FIRMS) and flood boundary and floodway maps published by the U.S. Federal Emergency Management Agency (FEMA). Guidance in using FIRMS is provided in "How to Read a Flood Insurance Rate Map" published by FEMA. FEMA also publishes "The National Flood Insurance Program Community Status Book" which lists communities that are in Emergency or Regular Flood Insurance programs, including communities that may not be involved in the National Flood Insurance Program but which have FIRMS or floodway maps published. Maps and other FEMA publications may be obtained from the FEMA Distribution Center. Areas not covered by the FIRMS or floodway maps may be included in flood plain maps available through the U.S. Army Corps of Engineers, the U.S. Geological Survey (USGS), the U.S. Soil Conservation Service, the Bureau of Land Management, the Tennessee Valley Authority, and State and local agencies. Many of the river channels covered by these maps may have undergone modification for hydropower or flood control projects and the flood plain boundaries represented may not be accurate or representative. The permit writer may want to compare the flood plain map series to recent aerial photographs to identify current river channel modifications and land use watersheds that could affect flood plain designation (EPA 1992a).

If flood plain maps are not available and the surface disposal site is located within a flood plain, then a field study to delineate the 100-year flood plain may be required. A flood plain delineation program would be based primarily on meteorological records and physiogeographic information, such as existing and planned watershed land use, topography, soils and geologic mapping, and aerial photo interpretation of geomorphic (land form) features. The U.S. Water Resource Council provides information to determine the potential for floods in a given location by stream gauge records. Estimation of the peak discharge by these methods also allows an estimation of the probability of exceeding the 100-year flood (EPA 1992a).

If the active sewage sludge units are not located on the 100-year flood plain, the permit writer need not include any condition in the permit. However, if the surface disposal site is located near a flood plain and there is a potential that future active sewage sludge units may be placed in the flood plain, the permit writer should include a permit condition that any active units constructed or placed in service during the term of the permit must not restrict the flow of the base flood.

If the active sewage sludge unit is located in a 100-year flood plain, the permit writer must evaluate whether the sewage sludge unit will restrict the flow of a base flood. The demonstration that the active sewage sludge unit does not restrict the flow of a base flood relies on estimates of the flow velocity and volume of flood plain storage in the vicinity of the active sewage sludge unit during a base flood. The assessment should consider the flood plain storage capacity and floodwater velocities that would exist in the absence of the active sewage sludge unit. Raising the base flood level by more than one foot can indicate that the active sewage sludge unit may reduce and restrict storage capacity and flow. In some smaller areas, a greater than one foot increase in the flood level may be acceptable (EPA 1992a).

The assessment of flood water velocity will require that the channel cross section be known above, at, and below the active sewage sludge unit. Friction factors on the overbank are determined from the surface conditions and vegetation present. River hydrologic models may be used to simulate flow levels and estimate flood velocities through these river cross sections. The U.S. Army Corps of Engineers has developed several numerical models to aid in the prediction of flood hydrographs, flow parameters, the effect of obstructions on flow levels, the simulation of flood control structures, and sediment transport (COE 1982).

If the permit writer determines that the active sewage sludge unit will restrict base flood flow, she may need to write site-specific conditions into the permit that will prevent restriction of the flow of a base flood or require closure of the active sewage sludge units. To determine whether to draft such site-specific conditions, the permit writer will require additional information about the site, the design parameters of the active sewage sludge units, and management practices that will be used to prevent restriction of the base flood. The permit writer also may need to develop permit conditions that require the active sewage sludge unit to be adequately protected from flood damage, such as embankment designs with rip-rap and geotextiles to prevent scour. Guidelines for design with these materials may be found in Maynard (1978) and the Department of Agriculture (1983). Embankment designs will require an estimate of river flow velocities, flow profiles (depth), and wave activity. The use of alternative erosion controls such as gabions (cubic-shaped wire structures filled with stone), paving bricks, and mats may be considered (EPA 1992a).

5.5.3 REQUIREMENTS IN A SEISMIC IMPACT ZONE

<u>Statement of Regulation</u>

§503.24(c) **When a surface disposal site is located in a seismic impact zone, an active sewage sludge unit shall be designed to withstand the maximum recorded horizontal ground level acceleration.**

Permitting Factors

Seismic impact zone is an area that has a 10 percent or greater probability that the horizontal ground level acceleration of the rock in the area exceeds 0.10 gravity once in 250 years. [§503.21(m)]

Ground motion from earthquakes can cause structural failure of the active sewage sludge unit(s). Studies indicate that, during earthquakes, superficial (shallow) slides and differential displacement are produced, rather than massive slope failures (Dept. of Navy 1983). Stresses created by superficial failures can affect liner and final cover systems, and leachate and gas collection and removal system performance. For example, tensional stresses within the liner system can fracture the soil liner and/or tear the flexible membrane liner. The effects of seismic activity on earth material are discussed in Section 5.5.5.

First, the permit writer should determine whether the surface disposal site is located in a seismic impact zone. If it is, the permit writer must require that the owner/operator ensure that the active sewage sludge units are designed to withstand the maximum recorded horizontal ground level acceleration. Table 5-2 lists documents and Table 5-3 identifies governmental and non-governmental organizations that can provide information on seismic impact zones and seismic hazards. These lists are not a complete compilation of sources for seismic information but should provide the permit writer with enough information to make an informed decision.

TABLE 5-2 SOURCES OF INFORMATION ON SEISMIC IMPACT ZONES AND FAULT AREAS

"Preliminary Map of Horizontal Acceleration in Rock With 90% Probability of Not Being Exceeded in 250 Years" - Algermissen and Perkins, Probabilistic Estimates of Maximum Acceleration and Velocity in Rock in the Contiguous United States, U.S. Geological Survey Open-File Report 82-1033, 1982 (Updated 1991) Available from USGS Map Center.
Preliminary Young Fault Maps, MF916, U. S. Geological Survey, 1978 -identifies the location of Holocene faults in the United States. Available from USGS Map Center.
National Aerial Photographic Program/National High Altitude Program (NAPP/NHAP) high altitude, high resolution aerial photographs. Available from U.S. Geological Survey, EROS Data Center.
USGS State seismic maps - USGS Map Distribution
Building Seismic Safety Council, "NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings" (U.S. Federal Emergency Management Agency 1991). Available from FEMA.

TABLE 5-3 GOVERNMENTAL AND NON-GOVERNMENTAL ORGANIZATIONS THAT MAY PROVIDE SEISMICITY INFORMATION

USGS
Earthquake Information Center, Colorado School of Mines, Golden, Colorado (seismicity maps of all 50 states and a database of known earthquakes and fault zones)
State Geologic Surveys
The National Information Service for Earthquake Engineering
The Building Seismic Safety Council
The American Institute of Architects

If active sewage sludge units are located in seismic impact zones, the permit writer should determine the amount of risk posed by geological and hydrogeological conditions. The permit writer should investigate the following potential site hazards:

- Liquefaction (the partial or total loss of shear strength of loose, saturated fine sands as a result of an increase in pore water pressure; the soil acts like a liquid)
- Soils with low foundation strength
- Slope instability

- Ground deformation
- Fault rupture.

For active sewage sludge units located in an area with an estimated maximum horizontal acceleration greater than 0.1 gravity (g), the permit writer's evaluation of seismic effects should consider both foundation soil stability and sewage sludge stability under seismic loading. Conditions that may be considered for the evaluation include the construction phase (maximum open excavation depth of new active sewage sludge unit) and closure activities.

The horizontal acceleration is expressed as a percentage of the acceleration due to gravity (g). The acceleration due to gravity is 9.8 meters/sec^2.

There are no standard procedures for designing active sewage sludge units for seismic events. Winterkorn and Fang (1975) and Department of the Navy (1983) do, however, review engineering evaluations that consider the influence of local soil conditions on ground response and shaking intensity, soil settlement, soil liquefaction, and slope instability during earthquakes. Design modifications to accommodate an earthquake may include shallower active sewage sludge unit side slopes and more conservative design of dikes and runoff controls. Well compacted cohesion-less embankments or reasonably flat slopes in insensitive clay are less likely to fail under moderate seismic shocks (up to 0.15g and 0.20g acceleration). Additional contingencies should be installed for leachate collection in the event primary systems are disrupted. The materials that make up the individual components must be able to withstand seismic forces while contributing to the unit's strength. New active sewage sludge units can be designed to these standards or to the requirements of this part (EPA 1992a).

5.5.4 REQUIREMENT OF 60 METERS OR MORE FROM A FAULT

<u>Statement of Regulation</u>

§503.24(d) **An active sewage sludge unit shall be located 60 meters or more from a fault that has displacement in Holocene time unless otherwise specified by the permitting authority.**

Permitting Factors

Seismologists generally believe that the structural integrity of an engineered unit cannot be unconditionally guaranteed when it is built within 60 meters (200 feet) of a fault along which movement is highly likely to occur (EPA 1991b). A 60 meter (200 feet) buffer zone is, in most cases, sufficient to protect engineered structures from seismic damages. The permit writer must first determine whether an active sewage sludge unit is within 60 meters (200 feet) of a fault that has had movement during the Holocene epoch. To make this determination, the permit writer should obtain information on any lineaments that suggest the presence of any faults within a 915 meter (3,000 foot) radius of the site. Sources of the information are:

- A review of available maps, logs, reports, scientific literature, or insurance claim reports
- An aerial reconnaissance of an area within a five mile radius of the site, including an aerial photo analysis

- A reconnaissance based on walking portions of the area within 915 meters (3,000 feet) of the unit (EPA 1992a).

In 1978, the USGS published a map series identifying the location of Holocene faults in the United States (Preliminary Young Fault Maps, MF916). For an area where movement along a Holocene fault is known to have occurred since 1978, when the maps were made, the owner/operator will need to conduct a geologic reconnaissance of the site and surrounding areas. The National Aerial Photographic Program/National High Altitude Program (NAPP/NHAP) aerial photographs with stereo coverage are a useful remote sensing aid for delineating fault traces and structural lineaments. This series of aerial photography provides coverage over most of the United States and is available through the USGS, EROS Data Center (EPA 1992a). Tables 5-2 and 5-3 list sources of more information about fault areas.

A fault is a fracture or a zone of fractures in any materials along which strata on one side are displaced with respect to strata on the other side. [§503.21(f)] A fault may have sudden movement or it may have very slow movement. A fault includes main, branch, or secondary faults.

Displacement is the relative movement of any two sides of a fault measured in any direction. [§503.21(e)]

Holocene time is the most recent epoch of the Quaternary period, extending from the end of the Pleistocene Epoch to the present. This is approximately the last 11,000 years. [§503.21(h)]

If a fault (or faults) is located within 915 meters (3,000 feet) of the active sewage sludge unit, the owner/operator should investigate further and determine the presence or absence of any faults within 60 meters (200 feet). A fault may be located by performing one or more of the following activities:

- Conducting a site walkover to detect any fault related phenomena, such as offset curbs or walls, offset drainage channels, or fault scarps
- Conducting subsurface exploration, including drilling and trenching to locate fault zones and evidence of faulting
- Trenching perpendicular to any fault or lineaments within 60 meters (200 feet) of the unit
- Determining the age of any displacements
- Constructing supporting maps and other analyses (EPA 1992a).

Displacement of surficial deposits across a fault may indicate that such displacement has occurred in recent times. In addition, seismic epicenters recorded in recent times may indicate recent movement or activity along structures in a given area. The results of the investigation should be prepared by a qualified professional. Data that should be contained in the report are:

- A plan view of any faults within 915 meters (3,000 feet) of the site
- A map showing all faults within 60 meters of the unit boundary and identification of faults that have had movement during the Holocene epoch

- A site topographic map of sufficient detail to show any offset streams, linear ridges, fault scarps, and other horizontal features
- A description of geology with respect to stratigraphy (e.g., comparison of soils across a fault) which can determine the fault's age.

Permit Conditions

If an active sewage sludge unit is not located within 60 meters (200 feet) of a fault that has displacement in Holocene time, the permit writer does not need to place any conditions addressing this Part 503 requirement in the permit.

If an active sewage sludge unit is located within 60 meters of a fault that has displacement in Holocene time, the permit writer must require the unit to be closed, if she cannot conclude that continued operation of the active sewage sludge unit is protective to human health and the environment. If an active sewage sludge unit is not located within 60 meters of a fault that has displacement in Holocene time, but is located within 915 meters (3,000 feet) of a fault that has displacement in Holocene time, the permit writer might consider additional requirements. These could include (1) a requirement to map all fault traces within 915 meters; (2) a requirement that all engineered structures must be at least 60 meters from any fault; or (3) a requirement to submit a site engineering plan that contains the investigative report and mapping of all faults.

5.5.5 UNSTABLE AREAS

Statement of Regulation

§503.24(e) **An active sewage sludge unit shall not be located in an unstable area.**

Permitting Factors

The permit writer should be able to recognize unstable areas such as landslide-prone areas, karst terrain, volcanic regions, areas that overlay extensive underground mining operations, and areas that overlay oil, gas, or water withdrawal operations. The owner/operator should certify that an active sewage sludge unit is not located in an unstable area. The permit writer may want to require the owner/operator to conduct an engineering assessment if the unit is located in a potentially unstable area. This assessment should be performed by a qualified engineering professional and should contain the following information:

- A detailed geotechnical and geological evaluation to assess the stability of the foundation soils, adjacent man-made and natural embankments, and slopes

Unstable area is land subject to natural or human-induced forces that may damage the structural components of an active sewage sludge disposal unit. This includes, but is not limited to, land on which the soils are subject to mass movement. [§503.21(q)] Unstable areas have features that indicate protective measures cannot be designed to withstand a natural event. Examples of unstable areas are: areas within 60 meters of a fault, karst terrains, fissures, surface areas weakened by underground mining or other excavations or oil, gas, or water withdrawals, and areas near volcanoes.

- A geotechnical evaluation of the ability of the subsurface to support the active sewage sludge unit adequately, without damage to the foundation or other structural components.

Landslide-Prone Areas

Landslides are a problem that can be remedied with varying degrees of success. Recognizing areas susceptible to downslope movements is important to design considerations. Many features are unstable when combined with seismic impact zones, such as liquefaction potential and slope failure. The type of slope material determines the earthquake resistance of the slope. The permit writer should require the owner/operator to assess the slope materials in areas subject to seismic activities. Slope stability maps should be available from State geological surveys. Slope materials vulnerable to earthquake shocks include:

- Very steep slopes of weak, fractured and brittle rocks or unsaturated loess that are vulnerable to transient shocks caused by tensional faulting

- Loess and saturated sand that may be liquefied by seismic shocks causing the sudden collapse of structures and flow slides

- Sensitive cohesive soils when natural moisture exceeds the soil's liquid limit

- Dry cohesion-less material on a slope at the angle of repose that responds to seismic shock by shallow sloughing and slight flattening of the slope (Winterkorn and Fang 1975).

Where the active sewage sludge units are comprised of the above types of slope materials, the permit writer should require closure of the units in areas where seismic activities occur.

Slope failures occur when the driving forces imposed on the soils or engineered structure exceed the resisting forces of the material. Such a slope failure often occurs in the absence of seismic activity. Non-seismic slope failure can be caused by:

- Excessive rainfall on steep slopes

- Removing the toe (downslope edge) of a slope

- Overloading a slope

- Removing vegetation from a slope.

The site can be evaluated by a site walkover to find evidence that may indicate a potential landslide problem. Specific features to look for include:

- Retaining walls, fences, and posts that are aligned in a uneven pattern

- Utility poles with taut or sagging wires

- Hummocky or step-like ground features

- Seeping water from the base or toe of a slope.

A computer software package and technical manual, *Geotechnical Analysis for Review of Dike Stability* (GARDS), developed by EPA's Risk Reduction Engineering Laboratory (RREL), can assist in evaluating earth dike stability. GARDS details the basic technical concepts and operational procedures for the analysis of site hydraulic conditions, dike slope and foundation stability, dike settlement, and liquefaction potential of dike and foundation soils. The program was designed as a geotechnical support tool to facilitate evaluation of existing and proposed earthen dike structures at hazardous waste sites (EPA 1988b). The GARDS concepts also apply to active sewage sludge disposal units.

The permit writer may want to include monitoring activities that could indicate potential problems. Monitoring parameters may include settlement, lateral movement and pore water pressure. Monitoring for pore water pressure usually is accomplished with piezometers screened in the particularly sensitive strata. Lateral movements may be detected on the surface by surveying (horizontal and vertical) movements while subsurface movements may be detected by slope inclinometers. Settlement may be monitored by surveying benchmarks.

Karst Terrain

Karst terrains are subject to progressive and/or catastrophic failure of subsurface conditions from sink holes, solution cavities, and subterranean caverns. Therefore, no active sewage sludge units should be located in Karst terrain.

Underground Mining Operations

Areas with extensive underground mining operations are subject to catastrophic failures and subsidence in a manner similar to karst terrains. Some mining operations may weaken the structural support for the overlying strata. In extreme cases, roof collapse of the mine could cause a catastrophic failure of any overlying engineered structures. Mine grouting or filling actions may not be feasible due to the uncertainty in the volume that is required to successfully fill the void and the interconnections between mines and breached barrier pillars. State mining departments can be contacted to obtain mine maps. Streets or roads located over land subject to underground mining operations that have a wavy, uneven pitch are good indicators of subsidence.

Oil, Gas, and Water Withdrawal Operations

Oil and gas operations and/or water pumping operations can lead to locally developed subsidence condition that can damage structural components. Oil and gas extraction subsidence tends to be more localized than subsidence due to water pumping operations. Subsidence due to oil and gas and/or water pumping operations occasionally can be reversed. To do this, water is injected into a formation to raise the fluid pressure in the formation.

Permit Conditions

Where a surface disposal site is located in an unstable area, the permit writer should develop a permit condition that prohibits the siting of any active sewage sludge units in unstable areas. Where an existing unit is located over potentially unstable areas (such as karst topography or landslide-prone areas), the permit writer should require the owner/operator to submit a detailed geotechnical and geological evaluation of the area and an engineering analysis of the design measures to ensure that the active sewage sludge unit has sufficient ground support to withstand any ground movement that could rupture the unit's integrity and cause a release of the sewage sludge pollutants. These investigations should be performed by qualified ground-water and engineering professionals. Existing active sewage sludge units located in unstable areas must have closed by March 19, 1994, to be in compliance with Part 503.

5.5.6 WETLAND PROTECTION

Statement of Regulation

§503.24(f) **An active sewage sludge unit shall not be located in a wetland, except as provided in a permit issued pursuant to section 402 or 404 of the CWA.**

Permitting Factors

If wetlands are within the surface disposal site boundary and the owner/operator plans to locate an active sewage sludge unit within a wetland, the owner/operator must apply for and receive a Section 404 permit from the U.S. Army Corps of Engineers. If an active sewage sludge unit is currently located in a wetland, the owner/operator should produce a valid Section 404 permit or a NPDES permit to demonstrate compliance with this regulatory provision.

EPA, the U.S. Army Corps of Engineers (COE), and FWS have identified wetlands protection as a top priority. Constructing and operating active sewage sludge units in wetland areas is essentially a fill activity; therefore, this activity has the potential to significantly alter the structure and function of a wetland. Once damaged by fill activities, wetland ecosystems are difficult or impossible to restore because of their complexity and fragility. Proposals to locate active sewage sludge units in wetlands should undergo rigorous demonstration requirements to establish that there are no suitable alternative locations. COE is the Federal agency with jurisdiction for issuing permits to entities proposing fill activities in wetlands. Fill activities in wetland areas are regulated by the COE and EPA under Sections 404 and 402 of the CWA. Many States also regulate activities in wetlands.

Any active sewage sludge unit located in a wetland and not covered by a valid Section 404 or NPDES permit must have been closed in accordance with §503.22(b) by March 22, 1994. An owner/operator of a surface disposal site that is planning construction or opening of a new active sewage sludge unit must determine whether the proposed location or construction activity is subject to Section 404 and obtain a Section 404 permit, if applicable, prior to project initiation.

To implement §503.24(f), the permit writer first needs to know if any active sewage sludge units are or will be located within a wetland. As part of the permit application, the permit writer should receive information as to whether the active sewage sludge unit is located in a wetland. If this information is not provided, the permit writer should require the owner/operator of the surface disposal site to indicate whether it holds or is applying for a valid Section 404 or 402 permit.

If the permittee does not have a Section 404 or 402 permit, the permit writer needs to determine (or require the owner/operator to certify) whether there is a wetland onsite. Wetlands are identified on the basis of soil conditions, vegetation type, and site hydrology. They are typically found along the fringe of waterbodies. Some types of wetlands such as prairie potholes, vernal pools, and cypress domes are not directly associated with surface water, but are found in surface depressions in the land. These depressional wetlands can be particularly difficult to identify because they are usually dry for a portion of the year. If the permit writer or the owner/operator suspects that there are wetlands on the site where active sewage sludge units are or may be located, he/she should contact the local COE District Office and request a wetland delineation.[2] A list of the District Offices and their address is published annually in 33 CFR Part 330. Additionally, any State agency that regulates activities in wetlands should be contacted and invited to inspect the location of an active sewage sludge unit.

> Definition of Wetlands
>
> Wetlands are areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation adapted for growth in water or wet soil. Wetlands include, but are not limited to, swamps, marshes, bogs, prairie pot holes, playa basins, and similar areas. [§503.9(bb)]

A wetlands assessment should be conducted by a qualified and experienced multidisciplinary team with a soil scientist and a botanist or biologist. The assessment identifies: (1) the limits of the wetland boundary based on soil and plant types, (2) the type and relative abundance of vegetation including trees, and (3) rare, endangered, or otherwise protected species of flora and fauna and their habitat (EPA 1992a). Criteria used in wetlands identification have been developed by a task force consisting of representatives from the EPA, FWS, Soil Conservation Service, and COE and are presented in the *Federal Manual For Identifying and Delineating Jurisdictional Wetlands* (COE 1989). This publication also contains an extensive list of literature available on identification and prevalence of plant species characteristic of wetlands throughout the United States, hydraulic soil classifications, and related wetland topics (EPA 1992a). Additional published information useful to the permit writer in identifying areas that are wetlands is listed in Table 5-4. If it is determined that wetlands are at the surface disposal site and the site does not have a Section 404 or 402 permit, the permit writer should require the active sewage sludge units at the site to close.

TABLE 5-4 SOURCES OF INFORMATION TO IDENTIFY WETLANDS

Federal Manual For Identifying and Delineating Jurisdictional Wetlands (COE 1989)
USGS topographic maps
National Wetland Inventory (NWI) Maps
Soil Conservation Service (SCS) soil maps
Local wetland inventory maps

If the owner/operator has a Section 402 or 404 permit, the permit writer should require the owner/operator to demonstrate that the site is in compliance with the permit. The permit writer can contact the Section 404 permitting authority and inquire about the permittee's compliance status. If the site is not in compliance with its Section 404 or 402 permit, the permit writer, working with the U.S. Army Corps of Engineers, should determine whether the active sewage sludge unit(s) at the site should be closed.

[2]The definition and regulatory strategy for wetlands is currently being reevaluated at the Federal level and may be revised.

Permit Conditions

If there are wetlands at the surface disposal site, it may be appropriate to include a permit condition requiring compliance with the Section 404 permit or to incorporate the Section 404 permit into the NPDES permit by reference, if the site has an NPDES permit. If the wetland assessment indicates that there are no wetlands on the surface disposal site, then the permit writer may either disregard this provision or include, as a general prohibition, that no future expansions of the surface disposal site may be located in wetlands, unless authorized in a permit issued pursuant to Section 404 of the CWA.

5.5.7 STORM WATER RUN-OFF MANAGEMENT

Statement of Regulation

§503.24(g)(1) **Run-off from an active sewage sludge unit shall be collected and shall be disposed in accordance with National Pollutant Discharge Elimination System permit requirements and any other applicable requirements**

§503.24(g)(2) **The run-off collection system for an active sewage sludge unit shall have the capacity to handle run-off from a 24-hour, 25-year storm event.**

Permitting Factors

Storm water run-off is a point source discharge regulated by the NPDES program. The run-off collection system from an active sewage sludge unit must have the capacity to handle the water volume generated from a 24-hour, 25-year storm. A 25-year storm is a storm event with a frequency of occurrence of 25 years.

Run-off is rainwater, leachate, or other liquid that drains overland on any part of a land surface and runs off of the land surface. [§503.9(v)]

Control of surface run-off can be accomplished in the following ways: (1) by minimizing water that enters the active sewage sludge units (i.e., run-on controls); (2) by minimizing the size and number of active sewage sludge units in a surface disposal site; (3) by preventing the placement of sewage sludge with low solids content on an active sewage sludge unit; and (4) collecting and managing the run-off.

The permit writer should determine whether appropriate controls and capacity for collecting and controlling a 24-hour, 25-year storm have been incorporated into the design of the surface disposal site. Therefore, brief descriptions of how to calculate the water volume generated by storm events and the different types of controls that may be used are provided below to aid the permit writer in making this determination.

Design for 24-Hour, 25-Year Storm

The typical approach to designing run-on/run-off controls includes the following:

- Identifying the intensity of the design storm
- Determining peak discharge rates

- Calculating the run-off volume during peak discharges
- Designing the controls.

Site-specific design storm information is generally obtained from local planning agencies, civil works departments, or local zoning boards. The most accurate determination of the design storm uses precipitation from at least the past 25 years. The permit writer may wish to verify the information used by the owner/operator by referring to a publication entitled "Technical Paper 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years" prepared by the National Weather Service of the Department of Commerce (1963) for the eastern and central United States. In western states, the permit writer should refer to the "NOAA Atlas 2, Precipitation Frequency Atlas of the United States" prepared by the National Oceanic and Atmospheric Administration of the Department of Commerce (1973).

To determine peak run-on/run-off flows, a designer most commonly uses one of two methods (although others are available). One method is the Soil Conservation Service (SCS) Method (USDA 1986). This model assumes that the rate and amount of rainfall is uniform throughout the watershed over a certain amount of time. The rainfall run-off volume is estimated from cumulative rainfall data by using a typified unit hydrograph. This allows the estimation of both peak discharges and total run-off hydrograph. Run-off curves used in this methodology have been developed to account for the effects of soils, plant cover, amount of impervious areas, interception, and surface storage. Another method, the Rational Method, assumes that maximum run-off, resulting from uniformly intense precipitation, will occur when the entire watershed upstream of the site location contributes to the discharge (Dunne et al. 1978). Details of these methods can be found in many common references and textbooks.

The permit writer may request calculations for the determination of peak flow and run-off volume associated with the 25-year, 24-hour storm from the owner/operator to ensure that the appropriate storm volume has been considered in sizing the run-off controls and collection systems. The owner/operator must design the controls and collection systems for at least the volume of storm water produced by the 25-year, 24-hour storm. If the area is located within an area subject to flooding, the owner/operator of the site may need to design controls that address flooding and a higher volume of storm water than the 25-year, 24-hour storm would produce (see Section 5.5.2).

The permit writer will need to review the storm water run-off management information provided by the owner/operator to determine that:

- All the storm water controls and collection systems for the active sewage sludge units or the entire surface disposal site are sized appropriately for the storm water magnitude of a 24-hour, 25-year storm event
- The calculation of run-off volume used to size the controls is correct
- The run-off is collected and disposed of in accordance with an NPDES or other permit.

Run-on/Run-off Storm Water Controls

Often, the most economical designs for collecting and controlling storm water discharges include run-on controls as well as run-off controls to prevent additional storm water from becoming contaminated and to minimize the amount of water that must be collected and treated. Both run-on and run-off controls are generally used in partnership and they will both be discussed. The permit writer should remember, however, that run-on controls are not required specifically by Part 503.

Run-on and run-off control structures, whether temporary or permanent, can be incorporated into the surface disposal site design. Because of the variety of types of controls, specific design considerations are beyond the scope of this document, and only a brief description of the more commonly used control structures is presented in Table 5-5. The permit writer can use the information in the table to review a choice of controls for a site and to determine which aspects of the design may need additional conditions in the permit to ensure proper collection and disposal of the storm water.

Maintenance and Inspections

One aspect of the controls and best management practices (BMPs) that the permit writer may want to evaluate is operation and maintenance. Often controls and BMPs require specific maintenance activities. Some are considered temporary and will need to be maintained and rebuilt on a regular basis if disturbed due to storm water or other activities. The permit writer will want to ensure that the appropriate maintenance activities are being performed at the surface disposal site so that the controls and BMPs maintain their ability to collect the volume of run-off from the 24-hour 25-year storm. The permit writer may request inspection and maintenance schedules from the owner/operator and incorporate these schedules in the permit. Inspections should be made monthly and after every storm event that is of a measurable size. A measurable storm event is often defined as having 0.1 inch of rainfall.

Erosion and Sedimentation Best Management Practices

Although not specifically required, the permit writer may wish to address other BMPs or run-off control measures in the permit. Conditions for minimizing erosion and sedimentation at surface disposal sites where large areas of land are disturbed may be appropriate. For more information on the erosion and sedimentation BMPs, see EPA's "Storm Water Pollution Prevention for Industrial Activities" (EPA 1992b).

Permit Conditions

If the site is located within an area subject to flooding, the permit writer may want to put special conditions in the permit for the surface disposal site to be able to retain a higher volume of storm water. The permit writer also may establish permit conditions for inspection and maintenance of the storm water run-on controls.

5.5.8 LEACHATE COLLECTION AND DISPOSAL

Statement of Regulation

§503.24(h) **The leachate collection system for an active sewage sludge unit that has a liner and leachate collection system shall be operated and maintained during the period the sewage sludge unit is active and for 3 years after the sewage sludge unit closes.**

§503.24(i) **Leachate from an active sewage sludge unit that has a liner and leachate collection system shall be collected and shall be disposed in accordance with the applicable requirements during the period the sewage sludge unit is active and for 3 years after the sewage sludge unit closes.**

TABLE 5-5 TYPICAL RUN-ON/RUN-OFF CONTROL BEST MANAGEMENT PRACTICES

Control	Description	Purpose/ Function	Maintenance	Special (Design) Considerations
Dikes and Berms	Dikes and berms are compacted ridges or ledges, generally earthen, constructed immediately upslope or around the perimeter of an active sewage sludge unit.	Diverts uncontaminated storm water around the active sewage sludge unit to natural or manmade drainage channels, manmade outlets, or sedimentation basins. Dikes can be used as interceptors to reduce slope lengths, minimize erosive forces, and divert the run-off away from a source of contamination.	Relatively impermanent. Must be inspected regularly, especially after heavy storms to maintain their integrity. Typically, dikes and berms are reconstructed yearly.	Construction is simple and typically designed from standard specifications.
Drainage Swales, Channels and Waterways	Drainage swales, channels and waterways are drainage ways installed to collect and convey the flow of storm water run-off in a manner that does not contribute to erosion. These controls can be temporary or permanent and can be lined with vegetation, rip rap, asphalt, concrete, or other materials.	Cross-sections vary and can be trapezoidal, triangular or parabolic. Generally swales have a less steep cross section and when vegetated may promote infiltration of some of the storm water discharge; however, they are appropriate only for uncontaminated discharges.	Should be inspected to remove debris within 24 hours of rainfall, or daily during periods of prolonged rainfall. Drainages to conveyances should be repaired as soon as possible.	Design of drainage swales, channels and waterways must consider the local drainage patterns, soil permeability, annual precipitation, area land use, and other characteristics of the watershed contributing to the run-off.

TABLE 5-5 TYPICAL RUN-ON/RUN-OFF CONTROL BEST MANAGEMENT PRACTICES (Continued)

Control	Description	Purpose/ Function	Maintenance	Special (Design) Considerations
Terraces and Benches	Terraces and benches are earth embankments or ridge and channels constructed along the contour of a steep slope, generally one with no vegetation and with a water erosion problem.	Diverts storm water run-off away from steep slopes where erosion may occur. Also minimizes erosion by reducing both the length of a slope and the velocity of the run-off. The permit writer will want to ensure that any contaminated discharges are diverted to an appropriate outlet that leads to a discharge that is in compliance with an NPDES permit.	Should be inspected at least once a year and after major storms.	Must be designed with adequate outlets, such as a grassed waterway, vegetated areas, or tile outlet. Should not be constructed on slopes with sandy or rocky soils.
Chutes and Down Pipes	Specifically, chutes are excavated earthen channels that have been lined with non-erodible materials, such as bituminous concrete or grouted riprap. Down pipes are rigid or flexible piping that has been installed.	Chutes and down pipes carry run-off to the bottom of a slope so that erosion is prevented while the sewage sludge unit is inactive and covers have been constructed, yet stabilization of the surface has not been completed.	Must be inspected on a regular schedule and after major storms to promptly clear clogged pipes.	The maximum recommended drainage area for a chute and down pipe is approximately 10 acres.
Seepage Drains and Ditches	A seepage basin typically consists of the actual basin, a sediment trap, and a bypass for extra flow and emergency overflow.	Seepage drains and ditches provide in-situ treatment and recharge to ground water. Not appropriate for contaminated run-off and should not be used for discharges from active sewage sludge units. Most effective in highly permeable soils and typically are used in areas where the water table is close to the surface.	Drains and ditches must be inspected regularly for pipe breaks or clogging debris in ditches.	If contaminated discharges could be directed to a seepage drain or ditch, the permit writer should consider adding a permit condition to ensure compliance with the requirements that the discharge from a 24-hour, 25-year storm be disposed in accordance with an NPDES permit.

TABLE 5-5 TYPICAL RUN-ON/RUN-OFF CONTROL BEST MANAGEMENT PRACTICES (Continued)

Control	Description	Purpose/ Function	Maintenance	Special (Design) Considerations
Sedimentation Basins	Major components include a principal and emergency spill way, an anti-vortex device, and the basin. Sedimentation basins often serve as the last step in the collection of storm water run-off from a site.	Sedimentation basins detain run-off so that settling of suspended solids can occur. They also store storm water run-off so that the discharge can be released at a slower rate. Sedimentation basins can be constructed by excavation or by placing an earthen embankment across a low area or drainage swale.	Maintenance is imperative to provide the designed capacity for storage. If the basin becomes filled with sediments, the capacity will be lessened. Inspections are also important to make sure the embankments are stable and that the outlet is not clogged with trash or other debris.	The permit writer should assess the need for specific permit conditions addressing sediment basins.
Surface Roughening	Soil is roughened by the creation of horizontal grooves, depressions, or steps that run parallel to the contour of the land.	This practice reduces erosion on steep slopes. It slows run-off, increases infiltration, traps sediment, and helps establish vegetative cover.	Should be seeded as soon as possible. Regular inspections should be made, especially after storms. Rills should be filled, graded, and reseeded.	The surface grade should be greater than 2 percent to promote collection of the run-off and inhibit ponding but less than 5 percent to reduce flow velocities and to minimize soil erosion.

Source: Extracted from Dunne & Leopold (1978), EPA (1992a).

Permitting Factors

To implement these requirements, the permit writer must draft permit conditions that require the owner/operator of a surface disposal site to:

- Operate and maintain the leachate collection system during the life of the active sewage sludge unit and for 3 years after the unit closes
- Collect and dispose of the leachate properly.

The permit writer should request that the owner/operator describe the leachate collection system and the provisions made for operating and maintaining the system while the sewage sludge units are active and for at least 3 years after closure. This information may be supplied by the owner/operator in the permit application.

To evaluate the data furnished by the owner/operator and develop adequate permit conditions, the permit writer will need to be familiar with the design and operation of leachate collection systems. The following technical guidance introduces the permit writer to leachate collection systems and to the options available for treatment and/or disposal of leachate.

Leachate Collection System

> Leachate collection system is a system or device installed immediately above a liner that is designed, constructed, maintained, and operated to collect and remove leachate from a sewage sludge unit. [§503.21(i)]

When a liner is included in the design of a surface disposal site to protect ground water, a leachate collection system must be installed. A leachate collection and removal system is installed under the active sewage sludge unit to relieve hydraulic pressures within a lined sewage sludge unit. Without a collection and removal system, the leachate may accumulate and increase the possibility of its migration through the liner. Also, the leachate may back up in the unit and eventually result in seepage at the surface.

Part 503 requires that the leachate collection system for an active sewage sludge unit that has a liner be operated and maintained during the period the sewage sludge unit is active and for a period of 3 years after the sewage sludge unit closes. The permit writer may want to evaluate the following three aspects of the active sewage sludge unit to determine if the permit for the surface disposal site needs to contain special conditions for the operation and maintenance of the leachate collection system:

- Design of the system
- Operations
- Maintenance.

Each aspect is briefly discussed below.

Design

The design considerations for a leachate collection system for an active sewage sludge unit are similar to those for solid waste landfills. Each leachate collection system consists of the following components:

- A low permeability base (i.e., liner).
- A high permeability drainage layer of either natural granular material, such as sand and gravel, or synthetic materials, such as a geonet. The drainage layer is placed either directly over the liner or over a protective layer (e.g., filter fabric) of the liner.
- Perforated leachate collection pipes within the high permeability layer to collect and convey the leachate to the sumps where it can be removed.
- A protective filter material that surrounds the pipe to prevent clogging of the pipes or perforations.
- A protective filter layer over the high permeability drainage material to prevent clogging of the permeable layer by finer materials.
- Leachate collection sumps or header pipe system where leachate can be removed.
- Storage tanks or ponds for storage, treatment or disposal (EPA 1978, EPA 1988b).

At a minimum, the permit writer will want a description of the design of the leachate collection system and the procedures for inspection, cleaning, maintenance, and operation of the system. Proper design is crucial to the long-term reliability of the system, and the permit writer may consider evaluating certain aspects of the design to ensure that proper operation and easy maintenance are provided. In particular:

- Sedimentation by granular drainage materials may clog pipes, and can be avoided by surrounding pipes with filter fabric (EPA 1992a).

- Precipitation of dissolved ionic species may settle in, and foul pipes; the system design should prevent this by allowing for flow velocities that are high enough to provide a self-cleansing action. These velocities depend on the diameters and specific gravities of the particles, but generally flows ranging from one to two feet per second are sufficient (EPA 1988b). The permit writer may request documentation and calculations for the designed flow rates and flow volumes.

- Biological fouling can also occur, and for this reason the system should be designed to accommodate pipe system cleanings as follows:

  - A minimum of six-inch diameter pipe to facilitate cleaning
  - Access points located at major pipe intersections or bends to facilitate inspections and cleaning
  - Valves, ports, or other appurtenances to introduce biocides or cleaning solutions (EPA 1988b).

The strength of the structural materials and chemical compatibility between the materials and leachate can affect the continued operation of the leachate collection system. The pipe materials should have the strength required to withstand the loads of the wastes and cover system of the active sewage sludge unit as well as the loads required by the equipment during the unit's construction. The permit writer may want to look at loading calculations to see that these loads were considered in the design.

Another design aspect is the size and construction of the pumps used, in particular:

- Sufficient capacity to ensure leachate removal at the expected rate of generation

- Sufficient operating head to lift the leachate to the required height from the sump to the access point

- Resistance to corrosion

- Ability to perform during the 3-year closure period.

Calculations and specifications should be available from the owner/operator that can verify these considerations.

Operations

The leachate must be removed from the active sewage sludge unit, at a frequency dependent on the amount of liquid being generated at the unit, and then must be treated or disposed. Usually, leachate collection systems are designed to maintain a certain level of leachate over the liner and, correspondingly, removal of leachate at a regular rate. The permit writer should develop permit conditions requiring adherence to operation schedules that ensure that the leachate is removed at the designed rate. The permit writer should also require the owner/operator to maintain documentation that demonstrates leachate collection, treatment and disposal. For example, if the leachate is hauled off-site for treatment or disposal, the volume of leachate hauled and the dates that the leachate was hauled off-site should be maintained by the owner/operator.

Operations at the site should allow for easy access to the removal points, whether they are sumps or tanks. Often access to the sumps is provided by either a solid pipe laid in a shallow trench along the sidewalls or a vertical manhole that is constructed as the unit is filled (EPA 1988b).

Clogging is the primary cause of concern in the long-term performance of leachate collection and removal systems. Clogging can occur by the following means: (1) the sand filter can clog the drainage gravel; (2) solid material in the leachate can clog the drainage material or geonet; and (3) solid suspended material in the leachate can clog the sand filter or geotextile fabric. Biological clogging arises from slime, sheath formation, and biomass accumulation. Inorganic clogging can be caused by cohering, sulfide deposition and carbonate deposition. For determining the potential for biological clogging, a high biochemical oxygen demand (BOD) in the leachate is a good indicator.

Maintenance

Maintenance of the leachate collection system entails regular inspection and cleaning, including the following:

- Maintenance of pumps
- Periodic flushing (or by cleaning by mechanical means) with biocides to remove deposited solids and to prevent biological fouling
- Inspection of equipment and piping to detect clogging problems or material failure.

Inspection and cleaning should be conducted periodically after the sewage sludge is placed in the unit. To flush particulates and to prevent biological clogging, a low-pressure cleaning jet system introduced into the drains of the leachate collection system dislodges the particles from the filter and drainage materials (EPA 1983a). For biological growth, biocides can be introduced with the flushing water or added to the system during manufacture.

Inspections are important aspects of any good operation and maintenance program. The intent of an inspection is to determine if the system is in the process of becoming clogged or has clogged so that maintenance procedures can be performed immediately or so that contingency plans can be set into action. A weekly inspection routine is recommended as well as inspections after large storm events. The following components should be present in a good inspection program:

- Confirmation that leachate levels above the liner in the sewage sludge unit are equal to, or less than, the design depth at all points
- Confirmation of the depth of leachate in the collection sumps
- Confirmation that pumps and piping are in good operating order
- Recording of leachate depths and flow rates in all parts of the system.

Detailed inspection guidance is not feasible in this document because there are many different types of systems. The permit writer, when evaluating the inspection program provided by an owner/operator, should ensure that the program has provisions for what, where, why and how checks will be made. Specific criteria that will trigger corrective action should also be stated.

Leachate is the liquid that is generated in a surface disposal unit due to: (1) percolation of surface waters into the soil; (2) water content of the sludge when disposed; (3) water produced during decomposition of the sludge; and (4) water migration from surrounding soils and sludges. The leachate's quality varies depending upon the quality of the sludge. Generally, leachate is high in biochemical oxygen demand, organics and, sometimes, in metals. Because of these characteristics, leachate has the potential for causing adverse conditions when discharged to surface or ground water. Therefore, it is important to treat and/or dispose of it properly so that it does not cause harm to human health and the environment.

Disposal or Treatment of Leachate

Part 503 requires that the leachate from an active sewage sludge unit that has a liner and leachate collection system be collected and disposed in accordance with the conditions of a National Pollutant Discharge Elimination System permit and/or other applicable requirements. This requirement extends for the time that the sewage sludge unit is active and for 3 years after the unit is closed. Collected leachate may be treated and/or disposed through one or more of the following methods:

- Discharge or haul to a publicly owned treatment works
- On-site treatment and release to surface waters
- Off-site disposal.

The treatment or disposal option used by the owner/operator should be evaluated by the permit writer to determine if appropriate requirements are being met or if special conditions for the disposal of the leachate should be incorporated into the permit.

Discharge or Haul to a Publicly Owned Treatment Works (POTW)

If leachate is discharged directly to a POTW collection system or hauled to a POTW for treatment, the owner/operator may be required to pretreat the leachate prior to discharging it into the treatment works. In some cases, the leachate may need pretreatment for high organic and metals loadings. The permit writer may request information from the owner/operator showing compliance with local requirements, such as permits or other control mechanisms issued by the POTW as well as local ordinances. The permit writer may contact the POTW directly for the compliance status on the active sewage sludge unit leachate discharge.

On-Site Treatment

Most commonly, on-site treatment of leachate consists of the following processes:

- Biological processes, both anaerobic and aerobic
- Physical-chemical treatment
- Evaporation in ponds.

Biological treatment processes include anaerobic filters, anaerobic sewage sludge bed reactors, aerated lagoons, rotating biological contactors, and trickling filters. Physical-chemical systems include chemical precipitation using lime and oxidation with calcium hypochlorite or ozone. Some systems may also employ carbon adsorption. Evaporation ponds are shallow lagoons used in areas where the evaporation rate is high. Ponds should be designed to provide ample capacity for storm water from a 25-year, 24-hour storm event so that the pond does not get washed out during large storms and threaten surface waters.

A surface disposal site is required to have an NPDES permit for any discharge of treated leachate to surface water. If the site has an existing NPDES permit, the permit writer should evaluate provisions in the permit to ensure that the site is in compliance. If the site is new, or does not currently have an NPDES permit, the permit writer should require the submittal of an NPDES permit application for a point source discharge.

Off-Site Disposal

Where off-site disposal is practiced, the permit writer should request a detailed description of how the leachate is collected and how it is transferred to the off-site disposal site. Also, the permit writer may want to contact the off-site disposal facility to identify leachate disposal requirements and whether those requirements are being met.

Permit Conditions

The permit writer will need to assess the operation and maintenance of the leachate collection system and the current treatment or disposal system for the collected leachate. He may need to draft specific permit conditions for such a system. When the permit writer determines that design, operation or maintenance of the leachate collection system is inadequate, she should include a compliance schedule in the permit to require the owner/operator to correct the inadequacies. The permit writer should develop permit conditions focusing on these issues. For example, the permit writer could develop specific conditions that require the owner/operator to conduct inspections of the leachate collection system and to maintain documentation of these inspections.

If leachate goes to a POTW or is hauled off site for disposal, the permit writer may want to establish permit conditions that require the owner/operator of the surface disposal site to comply with any requirements imposed by the POTW or other off-site disposal facility.

5.5.9 METHANE GAS CONTROL

Statement of Regulation

§503.24(j)(1) **When a cover is placed on an active sewage sludge unit, the concentration of methane gas in air in any structure within a surface disposal site shall not exceed 25 percent of the lower explosive limit for methane gas during the period that the sewage sludge unit is active and the concentration of methane gas in air at the property line of the surface disposal site shall not exceed the lower explosive limit for methane gas during the period that the sewage sludge unit is active.**

(2) **When a final cover is placed on a sewage sludge unit at closure, the concentration of methane gas in air in any structure within the surface disposal site shall not exceed 25 percent of the lower explosive limit for methane gas for 3 years after the sewage sludge unit closes and the concentration of methane gas in air at the property line of the surface disposal site shall not exceed the lower explosive limit for methane gas for 3 years after the sewage sludge unit closes, unless otherwise specified by the permitting authority.**

Permitting Factors

If sewage sludge is covered with soil or other material, the owner/operator of an active sewage sludge unit is required to install equipment to monitor methane continuously in air in structures and at the site property line. Methane gas levels cannot exceed 25 percent of the lower explosive limit (LEL) in on-site structures such as buildings. Methane levels cannot exceed the LEL at the site property boundary. The LEL for methane is 5 percent by volume in air.

Cover is soil or other material used to cover sewage sludge placed on an active sewage sludge unit. Final cover is the last layer of soil or other material placed on a sewage sludge unit at closure.

Methane Generation and Migration

Methane is generated as a result of anaerobic microbial decomposition of sewage sludge, and is a concern at surface disposal sites because it is odorless and highly combustible. In addition to methane, carbon dioxide and lesser amounts of other gases (hydrogen and hydrogen sulfide) are produced. While hydrogen (H_2) is explosive and is occasionally detected in gas from surface disposal sites, it readily reacts to form methane or hydrogen sulfide. Hydrogen sulfide (H_2S) is an asphyxiant and is readily identified by its "rotten egg" smell at a threshold concentration near 5 ppb (EPA 1992a).

Gas composition may vary spatially within a sewage sludge unit as a result of pockets of microbial activity. Partial pressure, density of the materials, and temperature gradients affect the migration of gases. Gas in an active sewage sludge unit tends to migrate laterally if the active sewage sludge unit has been covered with geomembranes or clay materials and if interior side slopes of the unit do not contain an effective gas barrier such as may exist with a composite infiltration layer. Lateral gas migration is common in active sewage sludge units that lack clay or geomembrane systems. The degree of lateral migration depends on the type of natural soils surrounding the unit. Coarse, porous soils, such as sand and gravel, allow greater lateral migration or transport of gases than finer-grained soils. Generally, resistance to gas flow increases slightly as moisture content increases, and an effective barrier to gas flow is created under saturated conditions. Thus, readily drained soil conditions, such as sands and gravels above the water table, may provide a preferred flowpath, but unless finer-grained soils are saturated, gases will not exclusively flow in the sand and gravel deposits (EPA 1992a).

Gas Monitoring

Detectors that monitor gas in the air continuously must be installed in the monitoring locations. Automatic detectors that sense the presence of combustible and/or toxic gases should be installed in ventilation areas, work areas, and utility vaults. The detectors should sound alarms or other types of warnings when gas levels exceed 25 percent of the LEL in onsite structures or the LEL at the property line. Detectors are sensitive to temperature and humidity changes and require regular calibration and periodic replacement.

Part 503 does not define "continuous monitoring." The monitoring frequency necessary to prevent dangerous methane levels varies with the site conditions. The permit writer should use her BPJ to decide what "continuous monitoring" should mean in each situation. The proximity to residential areas, the presence or absence of structures, and the presence of staff to maintain the monitors are among the conditions to be considered when deciding how to define "continuous."

Section 503.24(j)(2) requires that the methane gas be monitored for 3 years after a sewage sludge unit is closed. This is the minimum amount of time that the permit writer must specify in the permit. The permit writer, however, may specify longer monitoring periods based on the potential for methane gas generation at the active sewage sludge unit. The regulatory requirement is based on studies performed with sewage sludge that had been treated in anaerobic or aerobic processes. Because these processes provide a more stabilized sewage sludge, the permit writer may want to require a longer monitoring period for sewage sludges placed on an active sewage sludge unit that are not treated by such processes (e.g., lime stabilized sludges).

Explosive Conditions

If the methane concentration exceeds 25 percent of the LEL in air in a structure or exceeds the LEL in air at the surface disposal site property line, the danger of explosion is imminent. All personnel should be evacuated from the area immediately. Venting the building upon exit (e.g., leaving the door open) is desirable but should not replace evacuation procedures (EPA 1992a). Emergency procedures should be defined clearly in a site health and safety plan.

Because the presence of explosive conditions at a surface disposal site may endanger human health and the environment, the permit writer may require special conditions in the permit to develop emergency procedures and/or remedial action plans for potentially explosive conditions. These procedures or plans should be required if there is a history of methane gas problems at the site. The permit writer should require that these procedures and/or plans be maintained on site at all times.

Gas Control Systems

Some active sewage sludge units where the sewage sludge is covered are designed with gas control systems to prevent the build-up of explosive gas at the site. The permit writer should be aware of the type of system employed at the site, and may wish to request additional information on the system during the application process if gas problems have occurred at the site. The following information introduces the permit writer to gas control systems and some of the design considerations for both passive and active systems.

Systems used to control or prevent gas migration are categorized as either passive or active systems. Passive systems provide preferential flowpaths by means of natural pressure, concentration, and density gradients. Passive systems are primarily effective in controlling convective flow; they have limited success controlling diffusive flow. Active systems use mechanical equipment to direct or control gas by providing negative or positive pressure gradients. They are effective in controlling both types of flow. Suitability of the systems is based on the design and age of the sewage sludge unit, the soil, and the hydrogeologic and hydraulic conditions of the surface disposal site.

Passive System

A passive gas control system relies on natural pressure and convection mechanisms to vent gas to the atmosphere. A passive system typically uses "high-permeability" or "low-permeability" techniques, either singularly or in combination at a site. A high-permeability system uses conduits such as ditches, trenches, vent wells, or perforated vent pipes surrounded by coarse soil to vent gas to the surface. A low-permeability system blocks lateral migration using barriers such as synthetic membranes and high moisture-containing fine-grained soils (EPA 1992a).

A passive system may be incorporated into the unit design or may be used for remedial or corrective purposes. It may be installed within an active sewage sludge unit, along the perimeter, or between the active sewage sludge unit and the surface disposal site property line. A detailed discussion of passive systems for remedial or corrective purposes is found in the *Handbook—Remedial Action at Waste Disposal Sites* (EPA 1985).

A passive system may also be incorporated into the final cover. It may consist of perforated gas collection pipes, high permeability soils, or high transmissivity geosynthetics located just below the low-permeability gas and hydraulic barrier or infiltration layer in the cover system. These pipes may be connected to other pipes that vent gas through the cover system or are connected to header pipes located along the site's perimeter. The gas collection system also may be connected with the leachate collection system to vent gases in the headspace of leachate collection pipes (EPA 1992a).

A high-permeability passive control system should be installed in a gravel-lined trench at the boundary of the sewage sludge unit. The depth of the trench depends on the unit depth and the geology of the area in the unit's vicinity. The piping component of this passive control system has horizontal perforated pipes and vertical solid-wall pipes used to vent gas to the atmosphere if the top of the trench is blocked by debris. Polyvinylchloride (PVC) perforated pipe is the most common type of pipe installed. Joints can be cemented, heat welded, or screwed together. After the pipes are laid, the trench is filled with crushed gravel. The top should be sloped to provide runoff control and the ground should be graded to draw away from the trench to prevent the washing of soil into the voids of the stone (EPA 1985). However, this method may not be suitable if air emission requirements cannot be met.

A low-permeability design is identical to the high permeability system except that a synthetic barrier lines the trench and a low permeability material is used as a backfill. A geomembrane draped over the far wall of the trench is the barrier and the excavated earth is used for the backfill.

The two types of passive systems can be combined. In a combined low/high permeability passive system, the membrane is installed, and then the piping and high permeability material are installed in front. The high permeability material should be rounded gravel to avoid puncturing the geomembrane. This combination encourages gas to flow through the system.

Passive systems are prone to clogging through accumulation of snow and dirt, vandalism, and biological clogging. To work properly, passive systems should be designed to keep components clear of obstructions.

Active System

An active gas control system removes methane gas through either positive pressure (air injection) or negative pressure (gas extraction). A positive pressure system induces a pressure greater than the pressure of the migrating gas and drives the gas out of the soil and/or the unit in a controlled manner. A negative pressure system extracts gas from a unit by using a blower to pull gas out of the unit. The negative pressure system has wider use because it is more effective and offers more flexibility in controlling gas migration. The gas may be discharged directly to the atmosphere, recovered for energy conversion, treated, or burned in a flare system. A negative pressure system may be used as either a perimeter gas control system or an interior gas collection/recovery system (EPA 1992a).

An active system uses a series of wells, collection headers, and blowers to extract gas. The wells are installed to the depth of the seasonably low water table or to depth of the base of the sewage sludge unit, whichever is less. The well bore diameter should be between 12 and 36 inches in diameter. A 2 to 6 inch pipe, perforated in the monitoring zone and solid above, is installed in the wellbore. The wellbore is filled with crushed stone and a clay or cement seal is placed around the solid portion of the pipe at the top of the well to minimize infiltration of atmospheric air into the system. A valve is placed on top of the well to regulate the gas flow and to balance multi-well systems.

Well spacing is a critical consideration in the design of an active system, and depends on the size of the sewage sludge unit, the magnitude of the vacuum, and the rate of gas withdrawal. The radius of influence should allow for overlap between wells. The wells should be constructed first to allow system components to be positioned according to well location. The header system and piping can be buried or placed aboveground. Blowers or vacuums must also be installed and the header system connected to the gas treatment facility. In addition, construction materials should be resistant to corrosion because of the high moisture content of the gas. Monitoring effectiveness of the system is identical to those for passive systems.

An active system is not as sensitive to freezing or saturation of cover soils as a passive system. Although an active gas system is more effective in withdrawing gas from the sewage sludge unit, the capital, operation, and maintenance costs of such systems are higher and these costs continue throughout the post-closure period. As the disposal unit ages, the owner/operator may wish to convert active gas controls into a passive system when gas production diminishes. The conversion option and its environmental effects (i.e., gas releases causing odors and health and safety concerns) should be addressed in the original design (EPA 1992a).

Permit Conditions

In addition to writing permit language implementing §503.24(j), the permit writer may want to require the owner/operator to:

- Develop inspection, calibration, and replacement schedules for the methane gas detection devices. The schedules can be included in the closure plan for methane monitoring requirements.

- Develop a remedial action plan for use if methane gas levels exceed the allowable levels. This plan should include procedures to reduce the methane gas levels, emergency procedures to prevent potentially explosive conditions, and an evacuation plan.

The permit writer may also want to require a longer period of time for monitoring the air for methane gas.

5.5.10 FOOD, FEED, AND FIBER CROPS AND GRAZING RESTRICTIONS

Statement of Regulation

§503.24(k)	**A food crop, a feed crop, or a fiber crop shall not be grown on an active sewage sludge unit, unless the owner/operator of the surface disposal site demonstrates to the permitting authority that through management practices public health and the environment are protected from the reasonably anticipated adverse effects of pollutants in sewage sludge when crops are grown.**
§503.24(l)	**Animals shall not be grazed on an active sewage sludge unit, unless the owner/operator of the surface disposal site demonstrates to the permitting authority that through management practices public health and the environment are protected from the reasonably anticipated adverse effects of pollutants in sewage sludge when animals are grazed.**

Permitting Factors

Food crops are crops grown for human consumption (e.g., fruits and vegetables) or for use in making products for human consumption (e.g., soybeans for soybean oil). Feed crops are crops used to feed animals raised for human consumption (e.g., pigs) or to feed animals whose products are consumed (e.g., cows for milk). Fiber crops are crops used for making textiles (e.g., flax and cotton).

Food crops are crops consumed by humans. These include, but are not limited to, fruits, vegetables, and tobacco. [§503.9(l)]

Feed crops are crops produced primarily for consumption by animals. [§503.9(j)]

Fiber crops are crops such as flax and cotton. [§503.9(k)]

In general, the permit writer should prohibit, through a permit condition, the growing of food, feed, or fiber crops or the grazing of animals on active sewage sludge units. However, if the owner/operator requests permission to grow food, feed, or fiber crops or graze animals on the active sewage sludge unit, the permit writer may allow such activity if the owner/operator demonstrates to the permitting authority that management practices will be implemented that will adequately protect public health and the environment from reasonably anticipated adverse effects of pollutants in the sewage sludge. The permit writer will need to assess whether the proposed management practices are sufficient to protect human health and the environment if these activities are allowed. For example, the permit writer may need to evaluate the pollutant loadings to the surface disposal site and assess the potential for accumulation of these pollutants in the food, feed, or fiber crop or animals grazing on the land. The permit writer may want to establish management requirements, such as monitoring the crops and animal products, to ensure that human health is protected.

Permit Conditions

If the permit writer allows the growing of food, feed, or fiber crops or the grazing of animals, specific management practices should be applied as well as all the associated monitoring, recordkeeping and reporting requirements. The permit writer should also consider imposing requirements in the permit to monitor the food, feed, or fiber crop grown or the animals grazed or products (such as milk) from animals grazed on the site.

5.5.11 PUBLIC ACCESS CONTROL

<u>Statement of Regulation</u>

§503.24(m) **Public access to a surface disposal site shall be restricted for the period that the surface disposal site contains an active sewage sludge unit and for 3 years after the last active sewage sludge unit in the surface disposal site closes.**

Permitting Factors

The permit writer must require, through conditions in the permit, that the owner/operator of a surface disposal site ensure that exposure of the public to the sewage sludge placed on the active sewage sludge unit within the surface disposal site does not occur. The permit writer will need to determine the existence and adequacy of current management practices that restrict public access. This information may be in the permit application; if not, the permit writer may need to request this information from the owner/operator. The permit writer will have to consider whether the existing access restriction practices are adequate.

As part of her evaluation, the permit writer should consider the population density of the surrounding area and the land use practices of the surrounding areas. In general, the higher the population density or sensitivity of current land use practices in the surrounding area, the greater the degree of protection required. A land use practice that is sensitive to the presence of a surface disposal site is one which will increase the probability of exposure of the public to sewage sludge during a normal course of activity. For example, if the surface disposal site is in an urbanized area surrounded by residential housing developments, the likelihood of the public entering the surface disposal unit is high. Therefore, stringent measures must be used to prevent access.

Numerous measures are appropriate for controlling access to a surface disposal site, such as:

- Installation of perimeter fencing around the surface disposal site with gates and locks. The fencing can be chain link, barbed wire added to chain link, or open farm fence
- Restriction of vehicular traffic across access roads by installing locked gates in conjunction with perimeter fencing

- Installation of warning signs such as "Do not enter," "Sewage sludge disposal site, no trespassing," and "Access restricted to authorized personnel only."

The use of natural barriers, such as trees, hedges, embankments, berms and ditches, is not considered adequate access restriction because they can be crossed by pedestrians and off-road vehicles fairly easily. However, natural barriers coupled with warning signs in a remote rural area may be adequate.

At surface disposal sites containing active and/or closed sewage sludge units located in areas with high population densities or sensitive land use practices, several of the above management practices may be necessary. In areas that are less susceptible to public trespass, such as rural areas, warning signs alone may suffice. In areas with a high probability of vehicular traffic across the surface disposal site, measures restricting vehicular traffic must be taken. If a surface disposal site contains only closed sewage sludge units, provision must be made to maintain the access control practices for 3 years from the date that the last active sewage sludge unit on that surface disposal site closes.

Permit Conditions

The regulatory requirement of §503.24(m) can be embodied in the permit in three ways:

- By using the exact language from Part 503
- By prescribing specific public access controls as permit conditions
- By incorporating a permit condition that requires submission of a plan and schedule for implementation of best management practices to restrict public access.

If the permit writer determines that current access management practices are adequate, she may want to include these management practices in the permit or reference the surface disposal site's design plan or other document where these management practices are described. The permit writer should also include a permit condition requiring the maintenance and upkeep of access restriction measures.

5.5.12 GROUND-WATER PROTECTION

Statement of Regulation

§503.24(n)(1) **Sewage sludge placed on an active sewage sludge unit shall not contaminate an aquifer.**

§503.24(n)(2) **Results of a ground-water monitoring program developed by a qualified ground-water scientist or a certification by a qualified ground-water scientist shall be used to demonstrate that sewage sludge placed on an active sewage sludge unit does not contaminate an aquifer.**

Permitting Factors

Part 503 prohibits contamination of an aquifer. The regulation provides for two alternatives for the owner/operator to demonstrate that the aquifer is not contaminated: providing a certification that the sewage sludge being placed on the active sewage sludge unit will not contaminate the aquifer, or performing ground-water monitoring. The certification is not a simple signed statement; rather, it is a hydrogeologic assessment by a qualified ground-water scientist. Based on the hydrogeology of the site and the design of the surface disposal site, the scientist determines the likelihood of ground-water contamination occurring at the site and then certifies that, based on his/her knowledge of the site, contamination is not likely to occur. The ground-water monitoring alternative, on the other hand, is an actual demonstration that aquifer contamination is not occurring through actual measurement of nitrate in the ground water below the surface disposal site.

Contaminate an aquifer means to introduce a substance that causes the maximum contaminant level for nitrate in 40 CFR § 141.11 to be exceeded in ground water or that causes the existing concentration of nitrate in ground water to increase when the existing concentration of nitrate in the ground water exceeds the maximum contaminant level for nitrate in § 141.11. [§ 503.21(c)]

The permit writer must verify the information submitted to support either option. While verifying information, the permit writer should consider the potential of the site to cause contamination, and the risks to human health and the environment should contamination of the ground water occur.

Aquifer is a geologic formation, group of geologic formations, or a portion of a geologic formation capable of yielding ground water to wells or springs. [§ 503.21(b)]

To perform these assessments, the permit writer should obtain appropriate documentation from the owner/operator, and the State and local ground-water protection agencies, to determine if the surface disposal site is located over an aquifer designated for ground-water protection or whether the aquifer is already contaminated. In addition, preliminary design information and site-specific geological information may indicate if the site needs special consideration.

The first assessment should determine the potential of the surface disposal site to cause or contribute to nitrate contamination. This potential will depend on many considerations, such as:

- Age of the surface disposal site or sewage sludge unit
- Site design features (e.g., lined versus unlined)
- Site-specific hydrogeological and meteorological features.

Second, the permit writer should determine the risk to human health and the environment associated with the contamination of an aquifer below the surface disposal site. This assessment should consider the degree of contamination that could occur (i.e., whether the increase in nitrate levels in the aquifer will lead to levels above the maximum contaminant levels [MCLs]). This assessment also should consider the size of the affected community if contamination occurs (i.e., whether the site is located over a sole source aquifer serving a small community or serving several large communities). The permit writer should also determine if any applicable State or locality-specific ground-water protection requirements apply. To do so, the permit writer should consult the following documents, if available:

- State Wellhead Protection Plan
- Comprehensive State Ground-Water Protection Program Plan.

A State Wellhead Protection Plan is a plan that is established under the Wellhead Protection (WHP) Program to protect ground waters that supply wells and well fields contributing drinking water to public water supply systems (SDWA 1986). The Comprehensive State Ground Water Protection Program Plan is developed by States to implement the 1991 EPA Ground-Water Protection Strategy (EPA 1991c). These plans may include information useful to the permit writer, such as:

- Ground-water protection goals
- Identification of ground-water classification systems, special aquifers requiring protection, or priorities for ground-water protection
- Designated wellhead protection areas (WHPA) for each wellhead based on hydrogeologic data, ground-water flow, and aquifer recharge and discharge.

Performing these assessments allows the permit writer to assign the surface disposal site a relative risk factor. However, the permit writer should be aware that the determination of whether a site has a low, medium or high risk factor is a subjective determination. Some States and/or localities may have prioritized areas within their jurisdiction and have actually identified specific criteria on which to base the judgment (e.g., Wellhead Protection Programs or State Ground-Water Protection Programs) while others may not have.

Where the permit writer does not find institutionalized policies on assigning priorities and risks, she may develop a system for assigning the relative risk factors. The system may be based on one of several criteria:

- Quality of ground water beneath the active sewage sludge unit
- Designated uses or potential uses of ground water below the active sewage sludge unit
- Design of the active sewage sludge unit (i.e., lined versus unlined, and stable versus unstable land).

The permit writer may wish to develop the relative risk factor system based on one of these criteria or a combination of all three. For example, using the first criterion, low-risk sites may be identified as sites located over contaminated aquifers. A high-risk site would be located over ground water of exemplary quality. An example using all three criteria would yield low-risk sites where ground waters are contaminated and will never be useable as a drinking water source because of the cost of remediation, and where the sewage sludge unit has a liner and leachate collection system. A high potential risk site would be an unlined site located in an area with known seismic activity and over a high-quality drinking water source that is irreplaceable and ecologically vital.

Based on the relative risk factors assigned to the site, the permit writer can decide if the appropriate measures have been taken. In general, a certification is appropriate for a surface disposal site with low to medium relative risk factors. Ground-water monitoring may be necessary for high-risk surface disposal sites. Both the certification and the ground-water monitoring program must be developed by a qualified ground water scientist. The permit writer should request that information on the qualified ground-water scientist's educational and work experience be submitted along with the certification or ground-water monitoring plan to allow the permit writer to evaluate the scientist's credentials and expertise.

Certification

> A qualified ground-water scientist is an individual with a baccalaureate or post-graduate degree in the natural sciences or engineering who has sufficient training and experience in ground water hydrology and related fields, as may be demonstrated by State registration, professional certification, or completion of accredited university programs, to make sound professional judgments regarding ground water monitoring, pollutant fate and transport, and corrective action. [§503.21(l)]

As mentioned above, the certification alternative is most appropriate for low to medium risk sites. This certification is a hydrogeologic assessment that the aquifer will not be contaminated by sewage sludge placed in the active sewage sludge unit(s). This hydrogeological assessment must be based on site-specific data. The assessment report should:

- Identify regional geologic and hydrogeologic characteristics, such as geologic formations and origins, geomorphology, seismic activity, drainage, surface waters and their quality, soils, aquifer recharge and discharge areas, regional topography, and meteorological and climatological information
- Analyze the effect of site topographic and geomorphic features on the site ground-water hydrology
- Classify and describe site hydrogeological properties, such as aquifer thickness, porosity, texture, hydraulic conductivity, infiltration rates, transmissivity, and structure
- Include structural contour maps and geological sections showing hydrogeology of uppermost aquifer, perched zones, interconnections, and water table elevations
- Characterize ground water, including water levels, flow patterns, flow rates, and water quality.

The complexity of the certification depends on the relative risk factor and on specific site characteristics. For low relative risk sites, the permit writer may require that the certification be based on a hydrogeological assessment prepared from already existing documentation on the hydrogeology of the site and surrounding areas. Such documentation includes historical records (e.g., precipitation or land development), USGS information or State geologic survey maps, Soil Conservation Service reports and maps indicating soil types, studies performed on nearby sites, and geologic logs of existing wells or test borings that have been taken near the site. Ascertaining that the aquifer is not and will not be contaminated would be deduced from this information.

For medium relative risk sites, the permit writer may require that the above existing information on the hydrogeology of the site be verified or supplemented with site-specific, field-collected measurements, such as soil borings, rock corings, material tests, surface geophysical surveys, and hydraulic conductivity measurements. For medium relative risk sites that have existing problems with nitrates, the permit writer may consider requiring in the permit that the certification be based on fate and transport demonstrations, such as:

- Site-specific, field collected measurements, sampling, and analysis of physical, chemical and biological processes affecting nitrate fate and transport

- Nitrate fate and transport predictions that maximize nitrate migration and consider impacts on human health and the environment.

The permit writer could require a one-time monitoring of the aquifer to verify that the active sewage sludge units are not contaminating the aquifer. The permit writer may decide that there are sufficient wells in close proximity to the surface disposal site to provide the needed monitoring information or he may require the construction of wells specifically for this purpose. The monitoring information should be submitted with the certification. The results can be used by the permit writer to determine the need for additional periodic monitoring at that surface disposal site. If wells were constructed for this initial assessment, they can then be used for the required periodic monitoring.

Ground-Water Monitoring

Sites that a permit writer determines have a high relative risk factor may be required to monitor the ground water to demonstrate that the sewage sludge placed on any active sewage sludge units at the surface disposal site does not contaminate an aquifer. Such a demonstration is made by analyzing ground-water samples collected from monitoring wells placed downgradient and comparing the analytical results of the nitrate concentrations to samples taken from wells placed upgradient of the active sewage sludge unit.

Before the permit writer can determine which ground-water monitoring permit conditions to incorporate into the permit, he must have a clear understanding of the hydrogeological conditions at the surface disposal site. This is accomplished by requiring the owner/operator to submit a hydrogeologic report of the disposal site and to develop a ground-water monitoring plan. The permit writer should review and evaluate the hydrogeological report and ground-water monitoring plan. If the owner/operator does not have adequate information or resources to develop such a hydrogeologic report and monitoring plan for the permit application, the permit writer may choose to require the owner/operator to submit all available hydrogeologic information and issue the permit incorporating a compliance schedule for development and implementation of a ground-water monitoring program. The milestones in the compliance schedule could address the development of an adequate hydrogeologic report, completion of a monitoring plan, commencement of monitoring well development, and commencement of monitoring well sampling.

Hydrogeologic Assessment and Ground-Water Monitoring Plan

The permit writer must require that the ground-water monitoring plan be prepared by a qualified ground-water scientist. This plan can then be used by the permit writer to develop permit conditions for periodic ground-water monitoring. At a minimum, the permit writer should require the owner/operator to submit the following information as part of a hydrogeologic study that assesses aquifer contamination:

- A characterization of the site geology and hydrology (hydrogeologic assessment) including seasonal variability in ground-water flow directions and an interpretation of the information and data submitted

- A description of the ground-water monitoring system design and installation for the active sewage sludge unit(s) (including a well location map)

- A discussion of sampling and analytical procedures including statistical methods used
- Results of nitrate-nitrogen analyses of ground-water samples with associated quality assurance/quality control (QA/QC) data.

The permit writer will need to determine whether the ground-water hydrogeologic assessment and monitoring plan is complete and whether the information provided by the owner/operator verifies the absence of aquifer contamination. This type of evaluation requires: (1) a review of the data quality; (2) an understanding of the interpretation of the hydrogeologic and water quality data; and (3) an analysis of whether the data and information submitted fully characterize the potential ground-water impact of placing the sewage sludge on the sewage sludge unit. Finally, the evaluation should also include a comparison of the nitrate-nitrogen levels reported for each ground-water sample to the MCL for nitrate-nitrogen (10 mg/l) to verify the absence of aquifer contamination.

Several other guidance documents published by EPA may be useful to the permit writer in reviewing the ground-water assessment and monitoring plan. These documents are listed in Table 5-6. Much of the information provided in these documents is not duplicated in this document. Instead, only the most important technical considerations that the permit writer must address in a review of a hydrogeologic assessment and ground-water monitoring program are discussed. The following discussion details the type of information that should be included in the hydrogeologic assessment and monitoring plan submitted by the owner/operator.

TABLE 5-6 SUPPORTING DOCUMENTS FOR REVIEW OF GROUND-WATER ASSESSMENT AND MONITORING PLANS

Document Title	Guidance Provided to the Permit Writer
The Ground Water Monitoring Technical Enforcement Guidance Document	Provides technical guidance on the development of ground-water monitoring programs, including site characterization, well design and placement, and well construction
RCRA Comprehensive Ground-Water Monitoring Evaluation	Provides guidance to evaluate the compliance of a ground-water monitoring system
Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities (EPA/530-SW-89-026)	Provides information to review and evaluate ground-water quality data using statistical methods
Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities	Provides guidance for hydrogeologic investigation including characterization of site hydrogeology, design of detection monitoring systems, design and construction of monitoring wells, and sampling and analysis of ground water

Characterization of Site Geology and Hydrology

The permit writer should require that the owner/operator provide data on the site geology and hydrology to identify all potential migration pathways and the target monitoring zones. The collection of subsurface samples, ground water-level measurements, water quality data, aquifer data, meteorological and climatological data, and descriptions of other site-specific conditions are used to formulate interpretative tools, such as geologic cross sections, isoconcentration maps, water-level contour maps, flow nets, and aquifer characteristics. The final hydrogeologic assessment should identify the spacial variability of geologic units and the seasonal/temporal variability expected to occur in the ground- water flow systems.

The geologic units that compose the targeted monitoring zone must be identified and characterized. It is important to determine how these units may vary spatially and how they are connected hydraulically with surrounding units. The quantity of data required to characterize the target monitoring zone(s) depends on the site's geological complexity. For example, a subsurface environment composed of geologic units that are highly variable and appear to be discontinuous may require considerably more data than a system that is relatively homogeneous and predictable.

Important geologic features that indicate a high degree of variability and irregularity within the subsurface are: fracture zones, solution cavities, pinchout zones (i.e., discontinuous strata across the site), tilted or folded beds, or high hydraulic conductivity zones. These types of geologic features often control the direction and velocity of ground-water flow. For example, since fractures are often preferred pathways for ground water, the orientation of fractures can control the direction of ground-water flow.

Seasonal and temporal variability of ground-water flow directions and ambient ground-water quality must be characterized. The influence of surface water bodies on the ground-water system (e.g., tidal variations and river stage variations) is often an important control on the direction and quality of ground-water flow. Other local influences on ground-water flow that can change seasonally or temporally include on or off-site pumping wells, injection wells, irrigation or agricultural activities, and other land-use activities.

Site conditions may help identify the amount and extent of potential contaminant migration. For example, orientation and dimensions of an active sewage sludge unit will affect the placement of ground-water monitoring wells, and should be evaluated to ensure that all migration pathways are monitored.

The site characterization is adequate when the following conditions are satisfied: (1) the target monitoring zone is identified (usually the uppermost aquifer); (2) the degree of hydrogeologic variability within the targeted monitoring zone is defined; and (3) all potential contaminant migration pathways from the active sewage sludge unit are identified. This information fosters accurate placement of monitoring wells to detect potential contamination.

Description of the Ground-Water Monitoring System

The permit writer should require that the owner/operator provide a well location map as well as information on well installation and construction. Monitoring wells should be placed downgradient of the active sewage sludge unit to intercept ground water that flows beneath the unit. This requires identification of the area of ground-water flow that could interact with potential contaminant migration from the unit. The number of downgradient wells should be sufficient to determine water quality at the point of compliance (i.e., as close to the unit boundary as possible). Typically, at least three downgradient wells are required to monitor the lateral extent of contaminant migration. An upgradient well, which is not influenced by the sewage sludge unit but is within the vicinity to represent background ground water quality, should be part of the ground-water monitoring system. To avoid potential pathways of contamination, an upgradient/background well should be located where it won't be influenced by ground-water mounding beneath the unit.

Monitoring wells should be screened laterally and vertically within the target monitoring zone(s) and be constructed of materials that will not affect the quality of ground-water samples. The owner/operator of the surface disposal site should explain the number and placement of the monitoring wells. After consideration of all migration pathways and the effects of temporal variations on the ground water flow system, additional monitoring wells or alternative monitoring techniques such as vadose zone monitoring or tracer tests may be required. For example, fracture and solution channels in an aquifer (e.g., karst hydrology) may require non-conventional monitoring techniques. In addition, certain subsurface conditions such as multiple aquifers may require additional monitoring for hydrologic interconnectiveness.

Sampling and Analytical Procedures

The permit writer should require that the owner/operator submit a description of all sampling and analytical procedures used to collect the data. The following components of the sampling and analysis program should be addressed in the plan:

- Sample collection, preservation, and handling
- Analytical procedures
- Statistical methods used to assess ground-water monitoring data
- Chain-of-custody procedures
- Field and laboratory quality assurance/quality control procedures.

A representative ground-water sample is collected when the following are ensured: (1) the use of proper well evacuation techniques; (2) sampling equipment and techniques that minimize alteration of the chemical constituents in the ground water; (3) adequate documentation of field activities; and (4) identification and reporting of errors or anomalies. Sample integrity must be maintained through proper sample preservation, handling, and chain-of-custody procedures.

All activities related to characterizing the site hydrogeology, design and installation of ground-water monitoring wells, and sampling and analysis should include a quality assurance/quality control (QA/QC) program. All samples must be evaluated with respect to standard QA/QC procedures and to the specified data quality objectives (i.e., the amount of imprecision and bias that will be tolerated). QA/QC procedures should include the use of standards, laboratory blanks, field and trip blanks, and duplicates. Field QA/QC procedures should include equipment decontamination and chain-of-custody.

The frequency of any initial compliance sampling and number of samples collected should represent any expected seasonal variation in ground-water quality. Typically, at least four rounds of ground-water samples are collected over a course of 1 year to ensure seasonal variability. Statistical procedures are often used to determine the appropriate sampling interval that will reflect site-specific hydrogeologic conditions.

Developing Permit Conditions for Ground-Water Monitoring

Permit conditions for ground-water monitoring are developed according to the complexity of the site, site hydrogeology, and potential and real risks. The variability of sites is so great that it becomes difficult to provide guidance to the permit writer in developing the ground-water monitoring permit conditions. Appropriate permit conditions could range from simply incorporating the owner/operator's ground-water monitoring plan by reference to developing detailed conditions specifying construction details and statistical procedures. The following discussion provides the minimum information that the permit writer should address in the permit and furnishes guidance on the consideration of more detailed provisions.

If the permit writer determines that the proposed ground-water monitoring plan provides a sound technical basis for detection monitoring, the permit writer may incorporate the plan by reference in the ground-water monitoring section of the permit. If, however, the permit writer determines that the ground-water assessment and monitoring plan is deficient, she may decide to specify the terms and conditions of the monitoring to be performed in the permit. At a minimum, the conditions associated with ground-water monitoring that the permit writer should address in the permit include:

- Frequency of monitoring
- Well location, construction, and maintenance
- Monitoring program and data evaluation
- Reporting and recordkeeping.

Frequency of Periodic Ground-Water Sampling and Analysis

The permit writer should specify an appropriate frequency for sampling and analysis of nitrate in ground water for any active sewage sludge units at the surface disposal site. Monitoring frequency can be influenced by the following factors:

- Rate and direction of the ground-water flow
- Location of the monitoring well
- Trends in the water quality data
- Climatological and meteorological characteristics
- Others (such as the resource value of the aquifer and the fate and transport of the nitrate in ground water).

The permit writer must, therefore, develop a flexible monitoring schedule, allowing for modification based on these factors. Initially, the permit writer may want to base the frequency of monitoring on the ground-water flow rate, location, and climate. However, he may want to modify this provision later, based on the trends in the site's water quality data. Special considerations are warranted for sites where contamination is suspected and the frequencies must be altered for aquifer contamination assessment reasons.

Flow rates are primarily dependent on the aquifer porosity and permeability as well as the hydraulic gradient at the site. The higher the flow rate, the greater the monitoring frequency needed. For sites that are underlain by impervious clay soils, semi-annual or annual monitoring may be sufficient. For sites that have fracture or solution porosity aquifers, it is possible that nitrogen could migrate from the active sewage sludge unit within weeks or even days. Thus, quarterly or monthly monitoring may be more appropriate.

By considering regional climatological characteristics, the permit writer may obtain information on the fluctuations of leachate development that may occur over the year. This type of information may indicate that, instead of arbitrarily assigning a sampling date every third month (for quarterly monitoring), it would be more appropriate to correlate the sampling period with ground-water recharge periods when leachate generation is greatest.

Frequency of monitoring may also be based on the level of concentration of nitrate found in the ground water and whether the surface disposal site is located over an aquifer used for drinking water or with the potential to be used for drinking water. If the surface disposal site is located over an aquifer used for drinking water, the permit writer may elect to specify, in the permit, trigger-based monitoring such as that used in EPA's Phase II Rule for National Primary Drinking Water Standards. These regulations require that ground-water systems sample for nitrate annually as a baseline frequency. If any sample is greater than or equal to 50 percent of the MCL, this triggers an increase in monitoring frequency to quarterly sampling. If four quarterly samples are shown to be reliably and consistently below the MCL, then the sampling can be again reduced to annually, in which case samples must be taken during the quarter that previously yielded the highest analytical result.

Well Location, Construction and Maintenance

The permit writer should specify, in the permit, the design specifications for the ground-water monitoring system. This monitoring system may be the same system as that provided in the ground-water monitoring plan furnished by the owner/operator. If the permit writer determines that any aspect of the proposed system is deficient, the appropriate design specifications should be included in the permit. At a minimum, the permit writer should specify the design of the monitoring network, including the number, location, and sampling depths of all background and downgradient monitoring wells. This information can be specified through the use of maps and cross-sections. Construction materials and well design should also be specified. This may include as much detail as possible on drilling methods, well casing and materials, well diameter, well intake design, well development procedures, and methods for sealing the annular space.

The spacing and required number of downgradient wells is based on the size of the active sewage sludge unit. However, the permit writer should, at a minimum, require three downgradient wells located as close as possible to the edge of the unit penetrating the entire saturated thickness of the aquifer. The line of wells should not have less than one downgradient well for every 76 meters of frontage (EPA 1980). The permit writer may specify an additional well within the surface disposal site to indicate whether leachate is reaching ground water and to give early warning of potential aquifer contamination. In addition, the permit writer may want to add a provision that any detection of nitrates in the indicator well will trigger the owner/operator to monitor the downgradient wells more frequently.

The number and location of upgradient wells to determine background water quality should be specified based on the variability of the water quality prior to flowing under the site. In many cases, the permit writer may want to require multiple background wells to provide better measurements. However, at a minimum, one must be required. Additionally, the statistical procedure used to determine the presence or absence of contamination may dictate how many wells are needed. Background wells do not necessarily have to be placed upgradient of the active sewage sludge unit, but the permit writer should review any placement criteria to ensure that the wells are not being influenced by any contamination at the site.

The permit should require that the owner/operator provide appropriate maintenance for the wells. Ground-water monitoring plans should contain a schedule for maintaining the ground-water monitoring system, including replacing or redrilling monitoring wells, replacing seals and caps, repairing or replacing pumps, and any other kinds of general equipment maintenance.

Monitoring Program and Data Evaluations

The permit should specify sample collection, preservation, chain of custody controls, analytical procedures and QA/QC procedures to be used for the ground-water monitoring. The permit writer may also want to specify evacuation techniques to remove stagnant water from the wells prior to sampling. Monitoring wells require sampling at different depths to ensure that the contamination potentially migrating from the site will be intercepted by the wells. The permit writer should specify the amount of sampling and the sampling required in the vertical dimension. The permit writer should be careful when specifying sampling depths to avoid mixing of waters of different quality during sampling. In most cases, sampling of sites on the downgradient boundary requires sampling at the water table and several additional depths.

The sampling and analysis section of the permit should include provisions to measure static water elevations in each well prior to each sampling event. This collection of the water elevation is important in determining if horizontal and vertical flow gradients have changed since the initial hydrogeological characterization (EPA 1992a). Any changes would then require that the owner/operator modify the existing ground-water monitoring system.

The permit writer should also specify that the owner/operator use a statistical procedure that provides a reasonable confidence that the migration of nitrates in amounts that could cause contamination from the active sewage sludge unit into an aquifer is detected. The statistical performance standards will limit the possibility of making false conclusions from the monitoring data (EPA 1992a).

Recordkeeping and Reporting

At a minimum, the permit writer should require that the owner/operator maintain the results of any ground-water monitoring in the operating record during the period the sewage sludge unit is active and for 3 years after the sewage sludge unit closes. At high-risk sites, however, the permit writer may want to require that, in addition, the monitoring results be reported on a periodic basis. In this case, the owner/operator should be required to submit the results to the permitting authority along with an explanation of the sampling and analytical methods used and the statistical methods employed to determine presence or absence of contamination.

At a minimum, reporting should be required for those sites that have trigger-based monitoring requirements or when the owner/operator determines that there is a statistically significant increase above the MCL concentration for nitrates or, if the aquifer is already contaminated, above the existing concentration. In the case of contamination, the owner/operator may be required to submit an application for a permit modification to establish corrective action requirements in the permit.

5.6 OPERATIONAL STANDARDS

5.6.1 PATHOGENS

Sewage sludge to be placed in an active sewage sludge unit must meet one of the Class A or Class B pathogen reduction alternatives in §503.32 unless the sewage sludge placed on an active sewage sludge unit is covered with soil or other material at the end of each operating day. The site restrictions in §503.32(b)(5) associated with the Class B pathogen reduction alternatives do not apply to sewage sludge placed in a surface disposal site. Each of the pathogen requirements listed in Table 5-7 and their associated monitoring and recordkeeping requirements are further discussed in Chapter 8.

TABLE 5-7 PATHOGEN AND VECTOR ATTRACTION REDUCTION REQUIREMENTS FOR PREPARERS OF SEWAGE SLUDGE

Pathogen Reduction	**Vector Attraction Reduction**
Class A Alternative 1 time and temperature Alternative 2 pH, temperature and time Alternative 3 one-time demonstration correlating pathogen levels for enteric viruses and viable helminth ova and operating parameters Alternative 4 pathogen levels for enteric viruses and viable helminth ova Alternative 5 Processes to Further Reduce Pathogens (PFRP) 1. Composting 2. Heat drying 3. Heat treatment 4. Thermophilic aerobic digestion 5. Beta ray irradiation 6. Gamma ray irradiation 7. Pasteurization Alternative 6 equivalent to PFRP In addition all six alternatives include pathogen levels for fecal coliform or *Salmonella*	Option 1 38 percent volatile solids reduction Option 2 lab demonstration of volatile solids reduction anaerobically Option 3 lab demonstration of volatile solids reduction aerobically Option 4 SOUR $\leq$ 1.5 mg O_2/hour/g total solids Option 5 Aerobic process for 14 days at > 40°C Option 6 pH to $\geq$ 12 and retain at 11.5 Option 7 $\geq$ 75 percent solids for stabilized solids Option 8 $\geq$ 90 percent solids for unstabilized solids
Class B Alternative 1 pathogen levels for fecal coliform Alternative 2 Processes to Significantly Reduce Pathogens (PSRP) 1. Aerobic digestion 2. Air drying 3. Anaerobic digestion 4. Composting 5. Lime stabilization Alternative 3 equivalent to PSRP	

Table 5-7 lists the pathogen requirements that apply to the preparer of the sewage sludge. If the owner/operator covers the sewage sludge at the end of each operating day [vector attraction reduction requirement of § 503.33(b)(11)], then no pathogen requirements need to be met by the preparer of the sewage sludge.

In developing permit conditions, the permit writer will need to rely on the information provided by the applicant on the pathogen treatment processes employed by the preparer and by the owner/operator. The pathogen requirements for the owner/operator depend on whether the sewage sludge provided to the owner/operator by the preparer already meets one of the Class A or Class B pathogen reduction alternatives. If so, then the owner/operator would not be subject to any pathogen requirements. If the preparer does not meet one of the Class A or Class B pathogen reduction alternatives, the owner/operator must either meet one of them or cover the sewage sludge daily.

5.6.2 VECTOR ATTRACTION REDUCTION

Sewage sludge to be placed in an active sewage sludge unit must meet one of the vector attraction reduction alternatives listed in § 503.33, or an alternative equivalent to one of the first eight methods, as determined by the permitting authority. Each of the vector attraction reduction requirements listed in Table 5-7 and Table 5-8 and their associated monitoring and recordkeeping requirements are further discussed in Chapter 8. Table 5-7 lists the vector attraction reduction requirements that apply to the preparer of the sewage sludge. Table 5-8 summarizes those that apply to the owner/operator of an active sewage sludge unit.

TABLE 5-8 PATHOGEN AND VECTOR ATTRACTION REDUCTION REQUIREMENTS FOR OWNERS/OPERATORS OF SURFACE DISPOSAL SITES

Pathogen Reduction	Vector Attraction Reduction	
None	Option 9	injection below land surface
	Option 10	incorporation into soil
	Option 11	daily cover

In developing permit conditions, the permit writer will need to rely on the information provided by the applicant on the vector attraction reduction treatment processes employed by the preparer and by the owner/operator. The vector attraction reduction requirements for the owner/operator depend on whether the sewage sludge provided to the owner/operator by the preparer already meets one of the vector attraction reduction requirements in §§ 503.33(b)(1) through (8) or an equivalent alternative. If so, then the owner/operator would not be subject to any vector attraction reduction requirements. However, if the preparer does not meet one of these vector attraction reduction requirements, then the owner/operator would be required to comply with the vector attraction reduction alternatives in §§ 503.33(b)(9) through (11).

5.7 FREQUENCY OF MONITORING REQUIREMENTS

In developing permit conditions for monitoring sewage sludge placed on active sewage sludge units, the permit writer should consider including the following:

- Parameters to be monitored
- Monitoring frequencies
- Monitoring locations
- Sampling types and preservation protocol
- Analytical methods.

In addition, the permit writer may find that including a provision that specifies that QA/QC procedures must be followed will ensure that the results of the monitoring program are reliable and precise. The following subsections briefly highlight each of the above-listed monitoring issues that should be addressed in the permit.

If an active sewage sludge unit is not owned and/or operated by the generator of the sewage sludge, the permit writer needs to decide whether to impose the sewage sludge monitoring requirements on the surface disposal site, the generator, or both.

5.7.1 PARAMETERS TO BE MONITORED

Sewage sludge placed on unlined units must be monitored for the three regulated pollutants, pathogen reduction, and vector attraction reduction. Sewage sludge placed on units that are equipped with liners and leachate collection systems are only subject to the pathogen and vector attraction reduction requirements. If a cover is placed over the sewage sludge, air monitoring for methane is required continuously at the surface disposal site property line and within any structures at the site. This air monitoring is required while the sewage sludge unit is active and for 3 years after it is closed. This monitoring was discussed earlier as a management practice in Section 5.5.9.

The sewage sludge quality parameters established by §503.26 have been reproduced in Table 5-9. In addition, various pathogen and vector attraction reduction alternatives are technologies that must be maintained and monitored on a regular basis. Chapter 8 describes all the alternatives and the recommended monitoring frequencies for each aspect of the technology.

5.7.2 MONITORING FREQUENCY

The frequency of monitoring is typically established through permits on a case-by-case basis. However, to enhance the self-implementation of the regulation, monitoring frequencies have been established in Part 503 for pollutants, pathogen density requirements, and the vector attraction reduction requirements in §§503.33(b)(1)-(4) and (b)(6)-(8). The monitoring frequencies established by §503.26 for surface disposal are shown in Table 5-10, but the permit writer has the discretion to require more frequent monitoring than established by Part 503. Additionally, the regulation gives the permit writer discretion to reduce the pollutant monitoring frequencies if, after 2 years, the variability of pollutant concentrations

TABLE 5-9 PARAMETERS REQUIRED TO BE MONITORED AT SURFACE DISPOSAL SITES

Parameters To Be Monitored		
Pollutants[a]	**Pathogens**	**Vector Attraction Reduction**
Arsenic Chromium Nickel	Fecal coliform or *Salmonella* Enteric viruses[b] Helminth ova[b]	Volatile solids reduction[c] Specific oxygen uptake rate[d] pH[e] Percent solids[f]

[a]Percent solids of sewage sludge must be monitored to report pollutant concentrations on a dry weight basis
[b]Class A alternatives 3 and 4
[c]Vector attraction reduction options 1, 2, and 3
[d]Vector attraction reduction option 4
[e]Vector attraction reduction option 6
[f]Vector attraction reduction options 7 and 8.

TABLE 5-10 FREQUENCY OF MONITORING - SURFACE DISPOSAL

Amount of Sewage Sludge[a] (metric tons per 365-day period)	Frequency[b]
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)

[a]Amount of sewage sludge placed on active sewage sludge unit (on a dry weight basis).
[b]After the sewage sludge is monitored for 2 years at the above frequency, the permitting authority may reduce the frequency of monitoring for pollutant concentrations and for the pathogen density requirements in §§503.32(a)(5)(ii) and (a)(5)(iii) [§503.26(a)(2)].

Source: §503.26

are low and compliance is demonstrated so that a reduction in frequency appears appropriate. If no sewage sludge is disposed, there is no frequency of monitoring requirement. If the permittee is using pathogen Class A alternative 3, the permit writer can reduce the monitoring frequency for enteric viruses and viable helminth ova after 2 years.

The monitoring frequency is based on the amount of sewage sludge placed in an active sewage sludge unit in a given 365-day period. Whenever possible, the permit writer should specify the 365-day period and the corresponding monitoring frequency. The permit writer should also specify that if the amount of sewage sludge placed on the active sewage sludge unit during the 365-day period exceeds the amount on which the monitoring frequency was based, then the permittee must notify the permitting authority and increase the monitoring frequency to that required for the amount of sewage sludge to be placed. For example, if the permittee is expected to place between 200 and 750 metric tons per year during the 5-year permit period, the permit writer could specify two monitoring frequencies.

The permit writer should remember that, in some cases, it may be more appropriate to increase the monitoring frequency beyond the frequency required by § 503.26, particularly where the permit writer has noted the following:

- Concentrations of pollutants vary significantly between measurements
- Concentrations of pollutants are close to the pollutant limits
- A trend indicating worsening sewage sludge quality
- A lack of historical data on sewage sludge quality.

Sewage sludge data collected over a 2-year period should be adequate to calculate the variability of pollutant concentrations and to determine trends in pollutant concentrations. The permit writer also has the discretion to reduce the pollutant monitoring frequency after 2 years of monitoring at the frequency specified in Table 5-10. In deciding whether to reduce the frequency of monitoring, the permit writer should consider the following:

- Variability of the pollutant concentrations—The frequency of monitoring should not be reduced where sewage sludge quality varies significantly such that compliance with applicable numeric limits may be in question.
- Trends in pollutant concentrations—Treatment works with data indicating an increase in pollutant concentrations over the 2-year time period should not be granted a reduction in monitoring.
- The magnitude of the pollutant concentrations—If all sampling data reveal that the concentration of pollutants are significantly below pollutant limitations, a reduction in monitoring may be appropriate.

The monitoring frequencies in Table 5-10 assume that the sewage sludge is placed on an active sewage sludge unit throughout the 365-day period. The frequency of monitoring could be affected if the sewage sludge is stored before it is placed on an active sewage sludge unit.

Two approaches that could be use when sewage sludge is stored before it is used or disposed to show compliance with pollutant concentrations 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. Frequency of monitoring for sewage sludge that is stored prior to use or disposal to show compliance with pathogen and vector attraction reduction requirements also is discussed in section 8.4.

When pathogen and vector attraction reduction is achieved by covering an active sewage sludge unit daily, that requirement has to be met at the end of each operating day. Thus, the frequency of monitoring requirements in Table 5-10 are not appropriate in this case.

5.7.3 MONITORING POINTS

Representative sampling is one of the most important aspects of monitoring. To obtain a representative sample of sewage sludge, the sample must be taken from the correct location and represent the entire volume of sewage sludge. For some treatment works, the location of the sampling point may have a dramatic effect on the sewage sludge quality. It is important that samples be collected from a location representative of the final sewage sludge that is placed on an active sewage sludge unit. Samples should be taken in the same manner each time monitoring is performed. The sampling location should be safe and accessible.

The permit writer should determine if there is an appropriate monitoring location to specify in the permit. For example, there may be a receiving station or temporary storage pile that receives all sewage sludge loads hauled to the site for placement on an active sewage sludge unit. Instead of a specific monitoring location, the permit writer could specify that each load or a random number of loads of sewage sludge be sampled. For generators that send sewage sludge to a surface disposal site not owned or operated by the generator, the permit writer should determine whether a general description of the sampling location, such as "a location just prior to shipment to the surface disposal site" or a specific description of the exact location for collecting samples is appropriate, depending on the following considerations:

- The variability of the sewage sludge at different sample points
- The ability to obtain a well-mixed sample.

For example, where a surface disposal site receives sewage sludge from several different treatment works on a batch-basis, the ability to mix the sewage sludge to get a sample representative of all the sewage sludge may be difficult. The permit writer may want to require sampling of each sewage sludge load or a percentage of all the sewage sludge loads hauled to the site.

EPA has developed three guidance manuals and a video that provide more detail on proper sample collection for sewage sludge:

- *Control of Pathogens and Vector Attraction in Sewage Sludge* (EPA 1992c)
- *POTW Sludge Sampling and Analysis Guidance Document* (EPA 1989a)
- *Sampling Procedures and Protocols for the National Sewage Sludge Survey* (EPA 1989b)
- *Sludge Sampling Video* (EPA 1992d).

5.7.4 SAMPLE COLLECTION AND PRESERVATION PROTOCOL

Also important in ensuring representative samples of sewage sludge are the methods for sample collection and preservation prior to analysis. The technique for sampling sewage sludge varies depending on whether the sewage sludge is flowing through pipes, moving on a conveyor, or stored in a pile or bin. Sewage sludge that flows through pipes or moves on a conveyor should be sampled at equal intervals during the amount of time the unit operates in a day. When sampling from piles or bins, core samples should be taken from at least four points in the pile or bin.

The permit writer should consider whether it is more appropriate to specify that the permittee collect a single grab sample or composite samples. With sewage sludge, as with wastewater, grab samples are instantaneous samples where an amount of sewage sludge is collected all at one time. Composite samples for sewage sludge are a series of equal amount grab samples collected and then combined to make a single sample. Composite samples can be made from a series of grab samples collected from several points in the cross-section of the entire sewage sludge amount, or they can be a series of grab samples collected at regular time intervals over the duration of a sewage sludge discharge.

In determining whether to specify that a sample be collected using a single grab sample or composite sampling method, the permit writer may evaluate factors such as:

- How well the sewage sludge is mixed
- Whether the sample is collected from a single batch of sewage sludge or from a stock pile made up of several batches
- Whether the composition of the sewage sludge varies over time.

In general, combining several samples of the sewage sludge may provide a more representative sample than collecting one grab sample. Therefore, in most situations, composite samples should be required. Sewage sludge is most often used or disposed in a solid form and/or may be treated in batch processes. Sewage sludge characteristics may also vary over time. For these reasons, the quality may not be homogeneous from day to day or even within the sewage sludge volume itself due to the inability to completely mix sewage sludges that have high solids contents.

Appropriate preservation techniques ensure that a sample remains representative for the period of time it is held prior to being analyzed. For field and laboratory preservation of sewage sludge samples, cooling to 4°C is usually the most appropriate method due to the inability to mix high solid sewage sludges with other preservatives. The permit writer should consider specifying this preservation method in the permit because it differs from the more common methods for wastewater.

5.7.5 ANALYTICAL METHODS

All analyses performed to show compliance with the monitoring requirements of Part 503 must be conducted using the methods specified in Part 503. Methods to analyze specific parameters in sewage sludge are specified in the Part 503 regulation and shown in Table 5-11. The permit writer should indicate the methods needed for each analysis in the permit or incorporate the method by referencing the regulatory citation.

The permit writer should specify the methods needed for each analysis in the permit. When specifying methods, the permit writer should consider the following:

- The detection limit of the method should be below the pollutant limit in the permit
- Matrix interferences (many of the wastewater methods must be combined with digestion methods because of the solids contents of sewage sludge).

TABLE 5-11 ANALYTICAL METHODOLOGIES

METHODS FOR THE ANALYSIS OF SEWAGE SLUDGE 40 CFR PART 503			
Pollutant	**Analytical Method**	**Maximum Holding Time, Sample Preservation, Sample Container, Sample Preparation**	**Comments**
Arsenic	AA Furnace SW-846 Method 7060 AA Gaseous Hydride SW-846 Method 7061 Inductively Coupled Plasma SW-846 Method 6010	6 months Plastic or glass container Samples need to be digested prior to analysis.	All samples must be digested using SW-846 Method 3050 or 3051 prior to analysis by any of the procedures indicated. The AA Direct Aspiration analyses are applicable at moderate concentration levels in clean complex matrix systems. AA Furnace methods can increase sensitivity if matrix effects are not severe. Inductively Coupled Plasma (ICP) methods are applicable over a broad linear range and are especially sensitive for refractory elements. Detection limits for ICP methods are generally higher than for AA Furnace methods.
Chromium (total)	AA Direct Aspiration SW-846 Method 7190 AA Furnace SW-846 Method 7191 Inductively Coupled Plasma SW-846 Method 6010		
Nickel	AA Direct Aspiration SW-846 Method 7520 Inductively Coupled Plasma SW-846 Method 6010		
Total Solids, Volatile Solids, Fixed Solids	Gravimetric SM-2540 G	7 days Cool to 4°C Plastic or glass container	Method 2540 G is the recommended procedure for solid and semisolid samples.
Fecal Coliform	SM-9221 E (MPN) SM-9222 D (membrane filter)	24 hours Cool to 4°C Plastic or glass container	Both procedures are very temperature sensitive. Samples must be analyzed within holding times.
Salmonella	SM-9260 D.1 Kenner, B.A. and H.A. Clark	24 hours Plastic or glass container	Large sample volumes are needed due to the low concentration of *Salmonella* in wastewater. Also, due to the large number of *Salmonella* species, more than one procedure may be necessary to adequately determine the *Salmonella's* presence.
Percent Volatile Solids Reduction	ERT		See reference list.

TABLE 5-11 ANALYTICAL METHODOLOGIES (Continued)

METHODS FOR THE ANALYSIS OF SEWAGE SLUDGE 40 CFR PART 503			
Pollutant	**Analytical Method**	**Maximum Holding Time, Sample Preservation, Sample Container, Sample Preparation**	**Comments**
Enteric Viruses	ASTM-Method D 4994-89	2 hours at up to 25°C or 48 hours at 2 to 10°C Plastic or glass container	Concentration of the sample is necessary due to the presumably low numbers of viruses in the sample.
Helminth Ova	Yanko, W.A.		See reference list.
Specific Oxygen Uptake Rate	SM-2710 B	Perform as soon as possible Plastic or glass container	Quite sensitive to sample temperature variation and lag time between sample collection and test initiation. Replicate samples are suggested.

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SW-846 - *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, U.S. Environmental Protection Agency, November 1986.

ASTM - *Annual Book of Standards - Water*, American Society for Testing and Materials, Phila., PA, 1991.

ASTM[1] - "Standard Practice for Recovery of Viruses from Wastewater Sludge," *Annual Book of ASTM Standards*, Section 11, Water and Environmental Technology, 1992.

KC - Kenner, B.A. and H.A. Clark, "Determination and Enumeration of *Salmonella* and *Pseudomonas aeruginosa*," J. Water Pollution Control Federation, 46(9):2163-2171, 1974.

Yanko - Yanko, W.A., *Occurrence of Pathogens in Distribution and Marketing Municipal Sludges*, EPA 600/1-87-014, 1987. NTIS PB 88-154273/AS, National Technical Information Service, Springfield, Virginia.

ERT - *Environmental Regulations and Technology - Control of Pathogens and Vectors in Sewage Sludge*, U.S. Environmental Protection Agency, Cincinnati, OH, EPA-625/R-92/013, 1992.

5.7.6 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

A QA program is used to achieve a desired quality for activities, such as sample collection, laboratory analysis, data validation and reporting, documentation, and record keeping. A QA program should address the following major areas:

- Proper collection procedures, equipment, preservation methods, and chain-of-custody procedures to ensure representative samples
- Proper sample preparation procedures, instruments, equipment, and methodologies used for the analysis of samples
- Proper procedures and schedules for calibration and maintenance of equipment and instruments associated with the collection and analysis of samples
- Proper recordkeeping to produce accurate and complete records and reports, when required.

QC, which is a part of the QA program, relates to the routine use of established procedures and policies during sample collection and analysis. The objective of QC procedures is to ultimately control both the accuracy and the precision of all analytical measurements. QC for sampling procedures would include the use of duplicate, spiked, split samples and samples blanks. QC of analytical procedures should include the use of spiked and split samples, proper calibration protocols, and appropriate analytical methods and procedures. While QA/QC is standard practice for most laboratories, the permit writer may determine that specificity in the permit will ensure more reliable data, particularly where the sewage sludge is variable or where past NPDES permit history suggests that the self-monitoring program is questionable.

5.8 RECORDKEEPING REQUIREMENTS

Records must be kept to demonstrate that the permit conditions that implement all applicable Part 503 regulatory requirements are being met. Part 503 requires specific information be kept to show compliance with pollutant concentrations, pathogen reduction, vector attraction reduction, and management practices. These records must be retained for 5 years. The record keeping requirements for surface disposal of sewage sludge are shown in Table 5-12. This table identifies the minimum requirements for which records must be kept, who must keep the records, and how long they must be retained.

The permit writer is obligated to include at least the minimum appropriate recordkeeping conditions in each permit. Additionally, the permit writer may specify that other records be obtained or developed and maintained by the permittee to determine compliance with permit conditions. For example, if the permit writer determines that the active sewage sludge unit is located in a seismic zone, requirements to maintain geologic studies and design calculations should be placed in the permit. The following technical guidance provides examples of specific records the permit writer may want to require that the permittee retain.

TABLE 5-12 RECORDKEEPING REQUIREMENTS FOR SURFACE DISPOSAL SITES

Record Keeping (§ 503.27)

(a) When sewage sludge (other than domestic septage) is placed on an active sewage sludge unit:

(1) The person who prepares the sewage sludge shall develop the following information and shall retain the information for five years.

(i) The concentration of each pollutant listed in Table 1 of § 503.23 in the sewage sludge when the pollutant concentrations in Table 1 of § 503.23 are met.

(ii) A certification statement.

(iii) A description of how the pathogen requirements in §§ 503.32(a), (b)(2), (b)(3), or (b)(4) are met when one of those requirements is met.

(iv) A description of how one of the vector attraction reduction requirements in §§ 503.33(b)(1) through (b)(8), or an equivalent vector attraction reduction requirement as determined by the permitting authority, is met when one of those requirements is met.

(2) The owner/operator of the surface disposal site shall develop the following information and shall retain that information for five years.

(i) The concentration of each pollutant listed in Table 2 of § 503.23 in the sewage sludge when the pollutant concentrations in Table 2 of § 503.23 are met or when site-specific pollutant limits in § 503.23(b) are met.

(ii) A certification statement.

(iii) A description of how the management practices in § 503.24 are met.

(iv) A description of how the vector attraction reduction requirements in §§ 503.33(b)(9) through (b)(11) are met if one of those requirements is met.

5.8.1 DOCUMENTATION FOR POLLUTANT CONCENTRATIONS

Whoever is required to meet pollutant limits should be required to keep sampling and analysis results documenting the pollutant concentrations. The permit writer should require that this documentation include:

- Sampling records, including the date and time of sample collection, sample location, sample type, sample volume, name of person collecting sample, sample container, field preservation, and sampling QC.

- Analytical records including date and time of analysis, name of analyst, analytical methods, laboratory bench sheets with raw data and calculations used to determine results, analytical QC and analytical results.

5.8.2 DOCUMENTATION FOR PATHOGEN AND VECTOR ATTRACTION REDUCTION

Records must be maintained of certifications made by the preparer and the owner/operator that the pathogen reduction requirements and vector attraction reduction requirements were met and a description of how the requirements were met. Permit conditions should specify the required certification statement to be used by the permittee. These certifications must be signed by a responsible individual from the treatment works or surface disposal site. If the permit is an NPDES permit, there may already be language in the standard conditions defining the person who must sign all records and reports. If not, then the NPDES language in § 122.22 may be used.

The description of how the pathogen and vector attraction reduction requirements were met should be supported by analytical results documenting pathogen density, logs documenting operational parameters for sewage sludge treatment units, and records describing site restrictions to properly demonstrate compliance with the provisions. Further discussion of the suggested monitoring and recordkeeping requirements and supporting documentation is provided in Chapter 8.

5.8.3 DOCUMENTATION TO SHOW COMPLIANCE WITH MANAGEMENT PRACTICES

Records are required to contain a certification that the owner/operator of a surface disposal site is meeting the management practices in § 503.24 and to describe how the management practices have been met. There are specific signatory requirements for the certification as discussed in the previous section. Please note that the signatory requirements for certifying compliance with the management practice for aquifer non-contamination differ. The permit writer, at a minimum, can require that a description be maintained in the records or may be more specific in the permit as to the documentation that is required. If the permit writer decides that more specific information is needed to determine compliance with a management practice, the permit writer must specify in the permit the type of information or additional reports that are to be kept in the records.

The following discussions provide recommendations on the type of documentation that could be required to demonstrate compliance with the management practices. Some information can be used for several management practices so they have been grouped together.

Endangered Species

The following documentation may be necessary to demonstrate that the site was evaluated for potential effects on threatened or endangered species of plant, fish, or wildlife or their habitat and that necessary protective measures were identified and implemented:

- The general proximity of the nearest critical habitat, including migration routes for threatened or endangered species to the surface disposal site
- A description of how the nearby threatened or endangered species of plant, fish, or wildlife and their critical habitat were protected when sewage sludge was placed on an active sewage sludge unit
- A list of endangered or threatened species in the area or documentation that none exist

- If there are endangered or threatened species, a determination from the FWS or appropriate State or local agency that the placement of sewage sludge on an active sewage sludge unit will not likely adversely affect the survival of the species or its critical habitat

- If the above determination indicates that adverse impacts can be avoided if specific measures are taken, records containing documentation of the measures and how they have been implemented.

Flood Flow Restrictions

The types of information required to demonstrate compliance with flood flow restrictions may include the following:

- A flood plain insurance rate map (available from the U.S. Federal Emergency Management Agency) with the surface disposal site location marked. Other sources of this information include the U.S. Army Corps of Engineers, the USGS, Bureau of Land Management, Tennessee Valley Authority, and local and State agencies.

- If an active sewage sludge unit is in the 100-year flood plain, a description of the design details and management practices that will prevent restricted flow of the base flood, including a plan view, a cross section of the unit, and calculations used to determine that the site will not restrict the base flood flow.

Seismic Zone

The following types of information may be required to demonstrate compliance with the seismic impact zone management standards:

- A seismic map available from State or local agencies with the site location marked on the map

- Reports from State or local agencies on earthquake activity

- The maximum recorded horizontal ground level acceleration (as a percentage of the acceleration due to gravity (g), $g=9.8$ m/s^2) (this information is probably contained in reports on earthquake activity obtained from State or local agencies)

- A reconnaissance of the site that focuses on slopes that may have had the toe removed, water seeps from the base of a slope, less resistant strata at the base of a slope, posts and fences that are not aligned, utility poles with sagging or too tight wires, leaning trees, or cracks in walls and streets

- If the surface disposal site is located in a seismic impact zone, documentation on design modifications to accommodate the ground motion from earthquakes, such as shallower unit side slopes, more conservative design of dikes and runoff controls, and contingency plans for leachate collection systems

- Design plans for the active sewage sludge unit indicating the maximum ground motion that unit components are designed to withstand, including foundations, embankments, leachate collection systems, liners (if installed), and any ancillary equipment that could be damaged from the seismic shocks

- Copy of local building codes applicable to the active sewage sludge unit and building permits
- Certification by an engineer with seismic design and geotechnical experience that the unit is designed to withstand the maximum recorded horizontal ground level acceleration.

Fault Zones

Documentation to support this management practice may include the following:

- A Holocene fault map [available from local, State agencies, or the U.S. Geological Survey (USGS)] with the site location marked on the map. In 1978, the USGS published a map series identifying the location of Holocene faults in the United States (*Preliminary Young Fault Maps*, MF916).
- A report on the area reconnaissance findings of the site, emphasizing the location of faults, lineaments, or other features associated with fault movement, such as offset streams, cracked culverts and foundations, shifted curbs, scarps, or other linear features.
- A geotechnical report on the site indicating the presence or absence of any faults or lineations.

Unstable Areas

The following information may be required to demonstrate that the surface disposal site and individual sewage sludge units are located in stable areas:

- A detailed geotechnical and geological evaluation of the stability of the foundation soils, adjacent manmade and natural embankments and slopes
- An evaluation of the ability of the subsurface to support the active sewage sludge unit adequately, without damage to the structural components.

Wetlands

The types of information necessary to demonstrate compliance with wetlands restrictions may include the following:

- The location of the surface disposal site on a wetlands delineation map, such as a National Wetlands Inventory map, Soil Conservation Service (SCS) soil map, or a local wetlands inventory map
- A permit or permit application for a Section 402 or Section 404 permit
- Description of wetlands assessment conducted by a qualified and experienced multidisciplinary team, including a soil scientist and a botanist or biologist.

Storm Water Run-off Controls

The types of information required to support this management practice may include the following:

- Copies of the NPDES permit and any other permits
- Description of the design of the system used to collect and control run-off, including plan view, drawing details, cross sections, and calculations showing that the system has the capacity to collect total run-off volume
- Calculation of peak run-off flow, including data sources and methods used to calculate the peak run-off flow
- Description of inspection and maintenance required for the system
- Description of the procedures for managing liquid discharges and complying with NPDES and other requirements.

Leachate Collection and Control

If the active sewage sludge unit has a liner and leachate collection and removal system (LCRS), the owner/operator must present evidence that the LCRS is properly operated and maintained. In addition, documentation must indicate that the leachate is properly disposed. The types of information required to demonstrate compliance with the management practice for leachate collection and removal systems may include the following:

- Detailed material specifications for the liner, including drainage layer, filter layer, piping, and sumps
- Description of the LCRS design, leak detection, and removal of leachate and liquid from the system
- Design details, including layout of system and components shown in plan view and cross section, spacing and configuration of pipes, sumps, pumps, drainage plans
- Test results demonstrating the system's compatibility with sewage sludge and leachates for all system components and materials
- Description of inspection and maintenance of systems and schedules
- Operational plan describing method of treatment and/or disposal of leachate and disposal schedules.

Methane Monitoring and Control

Methane monitoring is required at covered sewage sludge units while they are active and for 3 years after closure. The system should be designed by an engineer with experience in methane monitoring at landfills, surface impoundments, or sewage sludge units. The methane monitoring system is required to detect the presence of methane in air in site structures and in air at the property line. Alarms, lights, or other warning devices should be deployed to notify site personnel of any methane levels exceeding 25 percent of the lower explosive limit (LEL) for methane in air in structures and levels exceeding 100 percent of the LEL for methane in air at the property line. Contingency plans should be developed as part of the methane monitoring plan. These plans may include a control system. The types of information required to demonstrate compliance with the management standards may include the following:

- Description of the system design
- Design details of the site, including monitoring locations
- Descriptions of methane monitoring schedules, alarm systems, emergency procedures, contingency plans, system maintenance schedules, and methane mitigation
- Cover design details, including plan view of the unit, details of penetrations for gas vents, and cross sections at several points
- Results of methane monitoring, including the maximum and average levels recorded.

Aquifer Contamination

The placement of sewage sludge on a sewage sludge unit shall not contaminate an aquifer. Part 503 allows two options for demonstrating compliance with this management practice; either a ground-water monitoring program or a certification by a qualified ground-water scientist that the aquifer is not contaminated.

If the first option is used, the permit writer should require that the ground-water monitoring records be retained.

The certification, which is supplied by a qualified ground-water scientist, must be supported by documentation that demonstrates a hydrogeologic assessment has been made that indicates that the aquifer is not contaminated. This documentation may include:

- Description of the methods used to reduce the possibility of contaminating ground water, such as liners and leachate collection systems
- Demonstration that the liner construction and/or geology of the site are sufficient to retard liquid flow during the active life and post closure period
- Data indicating that ground water is at a great depth, or hydrologic data demonstrating low rainfall at the active sewage sludge unit such that there is a low probability that contaminants will leach to ground water.

Food, Feed or Fiber Crops

Growing food, feed or fiber crops on any active sewage sludge unit is prohibited, unless explicitly authorized by the permitting authority. If crops are grown, the permit writer should specify the records and documentation that must be maintained to demonstrate compliance with the site-specific management practices established to protect the public health and environment. For example, the permit writer might require crop tissue sampling and analysis of pollutants.

Grazing

Animal grazing on active sewage sludge units is prohibited, unless specifically authorized by the permitting authority. The type of information necessary to demonstrate compliance with the grazing restriction on active sewage sludge units may include a description (and map showing the placement) of animal restriction devices, such as grates at gate entrances or electrified fencing.

If animal grazing is allowed, the permit writer will need to specify the records and documentation that must be maintained to demonstrate that the site-specific management practices are being implemented. For example, the permit writer may want to require periodic analysis of animal tissue.

Public Access

The following types of information may be required to demonstrate compliance with the public access restriction standards:

- Site map, showing the access control locations
- Description of access restriction measures, such as placement of vehicle barriers, signs, and construction plans with the placement and configuration of fences and gates
- Language on warning signs
- Inspection schedule for the access controls and repair procedures
- Schedules for security guard postings or security inspections.

Storage of Sewage Sludge

As discussed at the beginning of this chapter, sewage sludge that is placed on the land for less than 2 years is not covered by Part 503. If sewage sludge remains on the land for longer than 2 years the site is considered an active sewage sludge unit unless there is a demonstration otherwise. At a minimum, this demonstration must include the following:

- The name and address of the person who prepares the sewage sludge
- The name and address of the person who either owns the land or leases the land
- The location, by either street address or latitude and longitude, of the land
- An explanation of why sewage sludge needs to remain on the land for longer than 2 years prior to final use or disposal
- The approximate time period when the sewage sludge will be used or disposed.

The permit writer must determine if there are mitigating factors at the site justifying this longer period for sewage sludge to remain on the land before final use or disposal. The permit writer may want to develop specific conditions pertaining to sewage sludge storage. If necessary, the permit writer may want to stipulate that the treatment works develop plans to eliminate or reduce storage of sewage sludge.

5.9 REPORTING REQUIREMENTS

Statement of Regulation

§503.28(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 10,000 people or more shall submit the information in 503.27(a) to the permitting authority on February 19 of each year.**

Only a subset of treatment works required to keep records are required to report under §503.28 of the regulations. The reporting requirements in §503.28 apply to the following facilities:

- Class I sludge management facilities
- Publicly owned treatment works with a flow rate equal to or greater than one mgd
- Publicly owned treatment works serving a population of 10,000 or greater.

A Class I sludge management facility is any publicly owned treatment works (POTW), as defined in §501.2, identified under 40 CFR §403.8(a) as being required to have an approved pretreatment program (including such POTWs located in a State that has elected to assume local program responsibilities pursuant to §403.10(e)) and any treatment works treating domestic sewage, as defined in §501.2, classified as a Class I sludge management facility by the EPA Regional Administrator, or, in the case of approved State programs, the EPA Regional Administrator in conjunction with the State Director, because of the potential for its sewage sludge use or disposal practices to affect public health and the environment adversely. §503.7(b).

However, the permitting agency has the authority and discretion to require reports from other facilities not specified in Part 503. Under the NPDES regulations, the head of the permitting agency may designate any treatment works treating domestic sewage as a Class I sludge management facility because of the potential for its sewage sludge use or disposal practices to adversely affect public health and the environment. The permit writer may want to consider the following conditions to determine the need for a TWTDS to report:

- The amount of sewage sludge being used or disposed
- The design of the surface disposal site
- The operational and management practices at the site
- Other conditions that show the potential for any adverse effect on public health and the environment.

The reporting requirements specify that Class I sludge management facilities and other POTWs report annually on the information they are required to develop and retain under §503.27. The permit writer should develop permit conditions that specifically identify the information that must be reported, the date by which the information must be received, and the address to which the report must be submitted.

When the permittee is instructed to report the results of sewage sludge analyses for pollutant concentrations as §§503.27(a)(1) and (2) require, she should be required to include the following information:

- Units for reported concentrations
- Dry weight concentrations
- Number of samples collected during the monitoring period
- Number of excursions during the monitoring period
- Sample collection techniques
- Analytical techniques.

The permittee should report separately all data collected during the reporting period.

The permittee should identify the specific elements to be contained in the description of how the pathogen and vector attraction reduction requirements were met. Refer to Chapter 8 for a detailed discussion of appropriate elements for each pathogen reduction and vector attraction reduction alternative.

The permit writer may also require that additional information be reported to determine the compliance status of the TWTDS. In the case where additional information is needed, the permit writer must specifically require that information in the permit.

The permit writer should consider whether a yearly reporting requirement is sufficient. He may want to require some reports to be submitted at a more frequent interval than the yearly reporting requirement. Situations that may warrant the inclusion of more frequent reporting include:

- Where sewage sludge data show significant variations in quality or sewage sludge data indicate a trend toward poorer quality sewage sludge. In these cases, more frequent reporting may assist the permitting authority in addressing problems before violations.
- Where conditions at the site warrant more frequent reporting of the certification for management practices to ensure compliance with the practices.
- Where a compliance schedule was specified.

The permit writer should instruct the permittee to submit reports to the Water Compliance Chief at the appropriate EPA Regional office or to the appropriate State counterpart in an approved State. The permit should require that the reports be signed by an authorized representative. If the permit is an NPDES permit, the standard conditions may already contain language defining the authorized representative. If not, then the regulatory language found in § 122.22 may be included to clearly identify the authorized representative.

Signatory Requirement

(1) All certifications, reports, or information submitted shall be signed as follows:

(a) For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (1) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or (2) the manager of one or more manufacturing, production or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25,000,000 (in second-quarter 1980 dollars) if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

(b) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(c) For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this part, a principal executive officer of a Federal agency includes (1) the chief executive officer of the agency, or (2) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of EPA).

(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 with the reports.

(b) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

(3) Changes in Authorization. If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the above requirements must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

5.10 SCENARIOS FOR A SURFACE DISPOSAL STANDARD

This section discusses different scenarios for a surface disposal standard. Each scenario contains the appropriate 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 each of the scenarios protects public health and the environment from reasonably anticipated adverse effects of pollutants in sewage sludge. The requirements for each scenario vary depending on whether the active sewage sludge has a liner and leachate collection system and on the pollutant limits that have to be met.

5.10.1 SCENARIO 1 - ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM WITH A UNIT BOUNDARY TO SITE PROPERTY LINE DISTANCE OF 150 METERS OR GREATER

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 §§503.22(a)-(d)
Pollutant limits:	Pollutant concentrations in Table 1 of §503.23(a)(1)
Management practices:	Requirements in §§503.24(a)-(g) and (j)-(n)
Operational standards (pathogens):	One of the Class A or Class B pathogen alternatives in §503.32, unless the active sewage sludge unit is covered daily
Operational standards (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) - (b)(11) or an option determined by the permitting authority to be equivalent to one of the options in §§503.33(b)(1) - (b)(8)
Frequency of monitoring:	Requirements in §§503.26(a) and (c)
Recordkeeping:	Requirements in §503.27(a)
Reporting:	Requirements in §503.28

5.10.2 SCENARIO 2 - ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM WITH A UNIT BOUNDARY TO SITE PROPERTY LINE DISTANCE LESS THAN 150 METERS

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 2	
General requirements:	Requirements in §§503.22(a)-(d)
Pollutant limits:	Pollutant concentrations in Table 2 of §503.23(a)(2)
Management practices:	Requirements in §§503.24(a)-(g) and (j)-(n)
Operational standards (pathogens):	One of the Class A or Class B pathogen alternatives in §503.32, unless the active sewage sludge unit is covered daily
Operational standards (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) - (b)(11) or an option determined by the permitting authority to be equivalent to one of the options in §§503.33(b)(1) - (b)(8)
Frequency of monitoring:	Requirements in §§503.26(a) and (c)
Recordkeeping:	Requirements in §503.27(a)
Reporting:	Requirements in §503.28

5.10.3 SCENARIO 3 - ACTIVE SEWAGE SLUDGE UNIT WITHOUT A LINER AND LEACHATE COLLECTION SYSTEM FOR WHICH SITE-SPECIFIC POLLUTANT LIMITS ARE DEVELOPED

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 3	
General requirements:	Requirements in §§503.22(a) - (d)
Pollutant limits:	Site-specific in §503.23(b)
Management practices:	Requirements in §§503.24(a)-(g) and (j)-(n)
Operations standards (pathogens):	One of the Class A or Class B pathogen alternatives in §503.32, unless the active sewage sludge unit is covered daily
Operations standards (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) - (b)(11) or an option determined by the permitting authority to be equivalent to one of the options in §§503.33(b)(1) - (b)(8)
Frequency of monitoring:	Requirements in §§503.26(a) and (c)
Recordkeeping:	Requirements in §503.27(a)
Reporting:	Requirements in §503.28

5.10.4 SCENARIO 4 - ACTIVE SEWAGE SLUDGE UNIT WITH A LINER AND LEACHATE COLLECTION SYSTEM

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

ELEMENTS OF A PART 503 STANDARD - SCENARIO 4	
General requirements:	Requirements in §§503.22 (a) - (d)
Pollutant limits:	None
Management practices:	Requirements in §§503.24(a)-(n)
Operational standards (pathogens):	One of the Class A or Class B alternatives in §503.32, unless the active sewage sludge unit is covered daily
Operational standards (vector attraction reduction):	One of the vector attraction reduction options in §§503.33(b)(1) - (b)(11) or an option determined by the permitting authority to be equivalent to one of the options in §§503.33(b)(1) - (b)(8)
Frequency of monitoring:	Requirements in §§503.26(a) and (c)
Recordkeeping:	Requirements in §503.27(a)
Reporting:	Requirements in §503.28

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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) **Control efficiency 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) **Dispersion factor 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

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)

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.

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:

- Terrain Type—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:

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

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

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

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:

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

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:

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

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 10 grams of beryllium over a 24-hour period. 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 0.01 $\mu g/m^3$, averaged over a 30-day period. 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:

- Sewage Sludge Sampling Methods—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.

- Analytical Methods—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.

Grab—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.

Composite—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

<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(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

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(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?

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).

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.

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
<u>Records of Sampling and Analysis for *Salmonella* or Fecal Coliform and Percent Solids</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>
• 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

<u>Statement of Regulation</u>

§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	
Pathogen parameters	**Frequency**
***Salmonella* or fecal coliform**	**Once per year, quarterly, bimonthly, or monthly (see Table 8-1)**
Operating parameters	**Frequency**
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
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**
• **Analytical results expressed as dry weight.**
Records of Operating Parameters
• **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.

Statement of Regulation

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) • Air drying - Description of drying bed design - Depth of sewage sludge on drying bed - Drying time in days - Daily average ambient temperature • 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)	• 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 • Lime stabilization - pH of sewage sludge immediately and then 2 hours after lime addition

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.

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.

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).

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.

U.S. EPA. 1992. *Technical Support Document for Reduction of Pathogens and Vector Attraction in Sewage Sludge*. November 1992. EPA/822/R-93/004.

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.

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) stěreo 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.

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.

[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/m³)	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 ≤ x < 10
10	10 ≤ x < 15
15	15 ≤ x < 20
20	20 ≤ x < 30
30	30 ≤ x < 50
50	≥ 50

Table E-3. Distance to Property Boundary

Distance (m)	Range (m)
0	< 25
25	25 ≤ x < 50
50	50 ≤ x < 75
75	75 ≤ x < 100
100	100 ≤ x < 125
125	125 ≤ x < 150
150	**150 ≤ x < 200**
200	200 ≤ x < 250
250	250 ≤ x < 300
300	300 ≤ x < 400
400	400 ≤ x < 500
500	500 ≤ 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).

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 <u>all</u> no, complete Part 1 only (see instructions). If the answer to <u>any</u> of the above questions is yes, complete Part 2 rather than Part 1.

Send the completed application form to:

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:

____

____

____

____

FACILITY NAME: | **PERMIT NUMBER:** | **EPA ID NUMBER:** *(for official use only)*

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:
____
____
____
____

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:

Permit Number:	Type of Permit:

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:

____

____

____

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

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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. <u>Description of Sludge Generation, Treatment and Use/Disposal</u>

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. <u>Specific Limitations and Self-Monitoring Requirements</u> (Continued)

1. Outfall 201 (Continued)

b. Pathogen Limitations (Continued)

1) Class A Pathogen Requirements <u>a</u>/

Fecal Coliform and Salmonella Limits		Process Requirements (<u>One</u> of the following):
Fecal Coliforms shall be < 1000 MPN/gram of total solids <u>b</u>/ **OR** *Salmonella* shall be < 3 MPN/4 grams of total solids <u>b</u>/	**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.

<u>a</u>/ 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.

<u>b</u>/ 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. <u>Specific Limitations and Self-Monitoring Requirements</u> (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 <u>all</u> 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.

<u>Specific Limitations and Self-Monitoring Requirements</u>
(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. <u>Specific Limitations and Self-Monitoring Requirements</u> (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. <u>Specific Limitations and Self-Monitoring Requirements</u> (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. Specific Limitations and Self-Monitoring Requirements (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. Management Practices

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.

C. 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:

C. Reporting of Monitoring Results (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 (Continued)

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.