ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 257 and 503

[FRL-3479-9]

Standards for the Disposal of Sewage Sludge

AGENCY: Environmental Protection Agency.

ACTION: Proposed rule.

SUMMARY: Today, under authority of sections 405 (d) and (e) of the Clean Water Act (CWA), as amended (33 U.S.C.A. 1251, *et seq.*), the Environmental Protection Agency (EPA) is proposing regulations to protect public health and the environment from any reasonably anticipated adverse effects of certain pollutants which may be present in sewage sludge. The regulation establishes requirements for the final use and disposal of sewage sludge when the sewage sludge is applied to the land, distributed and marketed, placed in monofills (sludge-only landfills) or on surface disposal sites, or incinerated. The standards for each end use and disposal method consist of either limits on the pollutant concentrations in sewage sludge or equations for calculating these pollutant limits; management practices; and other requirements that prescribe the level of management control that treatment works, users, and disposers must exercise over sewage sludge. EPA also is proposing monitoring, record keeping, and reporting requirements.

Today's standards apply to publicly and privately owned treatment works that generate or treat domestic sewage sludge, as well as to any person who uses or disposes of sewage sludge from such treatment works. Consistent with the statute, the proposed rule requires compliance within 12 months of the date the rule is promulgated, or within 24 months if the regulation requires construction of new pollution control facilities. Qualified publicly owned treatment works (POTWs) that comply with the requirements in 40 CFR Part 403 may be eligible to revise categorical pretreatment standards applicable to industrial users in order to allow additional discharges into POTWs of the pollutants included in this rule.

The proposed standards do not apply to sewage sludge treatment processes that precede final use or disposal or to domestic sewage that is treated along with industrial waste and wastewater by privately owned industrial facilities. In addition, standards are not established in this Part for sewage sludge that is determined to be hazardous using the procedures in 40 CFR Part 261, Appendix II, or to sewage sludge found to contain greater than 50 parts per million (ppm) of polychlorinated biphenyls (PCBs). Requirements in 40 CFR Parts 261-268 apply to sewage sludge determined to be hazardous, and requirements in 40 CFR Part 761 apply to sewage sludge containing greater than 50 ppm of PCBs. Compliance with these requirements will constitute compliance with section 405 of the CWA.

Included in this Notice are conforming amendments to 40 CFR Part 257. The conforming amendments remove the applicability of Part 257 for sewage sludge disposed of by those practices for which EPA is proposing standards today.

DATE: EPA will accept public comments on this proposed rule until August 7, 1989.

EPA will conduct two 2-day workshops to discuss the technical bases of proposed rule and will hold several public hearings to take oral comments on the proposal. These workshops and hearings will be scheduled in the near future. Information on the workshops and hearings will be published in the **"Federal Register."**

Information on the workshops and hearings may be obtained by writing or calling Mark Morris, Sludge Regulation and Management Branch (WH-585), 401 M Street, SW., Washington, DC 20460, (202) 475-7301.

ADDRESSES: Comments on this proposed rule should be sent to: William R. Diamond, Criteria and Standards Division (WH-585), U.S. Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460.

The public docket is located in the Public Information Reference Unit, Room 2904, Waterside Mall, 401 M Street, SW., Washington, DC. The docket is available for viewing from 8:00 a.m. to 4:00 p.m., Monday through Friday, excluding legal holidays. The EPA public information regulation (40 CFR Part 2) provides that a reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Further information on the proposed rule may be obtained by writing or calling Dr. Alan Rubin, Sludge Regulation and Management Branch (WH-585), 401 M Street, SW., Washington, DC, 20460, (202) 475-7301.

Information on the availability of single copies of the proposed rule, technical support documents, and copies of the analyses and models discussed in today's proposal is provided in Part XIII of **SUPPLEMENTARY INFORMATION.**

SUPPLEMENTARY INFORMATION: The preamble to this Notice is organized as follows:

OVERVIEW

The Clean Water Act (CWA) requires municipalities receiving wastewater from households, industrial facilities, and other sources to treat this wastewater. Treatment produces an effluent that is discharged and sewage sludge. The sewage sludge usually contains more than 90 percent water, in addition to solids and dissolved substances. The chemical and biological constituents of the sludge depend upon the composition of the wastewater entering the treatment facility and the subsequent treatment processes. Typically, these constituents may include the following: volatile organic solids; nutrients; disease-causing pathogenic organisms (e.g., bacteria, viruses, etc.); heavy metals and inorganic ions; and toxic organic chemicals from industrial wastes, household chemicals, and pesticides.

The CWA of 1977 amended section 405 by adding subsection (d), which directed EPA to develop regulations containing guidelines for the utilization and disposal of sewage sludge. The regulations were to identify uses for sewage sludge, including disposal, and identify factors to be taken into account in the use or disposal of sewage sludge. In addition, the regulations were to specify concentrations of pollutants which would interfere with sewage sludge use or disposal. The Water Quality Act of 1987 amended section 405(d) by adding a formal requirement that, on the basis of available information, EPA identify the toxic pollutants in sewage sludge that may adversely affect public health or the environment and, in regulations, specify management practices and establish numerical limits for each of the pollutants. The Act requires that the standards be adequate to protect public health and the environment from any reasonably anticipated adverse effects of the pollutants.

Regulatory Determinations

Except for establishing a schedule for promulgation of the regulations, Congress provided little other guidance for the Agency to carry out its broad mandate to protect public health and the environment. Unlike the technology-based requirements of other provisions of the CWA under which the Agency determines appropriate pollutant discharge standards based on the pollutant reduction capabilities of equipment, the directive of section 405(d) requires the Agency to address a much broader range of issues. To develop standards that adequately protect public health and the environment, the Agency must examine and integrate a substantial volume of information and make determinations in a number of different areas. Today's proposal reflects the Agency's determinations on the following issues.

Scope of the Regulation. Different types of sewage sludge are generated and there are different ways of using or disposing of it. Given the different types of sludge that are generated, which types should the Agency regulate? Of the methods used by communities to dispose of their sewage sludge, which types and methods should the Agency regulate?

Pollutant Coverage. On what basis should the Agency select the pollutants (metals, pesticides, organic contaminants, pathogenic organisms) which are regulated in today's proposal?

Pathways of Exposure. What media (air, water, soil) transport the pollutants in sewage sludge into and through the environment?

Target Organisms. What individuals or groups of individuals, plants, or animals are most likely to be affected by the pollutants in sewage sludge?

Models. How will the Agency simulate the movement of the pollutants in sewage sludge into and through the various environmental media to the target organisms?

Type of Risks. What are the potential human health and environmental risks posed by the use or disposal of sewage sludge (e.g., breathing air around a sewage sludge incinerator, drinking water from a well near a monofill, eating food grown on soil to which sludge has been applied, plants growing on sludge-enriched soil, etc.) that the Agency should examine?

Effect Levels. At what concentration does a pollutant adversely affect human health and the environment?

Effects. What are the effects the standards should be designed to prevent (e.g., increased risk of developing cancer or hypertension, phytotoxicity, animal toxicity, etc.)?

Background Pollutant Levels. What are the sources of pollutant exposure other than sludge (e.g., lead from gasoline or from water supply pipes, etc.)?

Acceptable Level Of Risk. What level of risk adequately protects human health and the environment?

Uncertainties. How should the Agency measure and account for the unavoidable uncertainties in its analyses (e.g., use conservative assumptions, add a margin of safety)?

Type Of Effects To Be Evaluated. Should the Agency evaluate the human health and environmental effects on the most exposed target organisms (individual, plant, or animal) or should the Agency also examine the incidence of adverse effects on the total population associated with sewage sludge use or disposal?

Pollutant Limits. Should a single pollutant limit be established for all use or disposal practices or should a separate pollutant limit be established for each use or disposal method?

Form Of The Pollutant Limits. How should the pollutant limits be expressed (e.g., a limitation on pollutant concentrations in sewage sludge, a limitation on pollutant loading rates to the land, a limitation on pollutant emission rates, etc.)?

Regulatory Responsibility. Who should be responsible for meeting the requirements in the rule (end user, treatment work)?

Impacts. Who is affected by the rule? What are the benefits and costs of the proposal?

Since 1984, the Agency has been conducting an extensive information-gathering and analytical program to support the development of today's proposal. Subsequent to the 1987 amendments to the CWA, the Agency redoubled its efforts. This preamble, the technical support documents, and related analyses of the proposal's impact are the product of that effort and explain the basis for the determinations the Agency has made in establishing these standards.

Fundamental Regulatory Principles

The fundamental assumptions underlying today's proposal are discussed below.

Expand the Standards Later

The scope of the Part 503 standards is necessarily constrained by the adequacy of information on sewage sludge pollutants and means of use or disposal. However, rather than wait for more complete information in order to propose all-inclusive regulations, the Agency is proposing standards for those pollutants and use or disposal methods for which there was sufficient information. The Agency will expand and refine these standards in future rulemakings. Section 405 specifically contemplates that the Agency will issue these standards in stages and revise them periodically.

To remedy existing information gaps, the Agency is conducting a National Sewage Sludge Survey which will gather, among other things, additional information on the pollutants in sewage sludge. Furthermore, in cooperation with other Agency offices, EPA is gathering data on the movement of certain pollutants into and through the environment (e.g., dioxins and pathogenic organisms), refining and expanding its modeling capability for specific pollutants or disposal methods (e.g., pathogenic organisms, sewage sludge surface disposal sites), supplementing its information on disposal methods (e.g., sewage sludge incinerators, municipal solid waste incinerators co-firing sewage sludge, sewage sludge surface disposal sites), and identifying the charcteristics of industrial sludge with a domestic sewage component.

In addition during the comment period, EPA will have experts form both inside and outside the Agency review the scientific and technical bases of the proposal. This review may include the Agency's Science Advisory Board, the Cooperative State Research Service, Regional Research Technical Committee (sometimes called the W-17C Committee), representatives of academia, and/or other scientific/technical bodies with expertise in the areas covered by this proposed rule. With the additional data and the scientific and technical review of the proposal, the Agency should be able to expand and refine the standards.

Coordinate With Other Programs

The use and disposal of sewage sludge affect air, soil, and water. In preparing this proposal, the Agency carefully examined the requirements of other media programs and media-specific statutes. Where possible, for consistency, the Agency used the tools and standards developed under these other programs. For example, the air models used in developing the limits for the incineration of sewage sludge are the models used under EPA's air program. Thus, the pollutant limits for the incineration of beryllium and mercury are based on the National Emission Standards for Hazardous Pollutants (NESHAPs). The limit for the incineration of lead is based on the National Ambient Air Quality Standard (NAAQS) for lead. This principle is followed throughout the proposal. Therefore, when the pollutant limits are designed to protect ground water, the Agency used the drinking water standards (maximum contaminant levels—MCLS), where available. When protecting surface water, the Agency used the water quality criterion developed for individual pollutants.

In some cases, regulatory standards are undergoing revision. If the Agency has proposed an alternative standard, as in the case of the drinking water standard for lead, the preamble describes and shows the effect of the new standard on the pollutant limit for a use or disposal practice. If the Agency's analyses have not reached a point at which a regulatory option has been selected, the preamble notes that when a new standard is promulgated, the numerical limit for a disposal practice will be revised.

Control Sewage Sludge Quality

Section 405(d) of the CWA directs the Agency to control the quality of sewage sludge by establishing pollutant limits for a use or disposal method. Preventing the contamination of sewage sludge before it is used or disposed of is more equitable than requiring others to contain the contaminated sludge or to deal with the consequences. Only when it is not feasible for the Agency to set pollutant limits does section 405(d)(3) authorize management practices to contain the pollutants—the approach taken by the Agency in the criteria it has proposed for solid waste disposal in municipal solid waste landfills (MSWLFs) (53 FR 33314, August 30, 1988).

By setting limits on sludge quality, the regulation creates incentives for treatment works to generate clean sludge. Treatment works with sewage sludge that does not meet the standards must clean up the influent (e.g., strengthen their pretreatment programs), improve their treatment of sewage sludge (e.g., reduce the densities of pathogenic organisms), or select another use or disposal method.

Emphasize Waste Reduction and the Beneficial Reuse of Sewage Sludge

Achievement of desired national levels of environmental quality depend on the reduction and elimination of the substantial volumes of waste and wastewater generated at home and at work. Without a significant reduction in these volumes (e.g., by home composting food scraps rather than putting them down a garbage disposal), and a corresponding reduction in the residual from treatment (sludge) which must then be either used or disposed of, attainment of these goals is severely hampered.

Closely linked to the Agency's objective of reducing the volume of waste generated, is EPA's policy of strongly supporting the beneficial reuse of sewage sludge. Improving the productivity of our land with the soil conditioning properties and nutrient content of sewage sludge has human health and environmental advantages beyond those that are directly associated with applying sewage sludge to the land. Secondary or related benefits of reusing sewage sludge result from a reduction in the adverse human health effects of incineration, a decreased dependence on chemical fertilizers, a reduction in the emissions associated with incineration that contribute to the "greenhouse effect" and a reduction in fuel or energy costs associated with incineration. Prior to finalizing the rule, the Agency will carefully consider, and place heavy emphasis on, those comments and approaches that support the Agency's policy of beneficial reuse.

Preserve a Local Community's Choice of a Disposal Method

Although the Agency's preference is for local communities to beneficially use their sewage sludge, EPA's responsibility is to set standards, for each method, that are adequate to protect public health and the environment. While the choice of a use or disposal method is reserved by section 405(e) of the CWA to local communities, protection of public health and the environment, where risks are significant, dictate stringent pollutant limits. EPA believes communities, in certain cases, will be unlikely to meet the limits the Agency has proposed. For example, communities are unlikely to meet the limits that would allow them to place sewage sludge in a monofill over Class I ground water (i.e., an irreplaceable source of drinking water).

Base the Rule on Minimizing Risks to Individuals and to the Population as a Whole

The Agency evaluated the effect of a pollutant on the most exposed individual, plant, or animal (MEI) and on the population as a whole. Regulatory options were examined that would have resulted in a rule based on aggregate incidence analyses only (the effect on the whole population), on MEI analyses only, and a rule based on a combination of aggregate and MEI analyses. Today's proposal uses a combination of aggregate and MEI analyses.

For use or disposal methods that do not result in high levels of pollutant exposure to the MEI and that do not result in significant incidence of disease (e.g., applying sewage sludge to non-agricultural lands, placing sewage sludge in surface disposal sites), the pollutant limits are based on current sludge quality (i.e., the 98th-percentile pollutant concentration shown in "Fate of Priority Pollutants in Publicly Owned Treatment Works"—the "40 City Study"—Reference number 36). However, where current sludge quality and disposal methods result in high levels of pollutant exposure to an individual or to the population as a whole, or where there are significant scientific uncertainties as to the effect of a pollutant in a use or disposal practice, pollutant limits are based on models designed to protect the MEI.

Propose Reasonable Standards

Section 405(d)(2)(D) of the CWA requires the Agency to establish standards that are adequate to protect human health and the environment from any reasonably anticipated adverse effects of each pollutant. The Agency examined the effect of long-term pollutant exposure and circumstances that could: (1) Increase the toxicity and potency of a pollutant in the environment; (2) speed the movement of a pollutant into and through the environment; and (3) intensify the adverse effect that the pollutant may have on human health or the environment.

This approach is used throughout the rule to take account of potential data inadequacies, but does not protect against every conceivable combination of adverse conditions. In taking such an approach, the Agency recognizes that some risks may not have been fully evaluated and that some risks may remain after regulation. For example, the

Agency used the average background value of metals in agricultural soils for applying sewage sludge to agricultural lands and assumed that users of sewage sludge would follow simple label instructions. EPA expects that few, if any, individuals will receive higher doses of a pollutant than the doses used to establish the standards. Therefore, the Agency has made the determination that the proposal meets the statutory directive that the standards protect against reasonably anticipated adverse effects of the pollutants.

Propose an Implementable Rule

The proposal balances the flexibility associated with site-specific analyses against the simplicity of national numerical limits. A rule that allows exceptions for every conceivable contingency would prove difficult to understand. Moreover, implementation of such a rule would require an unwarranted commitment of the Agency's limited resources. Therefore, exceptions to national pollutant limits are few, based on a minimum number of site-specific conditions that would make a significant difference in the pollutant limits.

Section 405(e) of the CWA requires treatment works generating or treating sewage sludge, as well as persons using or disposing of sewage sludge, to comply with the technical standards. Realistically, the Agency can not issue permits to every user of sewage sludge. Therefore, primary responsibility is placed on treatment works for ensuring that sewage sludge meets the requirements of the rule. Greater flexibility is provided in the standards if the treatment works control the use or disposal practice or when, through agreements or other contractual mechanisms, the treatment works can effectively control the disposal. When this is impractical (e.g., when sewage sludge products are sold or given away to the general public), sewage sludge must meet higher standards of quality. However, the limits were not designed to protect against every conceivable misuse of the product that is distributed and marketed. Rather, the rule assumes that simple instructions on the proper use of the product will be followed.

Solicit Comment on a Wide Range of Issues

In addition to explaining the proposal, the preamble discusses alternative approaches that have been used by other programs at the Agency regulating pollutants in the various media and that were considered during the development of the rule. The Agency is soliciting public comment on the fundamental principles of the rule, the carcinogenic risk levels proposed, other human health and environmental criteria that could be used in establishing the numerical limits, changes that may occur because of other Agency actions (e.g., changes in the MCL and air standards for lead), the models, the MEI and aggregate risk analyses, the anticipated benefits and costs of the rule, and the data deficiencies. A separate part of the preamble integrates and summarizes the issues and questions raised throughout the preamble.

Some have characterized the preamble as an Advanced Notice of Proposed Rule Making (ANPRM). While the preamble has characteristics similar to an ANPRM, the Notice is a fully developed proposal. Unlike an ANPRM, this Notice solicits comment on specific numerical limits and provisions of the rule. EPA prepared the broadest possible notice to solicit wide public participation on a comprehensive range of issues in the decision-making process and to identify areas in the proposal where the Agency should make changes or repropose, if warranted, based on public comment and the data gathering initiatives underway.

Summary of the Proposed Rule

Today's proposal includes standards for the final use or disposal of sewage sludge when the sewage sludge is applied to agricultural and non-agricultural land, distributed and marketed, placed in monofills or surface disposal sites, or incinerated. Standards are not proposed for sewage sludge that is disposed with solid waste in MSWLFs. The disposal of sewage sludge in MSWLFs will be regulated under 40 CFR Part 258 (see 53 FR 33314, August 30, 1988). In addition, the rule does not cover sewage sludge that is incinerated with solid waste or disposed of in deepwell wet air oxidation systems.

The rule applies to sewage sludge that is generated or treated by publicly owned and privately owned treatment works treating domestic sewage and municipal wastewater. The rule does not apply to domestic sewage that is treated along with industrial wastewater by privately owned facilities. Sewage sludge that is determined to be hazardous under procedures in Appendix II of 40 CFR Part 261 is not included in this proposal, but must be disposed of in compliance with the hazardous waste regulations in 40 CFR Parts 261 through 268. Compliance with those regulations will constitute compliance with Section 405. Also, sewage sludge that is found to contain 50 ppm or more of PCBs is excluded from this proposal. Sewage sludge with 50 ppm of PCBs must be disposed of in accordance with the requirements established in 40 CFR Part 761.

Finally, the rule does not cover the ocean disposal of sewage sludge which is regulated by the Marine Protection, Research, and Sanctuaries Act (MPRSA). The Ocean Dumping Ban Act of 1988, Pub. L. 100-688, amended MPRSA to prohibit any person from dumping sewage sludge into ocean waters after December 31, 1991. In addition, Congress limited ocean dumping during the interim period to those who were authorized as of September 1, 1988, to dump either under an MPRSA permit or a court order. Further, Congress prohibited dumping after August 15, 1989, unless an MPRSA permit has been obtained by that time. EPA is moving forward to issue permits under 40 CFR Parts 220 through 228 for the limited universe of POTWs eligible to continue dumping.

Today's proposal includes specific numerical limits or equations for calculating these limits for 28 pollutants in one or more use or disposal methods. Not every pollutant is regulated under each method.

Today's proposal raises many precedential scientific, technical and policy issues. Therefore, the numerical limits included in today's proposal may change, based on the Agency's data gathering initiatives and public comments. It would not be advisable for permit writers to use these proposed numerical limits before the Agency revises "Guidance For Writing Case-By-Case Permits For Municipal Sewage Sludge" scheduled for later this year.

When sewage sludge is applied to agricultural lands, distributed and marketed, placed in monofills, or incinerated, numerical limits are established using exposure assessment models designed to protect the MEI. The models are used for these practices because the MEI and the population as a whole are likely to receive a high level of pollutant exposure or because there are significant uncertainties about the effect of a pollutant in a use or disposal practice.

The numerical limits derived from the exposure assessment models are based on human health or environmental criteria already published or promulgated by the Agency, on human health criteria developed by the Agency, or on plant and animal toxicity values published in the scientific literature. When sewage sludge is incinerated, the numerical limits for beryllium and mercury are based on the NESHAPs for these pollutants, and the numerical limit for lead is based on the NAAQS for lead. When the objective is to protect sources of drinking water, pollutant limits were developed which would ensure the MCLs are not violated. When the objective is to protect surface water, Water Quality Criteria are used.

If the Agency has not published or promulgated criteria for specific pollutants, EPA is proposing to use reference doses listed in the Agency's computerized Integrated Risk Information System (IRIS) and risk specific doses corresponding to an incremental carcinogenic risk level of 1×10^{-4}, except when sewage sludge is incinerated. For the incineration of sewage sludge, numerical limits are established to ensure pollutant levels do not exceed a risk specific concentration corresponding to an incremental carcinogenic risk level of 1×10^{-5}. Terrestrial criteria designed to protect plants or animals are based on toxicity values determined from the appropriate scientific literature.

For sewage sludge that is disposed of in monofills or is incinerated, treatment works may submit site-specific datas for a limited number of physical parameters related to the site. The permitting authority will use the treatment works' site-specific data to re-calculate a numerical limit using EPA-approved exposure assessment models. Because these re-calculated numerical limits are based on the same human health and environmental criteria as the national numerical limits, the re-calculated limits will adequately protect human health and the environment.

If practices do not result in high levels of pollutant exposure to the MEI and the aggregate analyses do not show significant human health effects on the population as a whole, the pollutant limits are based on existing sewage sludge quality. Numerical limits based on existing sewage sludge quality are derived from the 98th-percentile concentrations of the "40 City Study." These pollutant concentrations are used to establish numerical limits for pollutants in sewage sludge that is applied to nonagricultural lands or disposed of on surface disposal sites.

The rule also lists pollutants for which removal credits may be authorized. In addition to the pollutants for which numerical limits are established, removal credits may be available for pollutants that EPA examined without establishing numerical limits. No limits are established for this latter group of pollutants because either the Agency determined that at the concentrations found in sewage sludge, these pollutants do not interfere with the particular disposal practice or, for the incineration of sewage sludge, the Agency is proposing to establish numerical limits for total hydrocarbons rather than for individual organic pollutants.

The rule establishes limits for pathogenic organisms or indicator organisms (fecal coliforms and fecal streptococci/enterococci) for sewage sludge that is applied to land, distributed and marketed, or disposed of in monofills or on surface disposal sites. The proposal also includes requirements for reducing the attraction of vectors to sewage sludge.

Supplementing the numerical limits are management practices and other general requirements to reduce levels of pathogenic organisms and to prevent gross abuse of the environment. For the distribution and marketing of sewage sludge, the rule requires the distributor to label the product or to include information sheets with the product. The labels or information sheets are to identify the contents of the product and to provide instructions on the proper use of the product.

The rule also proposes monitoring, record keeping, and reporting requirements. The frequency with which sewage sludge is to be monitored depends on the size of the treatment work. The pollutants for which treatment works must monitor their sewage sludge depend on their use or disposal method. The record keeping and reporting requirements are also specific to a particular method of use or disposal.

The proposed rule is expected to cover approximately 5,300 of the approximately 15,300 POTWs that use one or more of the methods included in the proposal. These 5,300 facilities generate or treat approximately 55 percent of the sewage sludge. Of the remaining POTWs, an estimated 6,700 dispose of their sewage sludge (41 percent of the total sludge generated) in MSWLFs that are to be regulated under the proposed 40 CFR Part 258 (53 FR 33314, August 30, 1988). The remaining 3,300 POTWs use other disposal practices not covered in either this proposal or the MSWLF proposal.

The Regulatory Impact Analysis estimates that current use or disposal practices contribute 12.3 cancer cases annually, based on a life time cancer risk ranging from 5×10^{-2} for incineration to 2×10^{-8} for the land application to non-agricultural land. The other health effects are primarily associated with lead exposure and result in 5,998 cases of hypertension, diminished learning capacity in children, or prenatal birth effects. The Agency estimates the benefits of the proposal to be a reduction of 9.5 cancer cases and a reduction of 5,266 lead cases.

The Agency estimates that the use or disposal of sewage sludge costs POTWs approximately $844,000,000 annually. For the purpose of the regulatory impact analysis, the Agency estimated that approximately 509 POTWs may have sewage sludge which does not meet the proposed numerical limits. This estimate does not take into consideration the possibility that some POTWs may come into compliance by using site-specific data to calculate new numerical limits and by imposing more stringent pretreatment requirements on their industrial dischargers. The Agency estimates annual compliance costs of $157.7 million (in 1987 dollars) or an increase of $5 annually for each household served by the POTWs. The total annual incremental compliance costs include costs for sludge monitoring, management practices, and, in some cases, incremental costs of changing a practice for POTWs that fail to meet the numerical limits.

The technical support documents, aggregate human health risk analyses, the regulatory impact analyses, and the preamble discuss the factors that EPA considered, the data it evaluated, and the determinations that it made in developing today's proposal. The preamble summarizes this information in 15 parts.

Part I briefly describes the generation, volume, and constituents of sewage sludge and the factors that communities must consider in using or disposing of the sewage sludge that results from the treatment of domestic sewage and municipal wastewater. Part I also identifies the ways in which communities commonly use or dispose of their sewage sludge, the benefits of reusing sewage sludge, and the risks associated with its disposal.

Part II lists existing Federal and State requirements for the use and disposal of sewage sludge including the relationship of the existing requirements to today's proposal.

In Part III, the preamble begins to describe how the Agency developed the proposed rule. Initially, the Agency selected pollutants most likely to interfere with the safe use or disposal of sewage sludge and then refined the list of pollutants based on the availability of information on the toxic effects of the pollutants.

In refining the intial list of pollutants, the Agency simulated the movement of pollutants into and through the environment with a series of exposure assessment models to determine the concentrations of pollutants reaching an individual, plant, or animal. Part IV describes these models, the assumptions used in the models, and the questions and uncertainties about the models.

Parts V and VI discuss the human health and environmental criteria that the Agency considered and used in determinning the concentration at which a pollutant would cause an adverse human health or environmental effect.

Prior to selecting its approach for establishing standards for a particular use or disposal method, the Agency examined the aggregate human health effects on the nation from the use and disposal of sewage sludge. The methods used to conduct these analyses and the results are described in Part VII.

Part VIII discusses the four regulatory options considered by the Agency for establishing numerical limits and management practices. Included in the discussion are the factors on which the Agency based its selection of a regulatory approach that would adequately protect public health and the environment.

Part IX describes, in separate subparts, the requirements that apply to the use and disposal of sewage sludge and explains how and why they were selected. Examples illustrate how the pollutant limits are calculated and, where applicable, how the numerical limits may be recalculated based on site-specific data. The Agency discusses alternatives that were considered and invites public comment. In addition, separate subparts of Part IX describe the pathogen and vector attraction reduction requirements; the pollutants eligible for removal credits; and the monitoring, record keeping, and reporting requirements.

Part X briefly discusses the implementation of the rule through Federal and State permit programs. Under a separate rulemaking, the Agency proposed State program management requirements and changes in the National Pollutant Discharge Elimination System permitting requirements (see 53 FR 7642, March 9, 1988).

The benefits, costs, and regulatory impact of the proposed rule are discribed in Part XI. This part also discusses the data limitations and assumptions and determinations that the Agency made in fulfilling its responsibilities under Executive Order 12291.

Throughout the preamble, issues are raised and alternatives are discussed. Public comment is invited on these issues and alternatives. Where data are missing, the Agency identifies the information needed to complete its development of the proposal. The issues, alternatives, and data on which the agency is inviting public comment are delineated in PART XII.

Part XIII provides information on where interested persons may obtain copies of the proposed rule, the technical support documents, the models used in establishing the numerical limits, the aggregate effects assessment, and the regulatory impact analysis. Included in this part is the list of references cited throughout the preamble.

Part XIV describes the proposed changes in 40 CFR Part 257. These changes are limited to removing from coverage in Part 257 sewage sludge disposal methods which will be subject to the new standard the Agency is proposing in 40 CFR Part 503.

Finally, Part XV lists the subjects in 40 CFR Parts 257 and 503.

PART I: GENERATION, USE, AND DISPOSAL OF SEWAGE SLUDGE

Generation of Sewage Sludge

The Clean Water Act (CWA) requires municipalities to clean their wastewater prior to discharging it. Wastewater treatment generates sludge which in turn must either be disposed of or used. Sludge management begins with sludge generation and continues through sludge processing and ultimate disposal (see Figure I–1).

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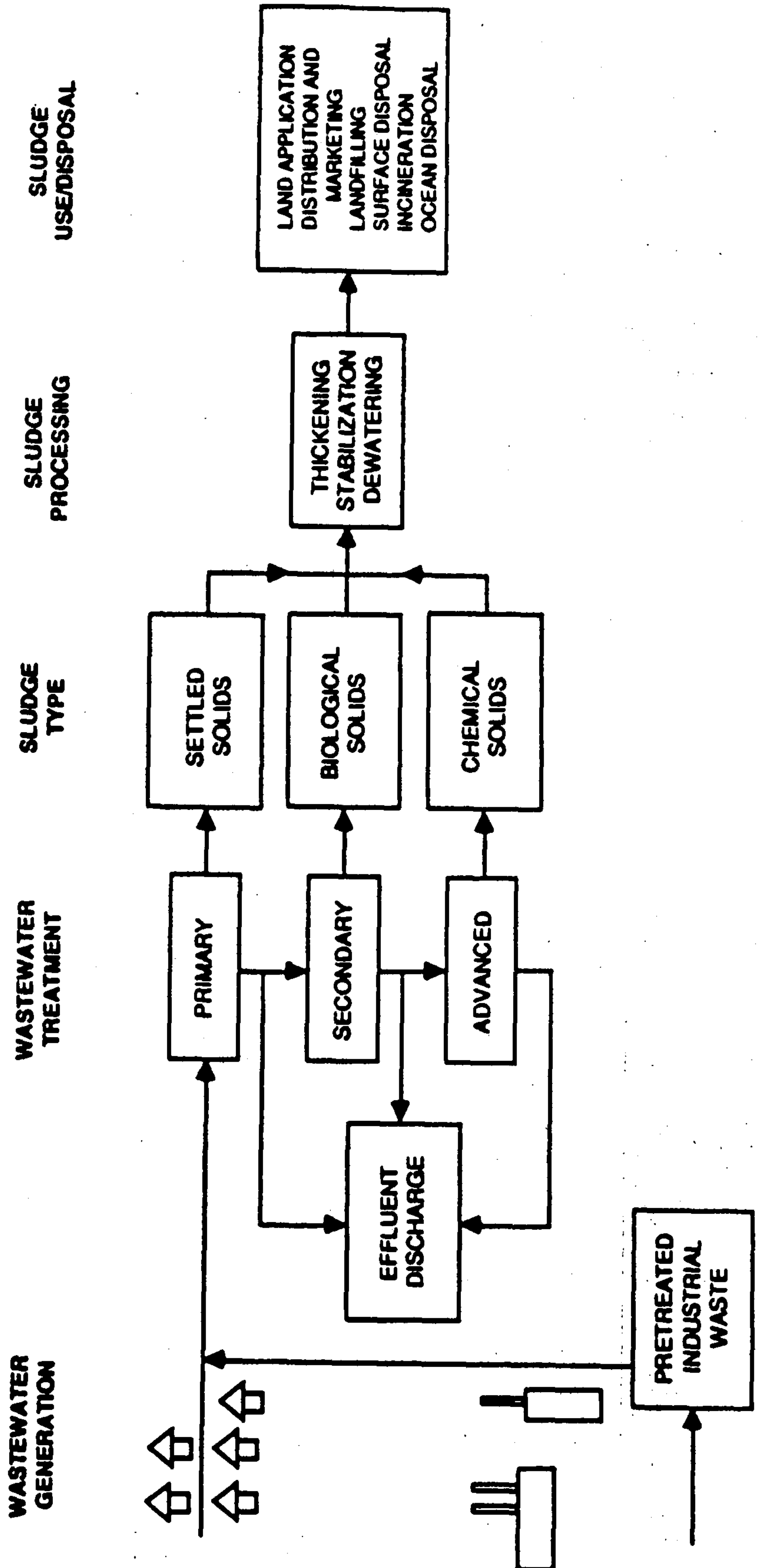
Figure I-1 **Generation, Processing, and Use/Disposal of Municipal Wastewater Sludge.**



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Domestic wastewater contains material flushed into household drains through toilets, sinks, and tubs. Components of domestic sewage include soaps, shampoos, human excrement and tissue, food stuffs, detergents, pesticides, household hazardous waste, and oil and grease. Typically a family of four discharges 300 to 400 gallons of wastewater per day.

Domestic wastewater is treated at its source in septic tanks, cesspools, portable toilets, or in publicly or privately owned wastewater treatment works. These treatment works may treat domestic wastewater alone, or a combination of domestic wastewater and industrial wastewater.

Municipal wastewater treatment works may use one or more levels of treatment (i.e., primary, secondary, or tertiary) to clean this wastewater. Each level of treatment provides both greater wastewater clean-up and greater amounts of sludge.

Primary treatment processes remove the solids that settle out of the wastewater by gravity. This generates 2,500 to 3,500 liters of sludge per million liters of wastewater treated. Primary sludge contains three to seven percent solids, 60 to 80 percent of which is organic matter. The water content of primary sludge can easily be reduced by thickening or by removing water.

Secondary treatment produces a sludge generated by biological treatment processes. Biological treatment processes (e.g., activated sludge systems, trickling filters, and other attached growth systems) utilize microbes to break down and convert the organic substances in the wastewater to microbial residue. These processes remove up to 90 percent of the organic matter in the wastewater and produce a sludge that typically contains from one-half to two percent solids. These solids are generally more difficult to de-water than primary sludges. The organic content of the solids ranges from 50 to 60 percent. Secondary treatment processes increase the volume of sludge generated over primary treatment by 15,000 to 20,000 liters of sludge per million liters of wastewater treated.

Advanced wastewater treatment processes, such as chemical precipitation and filtration, produce an advanced or tertiary sludge. Chemical precipitation uses chemicals to remove organics and nutrients and to separate the solids from the wastewater. Characteristics of these sludges vary depending upon the type of advanced treatment process used and the type of wastewater entering the treatment process. Because these sludges typically contain considerable amounts of added chemicals, the solids content will vary from 0.2 to 1.5 percent, while the organic content of the solids will be in the 35 to 50 percent range. Tertiary treatment increases the volume of sludge generated over secondary treatment by another 10,000 liters of sludge per million liters of wastewater treated.

Sewage sludge contains from 93 to 99.5 percent water, as well as the solids and dissolved substances that were present in the wastewater or that were added or cultured by the wastewater treatment process. While virtually all sewage sludge contains nutrients (e.g., nitrogen, phosphorus) and significant numbers of pathogens (e.g., bacteria, viruses, protozoa, and eggs of parasitic worms), some sludges also contain more than trace amounts of organic chemicals (e.g., chloroform) and inorganic chemicals (e.g., iron). These pollutants come from domestic wastewater, from the discharge of industrial wastewater to municipal sewers, and from the runoff from parking lots and lawns and fields where fertilizers and pesticides were incorrectly applied.

Sludge Processing

Prior to reusing or disposing of sewage sludge, treatment works generally thicken, stabilize, and dewater the sludge. Sludge thickening is the removal of water from sludge to achieve a volume reduction. The reduction in sludge volume decreases the capital and operating costs of subsequent sludge processing and disposal operations. For example, lowering the volume of sewage sludge reduces transportation costs. EPA estimates that the cost of transporting sewage sludge with a 22 percent solids content over a 20 mile trip is about one-half the cost of transportating sewage sludge with a six percent solids content over the same distance.

Treatment works frequently digest or compost their sewage sludge to reduce the level of pathogens and odors. The degree to which a sludge is processed is very important when applying sewage sludge to land, when distributing and marketing it, and when placing sewage sludge in monofills or on surface disposal sites in order to eliminate the spread of pathogenic diseases.

Amount of Sewage Sludge Generated

Approximately 15,300 publicly owned treatment works (POTWs) generate 7.7 million dry metric tons of sludge annually (see Table I-1), or 64 pounds of sewage sludge (dry weight basis) for every individual in the United States. This volume is expected to double by the year 2000 due to population growth, stricter wastewater treatment requirements, and a greater number of better-operated POTWs. The sewage sludge generated each year would fill 185,950 railroad cars, which, if connected, would span half the country.

Unless the volume of sludge is reduced, the nation cannot achieve its environmental quality objectives. Treatment alone is not the answer. Communities should consider the following measures: Implementation of waste separation and water conservation programs; encouragement of the recycling of garbage in compost piles; separation of household hazardous waste prior to collection and handling; and separation of storm water from wastewater sewer systems. These measures have proved successful in reducing the volume of wastewater generated and in improving the quality of the sewage sludge that is ultimately used or disposed of.

Use and Disposal Methods

The following are common methods of using or disposing of sewage sludge: application to agricultural and non-agricultural lands; distribution and marketing of sewage sludge for use in home gardens; disposal in landfills, monofills, and on surface disposal sites; incineration; and ocean disposal.

Table I-1 shows the amount of sludge that is generated based on the size of a facility and on the amount of sewage sludge that is disposed of by a use or disposal practice. Table I-2 shows the number of facilities using a particular method of use or disposal.

TABLE 1-1.—AMOUNT OF SEWAGE SLUDGE GENERATED BY SIZE OF POTW AND DISPOSED OF BY A USE/DISPOSAL PRACTICE*

[Thousands of dry metric tons per year]

Use/disposal practice	Size of POTW						Use/disposal practice as percent of total
	0<0.2 MGD	0.2<1 MGD	1<10 MGD	10<60 MGD	>60 MGD	Total	
Land application	23.1	103.0	438.3	321.5	316.2	1,202.2	15.6
Distribution and marketing	0.1	4.0	36.3	97.5	567.5	705.5	9.1
Municipal landfills	56.5	278.6	1,043.1	899.5	884.7	3,162.3	41.0
Monofills	0.1	2.8	25.5	44.5	28.5	101.4	1.3
Surface disposal	27.6	33.5	40.9	79.9	15.5	197.5	2.6
Incineration	0	0.6	94.1	383.6	1,173.1	1,651.4	21.4
Ocean disposal	0	0.3	1.2	35.4	387.4	424.4	5.5
Other	37.8	45.8	56.0	109.3	21.1	270.0	3.5
Total	145.3	468.6	1,735.5	1,971.2	3,394.0	7,713.6	
Size class as percent of total	1.9	6.1	22.5	25.5	44.0	100	

*Assumptions are that the amount of sewage sludge generated is identical to the amount of sewage sludge disposed of and that a facility uses a single practice to dispose of its sludge.

TABLE 1-2.—THE NUMBER OF POTWS USING A USE/DISPOSAL PRACTICE AND THE SEWAGE SLUDGE GENERATED BY POTWS USING THE PRACTICE

Use/Disposal practice	POTWS using a practice number	Percent of POTWS	Volume generated (1000's of dry MT/year) volume	Percent of sewage sludge
Land application	2,623	17.1	1,202.2	15.6
Distribution and marketing	106	0.7	705.5	9.1
Municipal landfills	6,664	43.5	3,162.3	41.0
Surface disposal	2,395	15.6	196.4	2.5
Monofills	49	0.3	101.4	1.3
Incineration	169	1.1	1,651.4	21.4
Ocean disposal	25	0.2	424.4	5.5
Other	3,274	21.4	270.0	3.5
Total	15,305	100.0	7,713.6	100.0

Source: Draft Regulatory Impact Analysis of the Proposed Regulation for Sewage Sludge Use and Disposal, November 1988.

Benefits Of Reusing Sewage Sludge

The organic and nutrient content of sewage sludge makes it a valuable resource to use both in improving marginal lands and as a supplement to fertilizers. Although not a high grade fertilizer, the organic content in sewage sludge contains $30 to $60 per dry ton worth of organic nitrogen and phosphorus. A study of sewage sludge and effluent use on selected agricultural crops in one area of Oregon found that the return per acre of sludge application ranged from a loss of $6 to an increase of $15 per acre, compared to traditional fertilizer sources, depending on the crop rotation involved, previous soil management practices, soil type, and level of sludge application. These were net savings in the cost of fertilizers, taking into account the fact that the sludge was available at no cost to the farmer (Reference number 7).

The beneficial uses of sludge are not limited to the production of agricultural commodities. Sludge is used in silviculture to increase forest productivity and to re-vegetate and stabilize harvested forest land and forest land devastated by fires, land slides, or other natural disasters. The application of sewage sludge to forest land shortens wood production cycles by accelerating tree growth, especially on marginally productive soils. Studies at the University of Washington on the use of sludge as a fertilizer in silviculture show height increases of up to 1,190 percent and diameter increases of up to 1,250 percent compared to controls in certain tree species. University of Washington research has also shown that trees grow twice as fast on sludge-amended soil. This means that a tree which would typically be cut after 60 years could be cut after only 30 years to supply lumber for a variety of purposes.

Sludge is productively used to stabilize and revegetate areas destroyed by mining, dredging, and construction activities. Air-dried sludge that looks like compost is frequently used to fertilize highway median strips, clover leaf exchanges, and for covering expired landfills. Historically, land reclamation has been very successful and comparable in cost to other commercial methods. In a strip-mined area in Fulton County, Illinois, reclamation using municipal sewage sludge cost $3,660 an acre, as compared with a range of $3,395 to $6,290 an acre using commercial methods (Reference number 86). Pennsylvania has used the sludge Philadelphia generates to reclaim over 3,000 acres of devastated lands. Sludge, in combination with fly ash, is currently used in the re-vegetation of soils that have become highly contaminated from the operation of a zinc smelter in Palmerton, Pennsylvania over the past 90 years (Reference number 31).

Our analyses show that current use practices, land application, and distribution and marketing pose less carcinogenic risk than disposal practices. On a per ton basis, carcinogenic risks from reusing sewage sludge range from $2x10^{-8}$ to $9.9x10^{-7}$, while those from incinerating and disposing of sewage sludge in monofills range from $3x10^{-3}$ to $5x10^{-2}$.

Studies using Philadelphia sludge have shown that the microbial communities in reclaimed mined soils revert to those of normal soils within 2 to 3 years. It may take as long as 10 to 15 years, or even longer, with conventional reclamation (Reference number 31).

Forest soils have been found to be well suited to sludge application because they have high rates of infiltration (which reduce run-off and ponding), large amounts of organic material (which immobilize metals from the sludge), and perennial root systems (which allow year-round application in mild climates). Although forest soils are frequently quite acidic, research at the University of Washington has found no problems with metal leaching following sludge application (Reference number 37). In addition, studies of animals living on sludge treated sites have found that the animals are healthier than those on control sites because of the increased availability of vegetative matter.

The sale of sewage sludge products can be used to defray the costs of de-watering and composting the sewage sludge, but there is no similar mechanism to defray the costs of de-watering sewage sludge placed in landfills or incinerated. Further, the labor, capital, and operating and maintenance costs of incinerating sewage sludge are substantial.

The Municipality of Metropolitan Seattle (METRO), which treats wastewater in the Seattle-King County region, began using sludge to improve soil in several Seattle area parks, restore land disturbed during strip mining, restore a gravel pit used for Interstate 90 construction, and enhance grass growth at the King County International Airport at Boeing Field. In October 1983, the METRO Council adopted a Sludge Management Plan that outlined its goal to use at least eight alternative sludge recycling or disposal methods through the year 2000. METRO reports that its plants produced 65,000 tons of sludge in 1985 and more than 91,000 tons in 1987. Sludge production is expected to increase dramatically in the next decade after METRO's Puget Sound plants are upgraded from primary to secondary treatment. The Agency says that by creating a demand for sludge and developing a variety of recycling options, it reduced program expenses from $227 per ton of sludge solids in 1983 to $148 in 1987.

The benefits of using sewage sludge to improve land productivity are substantial. However, if sewage sludge containing high levels of pathogenic organisms (e.g., viruses, bacteria) or high concentrations of pollutants is improperly handled, the sludge could contaminate the soil, water, crops, livestock, fish, and shellfish. The major human health, environmental, and aesthetic factors of concern in the land application of sewage sludge are related tc pathogens, metals and persistent organic chemicals content, and odors. The standards proposed today would prevent the contamination of soil and crops by pathogens, as well as the contamination of food and animal feed crops by methods and organic pollutants when sewage sludge is applied to lands used in the production of agricultural crops or to lands that may be converted to residential use.

In spite of the benefits of reusing sludge, only 25 percent of the sewage sludge generated in the United States is effectively reused by applying it to the land or by distributing and marketing it for use in home gardens (see Table I-2). In comparison, the 12 countries in the European Economic Community apply 35 percent of their sewage sludge to the land. Japan uses 42 percent of its sewage sludge for coastal reclamation and home garden or farming uses. The United Kingdom applies 51 percent of its sewage sludge to the land (Reference number 3).

While the CWA reserves the choice of use and disposal practices to local communities, EPA's preference is for local communities to reuse this resource in beneficial ways. On June 12, 1984, the EPA published its policy on the management of sewage sludge stating that the Agency will actively promote those municipal sludge management practices that provide for the beneficial use of sludge while maintaining or improving environmental quality and protecting public health (see 49 FR 24358).

When the quality of the sewage sludge appears to be a limiting factor for an otherwise desirable use, POTWs can require their industrial users to pretreat contaminated industrial wastewater before discharging the wastewater to the POTW for cleansing. Controlling the quality of industrial wastewater discharged into municipal sewers is an important element in managing the quality of sewage sludge.

POTWs designed to accommodate flows of more than 5 million gallons per day and smaller POTWs with significant industrial discharges are required to establish local pretreatment programs. Approximately 1,500 of the nation's 15,300 POTWs have local pretreatment programs. The local program must enforce all categorical pretreatment standards and may impose more stringent discharge requirements (i.e., local limits) where necessary to prevent pollutants from interfering with or passing through the POTW wastewater treatment processes.

In addition to wastewater reduction and the separation of contaminated waste from uncontaminated wastes, pretreatment of industrial wastewater is another key step in managing the quality of sewage sludge. If pretreatment does not reduce the pollutant levels sufficiently, communities may have to dispose of rather than use their sludge and, depending on the disposal method, add pollution controls and thereby increase the cost of sludge disposal.

Reuse Practices

Land Application to Agricultural Lands

Seventy-seven percent of the sludge applied to land (approximately 926,000 dry metric tons) is used to improve the condition and nutrient content of soil for agricultural crops, including row and feed crops and pastures. The method of applying sludge to agricultural land depends on the physical characteristics of the sludge and soil and on the crops grown. Liquid sludge may be applied with tractors, tank wagons, irrigation systems, or special application vehicles. Liquid sludge may also be injected under the surface layer of the soil. De-watered sludge, on the other hand, is typically applied to cropland by equipment similar to that used for applying limestone, animal manures, or commercial chemical fertilizers. Generally, the de-watered sludge is applied to the land surface and then incorporated by plowing or disking. When applied to pasture land, sludge is usually not incorporated into the soil.

Land Application to Non-Agricultural Lands

Sludge application to forest land has been undertaken, at least on an experimental field-scale level, in 10 or more States. The most extensive experience with this practice is in the Pacific Northwest. Sludge is most often sprayed from mobile equipment into established forest stands as a partially de-watered, but still liquid, material.

When sewage sludge is used to stabilize and revegetate land, typically large amounts of sludge (usually 112 metric tons per hectare) are applied on a one-time basis. This large amount is necessary to ensure that sufficient organic matter and nutrients are introduced into the soil to support vegetation until a self-sustaining ecosystem is established.

Distribution and Marketing

Nine percent of the sewage sludge generated is distributed and marketed. As a method of managing sewage sludge, distribution and marketing is a highly beneficial practice and one the Agency encourages.

Usually, sewage sludge that is distributed and marketed is composted.

In composting sewage sludge, the sludge is de-watered; mixed with a bulking agent, such as wood chips, bark, rice hulls, straw, or previously composted sludge; and allowed to decompose aerobically for a period of time. In this form, the sewage sludge is dry and easier to distribute. It is also easier for the user to handle. Sewage sludge that is distributed and marketed is used as a substitute for topsoil and peat on lawns, golf courses, parks, and in ornamental and vegetable gardens. Yield improvements have been valued at $35 to $50 per dry ton over other potting media.

Risks of Disposal Methods

Communities should consider alternatives other than burying or burning their sludge. These are wasteful practices that pose risks and incur costs. Some methods of sewage sludge disposal, such as incineration and uncovered landfills, may contribute to global warming (i.e., the "greenhouse effect") by releasing carbon dioxide and methane.

Sewage sludge with high concentrations of organic and metal pollutants could pose human health problems, when disposed of in monofills or on surface disposal sites, if the pollutants leach out of the unit into the ground water. Therefore, the concentration of the pollutants must be limited, or other measures must be taken, to ensure that ground water is not contaminated.

For the incineration of sewage sludge, municipalities must take sufficient measures to control the emissions from sewage sludge incinerators. Otherwise, particulates, sulfur dioxide, oxides of nitrogen, heavy metals, toxic organic compounds, and hydrocarbons will add to a community's air pollution problems.

Ocean dumping of sludge, which Congress banned after 1991, may result in the destruction of biota that influence the balance between oxygen and carbon dioxide. In ocean disposal, there is a potential for the bioaccumulation of certain pollutants often associated with municipal sludge, including mercury, cadmium, and polychlorinated biphenyls. High levels of these pollutants may interfere with the reproductive systems of certain marine organisms, may produce toxic effects in aquatic life, or may present public health problems if contaminated fish and shellfish are eaten.

Disposal Methods

Land Application to Dedicated Sites

Sludge is often disposed of at sites specifically set aside for sewage sludge disposal. Relatively large quantities of sludge (220 to 900 metric tons per hectare) are applied to sites for many years. No attempt is made to use the nutrient and soil conditioning properties of the sewage sludge.

The objective of this practice is to employ the land as a treatment system by using soil to bind metals and by using soil microorganisms, sunlight, and oxidation to destroy the organic matter in the sludge. These sites are generally owned by, or are under long-term leases to, a treatment work. Frequently, the dedicated land disposal site has a non-food chain vegetative cover crop (e.g., sod, pulpwood) to reduce the potential for runoff or leaching of the pollutants to surface or ground water.

Landfilling

Landfilling is a sludge disposal practice in which sludge is deposited in a dedicated area, alone or with solid waste, and buried beneath a soil cover. Landfilling is another disposal method that does not attempt to recover the nutrient content of the sludge for beneficial uses. However, the decomposition of organic matter in sewage sludge that is landfilled produces methane gas. The methane gas can be recovered and yields an energy value more than half as great as that of natural gas.

Forty-one percent of the sewage sludge disposed of by POTWs is landfilled with municipal solid waste. In co-disposal, the absorption characteristics of the solid waste and soil conditioning characteristics of the sludge complement each other. The solid waste absorbs excess moisture from sludge and reduces leachate migration. Sewage sludge usually makes up five percent or less of the material in a solid waste landfill.

Slightly more than one percent of the sewage sludge generated is disposed of in monofills (landfills only accepting sewage sludge). EPA has identified 49 POTWs that dispose of their sewage sludge in monofills. Most monofills consist of a series of trenches, dug into the ground, into which de-watered sludge is deposited and then covered with soil. Other monofill designs, in which the sludge is deposited on the ground surface (area fill mounds, area fill layers, and disked containment) do exist, but these are not commonly used.

Surface Disposal

Sewage sludge surface disposal, like land application to dedicated non-agricultural land and disposal in monofills, is a disposal practice. The majority of surface disposal sites are smaller than one acre and receive less than 50 gallons per day of waste.

The Agency is collecting additional data on the characteristics of surface disposal sites, as compared to monofills or to dedicated non-agricultural land-application sites. Generally, surface disposal sites do not have a vegetative or soil over. Depending on the State in which they are located, surface disposal sites may be regulated in a manner similar to monofills or landfills. In other cases, surface disposal sites are areas of land where sewage sludge has been placed for many years with little or no consideration given to its ultimate disposal.

Incineration

Incineration is a disposal practice that destroys the organic pollutants and reduces the volume of sewage sludge. Incineration takes place in a closed device using a controlled flame. EPA estimates that approximately 1.7 million dry metric tons of sewage sludge are incinerated each year, accounting for more than 20 percent of the sewage sludge disposed of by POTWs.

If the sewage sludge contains 20 percent solids, incinerators reduce the volume of sewage sludge by about 90 percent, on a wet weight basis. While this reduces the amount of material that must be landfilled, owners or operators must control the concentration of the pollutants in the incinerator emissions to prevent exacerbation of a community's air pollution control problems. They must also allocate sufficient funds to pay for the labor, capital, operating, and maintenance costs of sewage sludge incinerators.

Currently, 169 POTWs use 282 incinerators to dispose of their sewage sludge. Most of the incinerators (232) were built prior to 1973, when the New Source Performance Standards for Sewage Sludge Incinerators were published (40 CFR Part 60, Subpart O). Multiple hearth incinerators are the most commonly used sewage sludge incinerators. There are 231 multiple hearth incinerators (82 percent of the incinerators firing sewage sludge), 37 fluidized bed incinerators (13 percent of the total), and five electric incinerators. The remaining incinerators fire sewage sludge with solid waste in municipal waste combusters. A description of these incinerators is included in the "Technical Support Document for Incineration" (Reference number 56).

Ocean Disposal

Ocean disposal of sewae sludge involves the transport of sludge on ocean-going barges to a specially designated site. Under the authority of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, EPA has approved only one site for the ocean disposal of sewage sludge, the 106-Mile Ocean Waste Disposal Site. That site is located 106 nautical miles southeast of the Ambrose light and approximately 120 nautical miles southeast of Cape May, New Jersey. On November 18, 1988, the President signed the Ocean Dumping Ban Act of 1988, which prohibits the dumping of sewage sludge after December 31, 1991. Until the ban goes into effect, permits will be issued under MPRSA to those municipalities that were authorized as of September 1, 1988 to dump sewage sludge at the 106-Mile Site. In issuing permits during the interim period, the Agency will ensure that the rate of dumping will not attain a rate that would adversely affect aquatic life.

PART II: FEDERAL AND STATE REQUIREMENTS

The use or disposal of sewage sludge is currently subject to some Federal regulation. Existing Federal regulations are authorized under several legislative mandates and have been developed independently along media-specified concerns. State regulations generally are keyed to Federal regulatory requirements, primarily those in 40 CFR Part 257, covering the land application and landfilling of sewage sludge, and those in 40 CFR Part 60, Subpart O, covering sewage sludge incinerators.

This part starts with a discussion of the requirements of the Clean Water Air (CWA), followed by a description and summary of other Federal and State regulatory requirements and how they will relate to today's proposal.

Clean Water Act Statutory Requirements

Sewage sludge has been an important concern of the Agency since 1972, when EPA, through the Federal Water Pollution Control Act construction grants program began assisting in the financing of wastewater treatment facilities. The Clean Water Act of 1977 amended Section 405, mandating that EPA develop guidelines for the use and disposal of sewage sludge. Under Section 405(d), EPA was required to issue regulations that:

(1) Identify uses for sludge, including disposal;

(2) Specify factors to be taken into account in determining the measures and practices applicable to each such use or disposal (including publication of information on costs); and

(3) Identify concentrations of pollutants which interfere with each such use or disposal.

Responding to this mandate, in 1979, EPA adopted criteria which provided guidelines for sludge utilization and disposal when sludge was applied to land or disposed of in landfills. These criteria were included in regulations co-promulgated under Subtitle D of RCRA and section 405(d) of the CWA and are found in 40 CFR Part 257. These regulations contain a number of specific requirements for the management of sludge. To protect the ground water, the regulations prohibit any use or disposal of sludge that causes the concentration of ten heavy metals and six organic chemicals in an underground drinking water source to exceed maximum contaminant levels (MCLs) specified in the criteria. The criteria also included management standards applicable to sludge use or disposal methods to protect surface waters, flood plains, and endangered species. The criteria contain limitations on the concentration of two pollutants (cadmium and polychlorinated biphenyls—PCBs) in sludge when the sludge is applied to the surface of land used for the production of animal feed or food-chain crops. In addition, the requirements in Part 257 restrict sewage sludge disposal except in compliance with certain measures to control pathogens and disease-carrying rodents, insects, and birds. The regulation provided for different levels of pathogen reduction, depending on whether crops for direct human consumption were grown or animals for human consumption were allowed to graze on the sludge-amended soil. The methods for reducing the levels of pathogens include aerobic and anaerobic digestion, composting, lime stabilization, and heat treatment and drying.

As part of its sludge regulatory program, EPA has prepared a number of documents which provide guidance and direction to local publicly owned treatment works (POTWs) on the proper management and handling of sludge. EPA has actively encouraged and assisted in the development and implementation of various practices and processes leading to the beneficial use of sludge. In addition to supporting long-term research and demonstration projects, the Agency has also assisted in the development of detailed design guidance for various beneficial methods of disposal and such technologies as digestion, composting, and lime stabilization. The Agency has also supported development of improved de-watering systems, pyrolysis, and other technologies to improve energy recovery from thermal conversion systems, methane recovery from anaerobic digestion systems, and the recovery of various potentially marketable by-products from sludge.

A lack of action in developing the comprehensive sewage sludge regulations promised in the preamble to the 40 CFR Part 257 rule (44 FR 53439, September 13, 1979) led to the creation of an Intra-Agency Sludge Task Force in 1982. The Task Force was assigned the following tasks: (1) Conducting a multimedia examination of sludge management, focusing on sludge generated by POTWs; and (2) developing a cohesive Agency policy on sewage sludge management, designed to guide implementation of the Agency's sewage sludge regulatory and management programs. Numerous Agency offices and *ad hoc* groups had wrestled with sewage sludge management, but none of these groups had been able to decide how to equitably regulate, on a national level, a complex and variable waste in an environmentally protective and cost-effective manner. Sewage sludge use or disposal involved a myriad of site-specific circumstances, could result in multimedia effects, and depended on proper planning and decision-making at the local level. The Agency lacked experience in developing performance standards for solid waste that would attenuate multimedia environmental effects. Furthermore, at that time, Congress had not provided a compliance mechanism for the regulations.

The Task Force, which included representatives from all parts of the Agency, recommended that the Agency develop an integrated, comprehensive regulatory structure for sludge use or disposal using the combined authorities of section 405 of the CWA and other laws. This structure would also incorporate existing regulations and, where appropriate, new regulations to complete regulatory coverage where important gaps remained.

While the Agency was working on a regulatory approach consistent with the recommendations of the Task Force, the Natural Resources Defense Council sued the Agency over EPA's pretreatment regulation (40 CFR Part 403). In that suit, the U.S. Court of Appeals for the Third Circuit (*Natural Resources Defense Council v. EPA*, 790 F.2d 289, 3rd Cir., 1986) ruled that the pretreatment regulation was invalid in four respects. Most relevant here is the Court's fourth holding:

> We hold that, despite EPA's contention that sludge regulations are in place, EPA's device of incorporating other regulations does

not meet the statute's command for a comprehensive framework to regulate the disposal and utilization of sludge and that EPA cannot, in the absence of Section 405(d) regulations authorize the issuance of removal credits under Section 307(b)(1).

Throughout its lengthy consideration of the amendments to the CWA, some members of Congress expressed concern that, without sewage sludge regulations, industry would continue to discharge toxic pollutants into wastewater for POTWs to treat, making it more difficult for a city to find sludge management alternatives. They believed sludge criteria would stimulate effective pretreatment programs and would encourage recycling and reuse of toxic pollutants by industry. In the Water Quality Act of 1987 (Pub. L. 100-4, February 4, 1987), Congress reaffirmed its directive that EPA develop comprehensive sewage sludge regulations and set forth a schedule for the agency to do so. The Water Quality Act amended section 405(d) to include requirements that:

(1) By November 30, 1986, EPA propose regulations establishing numerical limits and acceptable management practices for toxic pollutants that EPA identified as present in sewage sludge in concentrations which, on the basis of information available on their toxicity, persistence, concentration, mobility, or potential for exposure, may adversely affect public health or the environment;

(2) By August 31, 1987, EPA promulgate regulations specifying acceptable management practices and establishing numerical limits for these pollutants that "shall be adequate to protect public and health and the environment from any reasonable anticipated adverse effects of each pollutant;"

(3) By July 31, 1987, EPA identify and propose regulations for those toxic pollutants not identified in the regulations promulgated August 31, 1987, and promulgate regulations for those toxic pollutants by June 15, 1988; and

(4) From time to time, but no less often than every two years, EPA review the regulations for the purpose of identifying additional toxic pollutants and promulgating regulations.

The amendments specify that compliance with the requirements of the regulations must occur not later than 1 year after publication of the regulations, unless the regulations require the construction of new pollution control facilities. In this latter case, compliance must occur no later than 2 years from the date of the regulations' publication.

Section 405(d)(5) also provides that nothing in the section is intended to waive more stringent requirements in the CWA or in any other law. This means that States and local communities remain free to impose more stringent requirements than those included in today's proposal. In addition, as described later in the preamble, where EPA has established requirements applicable to sewage sludge under other statutes, those requirements are included in the proposed Part 503 requirements.

Section 405(e) was further amended to read as follows:

The determination of the manner of disposal for use of sludge is a local determination, except that it shall be unlawful for any person to dispose of sludge from a publicly-owned treatment works or any other treatment works treating domestic sewage for any use for which regulations have been established pursuant to subsection (d) of this section, except in accordance with such regulations.

The implications of this section are presented later in the preamble.

Other Federal Requirements

Traditionally, the Agency has used the standards, definitions, and approaches developed under other Federal public health and environmental programs when they are consistent with the goals and objectives of the CWA. The use of other Federal standards in responding to the broad mandate of section 405(d) is desirable in order to minimize duplicate, overlapping, and conflicting policies and programs. Further, as discussed above, section 405(d)(5) provides that nothing in section 405(d) is intended to waive more stringent requirements established under other statutes. Therefore, as previously indicated, one principle followed in developing today's proposal was to base pollutant limits on human health or environmental criteria established under other statutory authorities.

Under section 304(b) of the CWA, the Agency publishes Water Quality Criteria. For the purposes of Part 503, these criteria are used in making the determination that a pollutant limit for a particular method of use or disposal would not exceed a fresh-water quality criterion, should the pollutant reach the surface water. When the concern is to protect the drinking water supplies, the basis of the pollutant limits is the MCLs promulgated under authority of the Safe Drinking Water Act.

The National Ambient Air Quality Standard (NAAQS) for lead, promulgated under authority of section 109 of the Clean Air Act, and the National Emission Standards for Hazardous Air Pollutants (NESHAPs) for beryllium and mercury, promulgated under authority of section 112 of the Clean Air Act, were used in developing the pollutant limits for these pollutants when sewage sludge is incinerated. Other applicable regulatory requirements for the incineration of sewage include the New Source Performance Standards for Sewage Sludge Incinerators promulgated under section 111 of the Clean Air Act and found at 40 CFR Part 60, Subpart O. Owners or operators of sewage sludge incinerators also must ensure that their operations, including the location of new incinerators, conform to State Implementation Plans approved under the regulations authorized by section 110 of the Clean Air Act and found at 40 CFR Parts 50 through 51.

State Requirements

The information on existing State requirements summarized below was gathered as part of EPA's effort in developing guidance for writing sewage sludge interim permits. Further information may be found in "Guidance For Writing Case-By-Case Permit Requirements For Municipal Sewage Sludge" (Reference number 52). After promulgation of the Part 503 standards, under section 510 of the CWA, States and local entities will retain the authority to impose more stringent standards than provided in this part.

At present, 42 States have regulations or guidelines covering the land application of sewage sludge which set either a maximum allowable concentration or maximum pollutant loading rate for at least one pollutant. Paralleling the requirements in 40 CFR Part 257, 41 States have set restrictions on the growing of crops on soil to which sludge has been applied (e.g., human food chain crops cannot be grown on sludge-amended soil until 18 months after the application of the sewage sludge). In addition, 41 States have established management practices for the land application of sewage sludge.

When States regulate the giveaway or sale of composted sludge, it is regulated under State land application requirements. Eleven States have set numerical limits on the concentration of pollutants in sewage sludge that is distributed and marketed and 22 States have established management practices governing the distribution and marketing of sewage sludge.

Many States enforce landfilling restrictions for non-hazardous sludge that follow the requirements in 40 CFR Part 257. While States have not set maximum pollutant concentrations for sewage sludge that is landfilled, 31

States do have some site restrictions or other management practices governing landfills.

Many States regulate the ambient emissions of sewage sludge incinerators. State implementation plans under the Clean Air Act limit emissions of various pollutants subject to NAAQS or NESHAPs. Twenty States have established opacity limits as well as emission limits for beryllium, mercury, particulates, sulfur dioxide, and carbon monoxide. No State has established a limitation on lead emissions from sewage sludge incinerators. Twenty-nine States have regulations or guidelines governing operation of incinerators, including disposal of the ash.

In one State, the development and enforcement of controls on all methods of sewage sludge use and disposal are delegated entirely to local agencies, as is the issuance of permits. In other States, local as well as State controls are imposed on the disposal of sewage sludge.

PART III: SELECTION OF POLLUTANTS FOR REGULATION

This part describes how the Agency selected the initial list of pollutants for which it is proposing numerical limits and the data bases used to collect information about the pollutants. Additional information may be found in "The Record of Proceedings on the OWRS Municipal Sewage Sludge Committees" and "Summary of the Environmental Profiles" (Reference numbers 80 and 41).

Initial List of Pollutants

In the Spring of 1984, EPA enlisted the assistance of Federal, State, academic, and private sector experts to determine which pollutants, likely to be found in sewage sludge, should be examined closely as possible candidates for special numerical limits. These experts screened a list of approximately 200 pollutants in sludge that, if disposed of improperly, could cause adverse human health or environmental effects. The experts were requested to revise the list, adding or deleting pollutants. The test for inclusion or exclusion was the potential risk to human health and the environment when sewage sludge containing a particular pollutant was applied to the land, placed in a landfill, or incinerated. The Agency also requested that the experts identify the most likely route through which a pollutant could reach target organisms, whether human, plant, or wild or domestic animals. The experts attending the meetings recommended that the Agency gather additional environmental information on approximately 50 pollutants. These pollutants are listed in Table III-1.

TABLE III-1.—POLLUTANTS SELECTED FOR ENVIRONMENTAL PROFILES/HAZARDS INDICES

Pollutants	Land application	Landfill	Incineration
Aldrin/Dieldrin	X		X
Arsenic	X	X	X
Benzene		X	X
Benzidine			
Benzo(a) anthracene.	X		X
Benzo(a) pyrene	X	X	X
Beryllium			X
Bis(2-ethylhexyl) phthalate.	X	X	X
Cadmium	X	X	X
Carbon tetrachloride.			X
Chlordane	X	X	X
Chlorinated dibenzodioxins.			X
Chlorinated dibenzofurans.			X
Chloroform			X
Chromium	X	X	X
Cobalt	X	X	
Copper	X	X	X
Cyanide	X	X	
DDT/DDD/DDE	X	X	X
3,3'-Dichlorobenzidine.			
2,4-Dichlorophenoxy-acetic acid.		X	
Dimethylnitrosamine.	X		
Fluoride	X		
Heptachlor	X		X
Hexachlorobenzene.	X		
Hexachlorobutadiene.	X		
Iron	X		
Lead	X	X	X
Lindane	X	X	X
Malathion		X	
Mercury	X	X	X
Methylene bis (2-chloroaniline).	X		
Methylene chloride.	X	X	X
Methylethyl ketone.		X	
Molybdenum	X	X	
Nickel	X	X	X
PCBs	X	X	X
Pentachlorophenol.	X		X
Phenanthrene		X	X
Phenol			X
Selenium	X		
Tetrachloroethylene.			X
Toxaphene	X	X	X
Trichloroethylene	X		X
Trichlorophenol			X
Tricresol phosphate.	X		
Vinyl chloride			X
Zinc	X	X	X

Environmental Profiles

During 1984 and 1985, the Agency collected data and information from published scientific reports on the toxicity, persistence, means of transport, and environmental fate of these 50 pollutants. EPA also developed information on their occurrence and concentration in sewage sludge by analyzing the sludge of 43 to 45 publicly owned treatment works (POTWs) (depending on the pollutant) in 40 cities ("Fate of Priority Pollutants in Publicly Owned Treatment Works"—the "40 City Study"—Reference number 36). The sludge data from the "40 City Study" consist of concentrations of 40 pollutants (12 metals, six base neutral organic compounds, six volatile organic compounds, nine pesticides, and seven polychlorinated biphenyls—PCBs) in sludge analyzed from the target POTWs.

Using this information on the occurrence and concentration of pollutants in sewage sludge, their toxicity and persistence, the pathways by which the pollutants travel through the environment to a receptor organism (plant, animal, or human), the mechanisms that transport or bind the pollutants in the pathway, and the effects of the pollutants on the target organism, EPA made a preliminary assessment of the likelihood that each pollutant would adversely affect human health or the environment. For this analysis, EPA relied on simple screening models and calculations to predict the concentration of a pollutant that would occur in surface or ground water, soil, air, or food. EPA then compared the predicted concentration with an Agency human health criterion, such as a drinking water standard promulgated under the Safe Drinking Water Act, to determine whether the pollutant could be expected to have an adverse effect on human health. For purposes of this initial screening, EPA assumed conditions that would maximize the pollutant exposure of an individual, animal, or a plant, as well as the worst possible pollutant-related effects.

Based on the factors previously listed (concentration, toxicity, persistence, etc.), EPA "scored" each pollutant and ranked them for more rigorous analysis. EPA excluded two categories of pollutants for further evaluation. First, EPA excluded pollutants which, then compared to a simple index, presented no risk to human health or the environment at the highest concentration that the Agency found in the "40 City Study" or in other available data bases. Second, EPA deferred consideration of pollutants for which there were no EPA human health criteria or there were insufficient data.

Information on each pollutant, the simple screening models an calculations used to describe the pollutant's path through the environment, and the indices used to evaluate the pollutants are compiled in an "environmental profile" for each pollutant. The summary of the environmental profiles is listed as Reference number 41 in Part XIII of the preamble.

Table III-2 shows the pollutants EPA did not analyze further because the pollutant did not exceed an EPA human health or environmental criterion at the highest concentrations shown. The Agency invites commenters to submit any municipal sewage sludge data, that shows higher concentrations of the pollutant than those shown in the Table III-2. In addition, the Agency would like any documented evidence which would contradict the Agency's conclusion that, at the concentrations shown in Table III-2, these pollutants would not cause adverse human health or environmental effects. The pollutants listed in Table III-2 are included in the list of pollutants for which eligible POTWs, complying with the requirements in Part 503, may, under 40 CFR Part 403, apply for authorization to grant removal credits to their industrial dischargers (see Table 12 in § 503.72).

TABLE III-2.—POLLUTANTS THAT WERE EVALUATED AND FOUND NOT TO INTERFERE WITH SEWAGE SLUDGE USE OR DISPOSAL

Pollutants	Disposal practice (concentration)
Chlordane	Monofill over Class II, III ground water (12 mg/kg).
Chromium	Monofill over Class II, III ground water (1,499.7 mg/kg).
Copper	Incineration (1,427 mg/kg).
Cyanide [1]	Land Application, Distribution and Marketing, Monofill (2,686.6 mg/kg).
Dimethyl nitrosamine [1].	Distribution and Marketing (2.55 mg/kg).
2,4-Dichloro-phenoxy-acetic acid.	Monofill (7.16 mg/kg).
Fluoride [1]	Land Application, Distribution and Marketing (738.7 mg/kg).
Heptachlor	Incineration (0.09 mg/kg).
Iron [1]	Land Application, Distribution and Marketing (8,700 mg/kg).
Malathion	Monofill (0.63 mg/kg).
Molybdenum	Monofill (40 mg/kg).
Nickel	Monofill over Class II, III ground water (662.7 mg/kg).
Pentachlorophenol.	Land Application, Distribution and Marketing (30.43 mg/kg).
Phenol	Monofill (82.06 mg/kg).
Selenium	Monofill, Incineration (4.85 mg/kg).
Tetrachloroethylene [1].	Distribution and Marketing (13.07 mg/kg).
Zinc	Monofill, Incineration (4,580 mg/kg).

[1] Exposure assessment models were used in making the determination that these pollutants, at the concentrations shown, do not interfere wtih the disposal of sewage sludge.

Table III-3 shows the pollutants for which a lack of data precludes the Agency from proposing numerical limits at this time. The Agency also solicits information from commenters on these pollutants in order to evaluate them for future rulemaking proceedings.

TABLE III-3.—POLLUTANTS DEFERRED BECAUSE OF INSUFFICIENT DATA

Pollutants	Disposal practice
Benzo(a) anthracene	Land application, distribution and marketing, incineration.
Bis(2-ethylhexl) phthalate	Distribution and marketing.
Chlorinated dibenzo-dioxins.	Land application, distribution and marketing, monofills.
Chlorinated dibenzo-furans.	Land application, distribution and marketing, monofills.
Cobalt	Land application, distribution and marketing, monofills.
Methylene bis (2-chloroanline).	Land application, distribution and marketing.
Methylate chloride	Land application, distribution and marketing, monofills.
Methylene ketone	Monofills.
Pentachlorophenol	Land application, distribution and marketing.
Phenanthrene	Monofills, incineration.
Tricresol phosphate	Land application, distribution and marketing.
Vinyl Chloride	Incineration.

Recently, the Agency established human health criteria for methylene chloride and methylethy ketone. Therefore, these two pollutants are likely to be included on a list of pollutants to be considered for future rulemaking proceedings.

When EPA initiated these pollutant assessments in 1984, the Agency did not include dioxin as a pollutant which it evaluated for this rule. At that time, EPA lacked the data required to assess numerical limitations for dioxin in sludge. Adequate data were not available on the levels of dioxin or its pervasiveness in sewage sludge.

The Agency did not analyze sludge for dioxins as part of the "40 City Study" because, at the time the samples were collected (1979–1980), methodologies did not exist for analyzing trace quantities (parts per trillion) of dioxins in sewage sludge. Because better analytical methods now exist, the Agency is collecting sewage sludge samples for dioxins analyses as part of the National Sewage Sludge Survey (see discussion later in this part of the preamble).

When the analyses of the sewage sludge samples are complete, EPA will use the National Sewage Sludge Survey data and recent scientific studies to propose numerical limits for dioxins. In the interim, as explained later in the preamble, the Agency is limiting the emission of dioxins from sewage sludge incinerators by proposing a limit on total hydrocarbons.

Table III-4 lists the 28 pollutants for which the Agency is proposing numerical limits when a particular method of use or disposal is employed. The pollutants in Table III-4 will be eligible for removal credits. In addition to the pollutants listed in Table III-2 and Table III-4, all organic pollutants for which categorical standards have been promulgated by the Agency and for which the Agency has developed numerical limits will also be eligible for removal credits if the sewage sludge is disposed of by incineration. The rationale for this approach is discussed in connection with Subpart H of the rule (§§ 503.70 through 503.72) in Part IX of the preamble.

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TABLE III-4

POLLUTANTS FOR WHICH SPECIFIC NUMERICAL LIMITS ARE PROPOSED

Pollutants	LA	D & M	MP	SD	I
Aldrin	X	X			
Arsenic	X	X	X	X	X
Benzene			X	X	
Benzo(a) pyrene	X	X	X	X	
Beryllium					X
Bis (2-ethyl - hexyl)-phthalate			X	X	
Cadmium	X	X	X	X	X
Chlordane	X	X	X	X	
Chromium	X	X			X
Copper	X	X	X	X	
DDD, DDE, DDT	X	X	X	X	
Dieldrin	X	X			
Dimethyl nitrosamine	X		X	X	
Heptachlor	X	X			
Hexachlo-robenzene	X	X			
Hexachlo-robuta-diene	X	X			
Lead	X	X	X	X	X

Pollutants	LA	D & M	MF	SD	I
Lindane	X	X	X	X	
Mercury	X	X	X	X	X
Molybdenum	X				
Nickel	X	X	X	X	X
PCB	X	X	X	X	
Selenium	X	X			
Toxaphene	X	X	X	X	
Trichloro-ethylene	X		X	X	
Total hydrocarbons[1]					X
Zinc	X	X			
	25	22	18	18	8

[1]Total hydrocarbon emissions encompass all organic compounds in the emissions of an incinerator

KEY:

LA refers to land application
D & M refers to distribution and marketing
MF refers to sludge-only landfill (monofill)
SD refers to surface disposal
I refers to incineration

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Use Of The "40 City Study" Data Base

As discussed earlier in this part, the Agency relied on the "40 City Study" data as the primary source of information on the pollutant concentrations in municipal sewage sludge. At this time, the "40 City Study" provides the most comprehensive and best documented nationwide data on the concentration of pollutants in sewage sludge.

EPA recognizes several deficiencies in using the "40 City Study" data. Key among them is the fact that data on final processed sewage sludge is generally not available from the "40 City Study." The Study was designed not to assess the quality of the sewage sludge leaving a POTW, but to determine the fate of section 307(a)(1) priority toxic pollutants entering the POTW. Moreover, some sludge samples were taken at points within the POTW prior to final sewage sludge processing. However, the Study did include information that enabled the Agency to estimate the final dry weight of pollutants in the sewage sludge leaving the POTW.

Another deficiency of the "40 City Study" is that the data were collected in 1979 and in 1980. At that time, analytical methods for measuring organic pollutant concentrations in materials with high suspended solids content were in their infancy. Today, the analytical methods are far more precise and analyses of materials with high suspended solids content are conducted routinely by many laboratories.

A third deficiency in using the "40 City Study" data is that the data may not reflect the current sludge quality. The data were collected prior to the implementation of many pretreatment programs. In cities where pretreatment programs have been implemented, particularly for metals, the concentrations of metals in sewage sludge may be lower than those shown in the "40 City Study". On the other hand, treatment works may find that their sewage sludge contains higher concentrations of organic pollutants because more organic wastes are discharged into municipal sewers as limits are imposed on the disposal of liquid hazardous wastes.

Although other data sources of sewage sludge quality are available, these other data sources are also deficient. EPA has been unable to use these for a number of reasons. Some data were drawn from too narrow a geographic area or were drawn from POTWs of a particular size. Frequently, these data were not collected systematically and different sampling and analytical protocols were used in the same survey. In addition, many of these other data were collected prior to the "40 City Study" data.

EPA believes that based on currently available information, the "40 City Study" data are the appropriate data on which to base its proposal. Although these data were obtained nearly ten years ago, analyses of recent data submitted by the Association of Metropolitan Sewerage Agencies suggest that the "40 City Study" data, particularly for metals, provide a reasonable basis for developing a proposal (see Reference number 36). However, EPA believes that the "40 City Study" data need to be supplemented to support the final regulation. Therefore, EPA is conducting a National Sewage Sludge Survey to provide a current and a reliable data base that will be used to set pollutant limits for a limited number of practices, to better assess the risks of sewage sludge disposal practices, and to evaluate the impact of the rule. The data base will also be used in developing a list of pollutants from which the Agency will select additional pollutants for further analyses and potential regulation under section 405(d) of the CWA.

The results from the National Sewage Sludge Survey are necessary for a number of essential analyses required before promulgation of the final regulation. In establishing numerical limits, the Agency needs the pollutant concentration data from the National Sewage Sludge Survey to determine the level of risk posed by current sludge quality and current use or disposal methods. EPA must also have the data from the Survey to test the reasonableness of its analyses and regulatory approach. Some areas of concern include the accuracy of anticipated risks and analyzed characteristics of increased incidence of disease in proximity to particular use or disposal methods. This information will assist the Agency in further evaluating today's regulatory approach.

In addition, as will be explained later in the preamble, the Agency is proposing to use current sludge quality as the basis of the numerical limits when sewage sludge is applied to non-agricultural land and when sewage sludge is disposed of on surface disposal sites because insignificant adverse health impacts are anticipated from these use and disposal methods. The National Sewage Sludge Survey may show that other use or disposal methods have a similar insignificant impact. In that case, the Agency may conclude that the numerical limits for other use of disposal methods should be based on current sludge quality.

The results of the Survey will also be used to assess the potential shifts among the various use or disposal methods as a result of today's proposal. The effect of today's proposal is an important element in determining how to implement the regulation. For instance, if there is likely to be only a slight impact from a particular numerical limitation, immediate implementation may be appropriate. If, on the other hand, wide shifts in current methods of use or disposal are anticipated from the numerical limits, it might be appropriate to assist the POTWs in the development of more stringent pretreatment limits for their industrial dischargers or in the adoption of alternative use or disposal methods.

In collecting data for the survey, EPA is sending a questionnaire to a random, stratified sample of 479 POTWs employing secondary or advanced wastewater treatment processes and is sampling the sludge from a subset of the 479 POTWs receiving a questionnaire. The statistical sample is designed to produce a statistically unbiased national estimate of the volume of POTW-generated sewage sludge, the frequency with which particular pollutants occur in sewage sludge, and the concentrations of the pollutants found in the sewage sludge analyzed. The sample is also constructed to allow separate analysis by four POTW size groups as measured by wastewater flow (less than 1 million gallons per day—mgd, between 1 and 10 mgd, between 10 and 100 mgd, and over 100 mgd) and by five use or disposal practices (land application, distribution and marketing, monofills, incineration, and others, primarily municipal landfills).

An EPA representative is taking the sample and contract laboratories are analyzing each sample. The sampling protocol is based on the procedures in EPA's protocols for sampling and analysis (see Reference numbers 51 and 55). The protocol includes procedures for selecting and documenting the sampling point, handling and preservation, labeling, transmitting the sample to the laboratory, and chain-of-custody.

The suite of 400 pollutants to be analyzed include those pollutants on the CWA section 307(a) list of pollutants, those toxic compounds highlighted in the Domestic Sewage Study, and those Resource Conservation and Recovery Act Appendix VIII compounds for which analytical methods have been developed. The chemical analysis of the sludge samples will be performed using standard EPA methods for conventional and organic pollutants and Method 8290 for dioxin developed by EPA's Las

Vegas, Nevada Environmental Monitoring Systems Laboratory. These protocols specify sewage sludge matrix clean up by gel permeation chromatography followed by the use of gas chromatography-mass spectrometry (GC/MS) together with isotope dilution. These methods provide better performance in terms of detection, precision, and accuracy than other GC/MS procedures. Further information on the National Sewage Sludge Survey, including the sampling protocols and the questionnaire may be found in the supporting statement for the survey (see Reference number 81).

When completed, all survey reports and other analyses based on survey data will be placed in the Regulatory Record in a masked form to protect any information claimed to be confidential. EPA will notice the availability of the data and make it available to the public. Depending on the results of the analyses, the Agency may re-open the comment period on today's proposal.

Coverage of the Proposal

Today's proposal covers those pollutants and practices for which sufficient information is available for the Agency to establish numerical limits, management practices, and other requirements that will protect public health and the environment from reasonably anticipated adverse affects of each pollutant. The Agency recognizes that today's proposal is not comprehensive. The rule does not establish numerical limits for all pollutants or for radioactive sludge that may interfere with the use or disposal of sewage sludge.

Section 405(d) of the CWA specifically contemplates a phase approach to establishing numerical limits for sludge pollutants. Moreover, section 405(d)(2)(D) of the CWA also provides that "[F]rom time to time, but not less often than every 2 years, the Administrator shall review the regulation * * * for the purpose of identifying additional toxic pollutants and promulgating regulations for such pollutants * * *" The National Sewage Sludge Survey will be used by the Agency to identify additional pollutants in sewage sludge that may interfere with the safe use or disposal of the sludge. From this list of pollutants, the Agency will initiate rulemaking processes to increase the coverage of this Part 503 rule. EPA is today proposing the regulation called for by section 405(d)(2)(A). Additional pollutants not identified at this time will be regulated in the second phase required by section 405(d)(2)(B).

The first step in the process is to determine if there is an EPA-derived human health criterion for the pollutant. For those pollutants that have human health criteria, the Agency will gather sufficient data to evaluate the pollutants using exposure assessment models and analytical techniques EPA has developed for assessing the aggregate effects. The analytical techniques are discussed in the next two parts of the preamble. If sufficient data are available on a pollutant, the Agency will use the exposure assessment models to make a determination as to whether the pollutant may interfere with the safe use and disposal of sewage sludge at the concentrations shown in the National Sewage Sludge Survey. If the pollutant does not pose an unreasonable human health or environmental risk, the Agency would propose that the pollutant be added to the list of pollutants eligible for removal credits. If, based on the exposure assessment models, the pollutant presents an unreasonable human health or environmental risk, the Agency would propose numerical limits for the pollutant appropriate to a particular method of use or disposal. Where the Agency has not developed a human health criterion for a pollutant, EPA would begin to develop the data and information necessary to establish a human health criterion for the pollutant, consistent with the need for and priority of other pollutants. The process is time-consuming particularly if the Agency also must develop a human health criterion.

The Agency is soliciting public comment on the way in which it will expand the coverage of pollutants included in the Part 503 rule. If there are pollutants that are not covered in this rule that should receive immediate attention in future rulemakings, such as dioxins and asbestos, the Agency will consider any suggestions that are offered.

PART IV: EXPOSURE ASSESSMENT MODELS

Introduction

EPA adapted existing models and developed new models to determine the concentration of sludge-borne pollutants that may be applied to the land, placed in sludge-only landfills (monofills), or incinerated without exceeding human health or environmental criteria (Reference numbers 48, 56, and 66). The models simulate the movement of pollutants into and through the environment with a series of mathematical equations or algorithms. These equations or algorithms link the pollutant disposal or release rates to the concentration of the pollutant that moves into the air, water, or terrestrial medium and, subsequently, reaches a target organism (i.e., plants, animals, and humans). Each algorithm in a model represents one exposure pathway through which sludge-borne pollutants enter and pass through or effect an environmental medium.

The target organism is a most exposed individual, plant, or animal (MEI) that remains for an extended period of time at or adjacent to the site where the maximum exposure occurs. The models calculate individual pollutant exposure, relying on certain fixed assumptions about the exposure route. For example, the models assume inhalation of 20 cubic meters of air per day and an average individual diet and two liters of drinking water per day. Other assumptions included in the models are the location of the MEI relative to the site where the sludge is placed and the source of food in the diet of the MEI. The same duration of exposure is used as that assumed in developing the applicable human health or environmental toxicological criteria (allowable doses). For example, where cancer risks are evaluated, the MEI is assumed to be continuously exposed for 70 years.

The Agency's Science Advisory Board (SAB) reviewed the models but not the specific values included in the model algorithms or the way in which the models were used to calculate the proposed numerical limits. The major comments of the Board are discussed in conjunction with each of the models below. The complete report of the SAB is listed in Part XIII of the preamble.

The Agency selected the appropriate numerical values for the parameters in the algorithms of each model, translated the models into computer programs, and, where appropriate, used the models to calculate the numerical limits in today's proposals. The following sections discuss the models that the Agency used to assess the concentrations of the pollutants reaching the MEI when sewage sludge is (1) applied to the land used in the production of agricultural commodities, (2) distributed and marketed, (3) landfilled in monofills, and (4) incinerated.

In addition, the Agency is developing an exposure assessment model to be used in determining the fate of pathogenic organisms in the environment and in determining the concentration of pollutants that may reach target organisms when sewage sludge surface disposal site is the method of disposal. When the models are completed, the Agency will make them available for public review and comment.

The following discussion provides an overview of the concepts EPA used in developing the models. In this discussion and in other parts of the preamble, EPA points out particular areas of uncertainty on which the Agency would like the public to focus its attention and comments. Full descriptions of the models are presented in the Technical Support Documents prepared in conjunction with today's proposal (Reference numbers 56, 57, and 58).

During the comment period, EPA will solicit the assistance of experts in the review of the scientific and technical bases of the proposal. The experts may include the Agency's Science Advisory Board, the W-170 Committee, representatives of academia, and/or scientific/technical bodies with expertise in the areas covered by this proposal.

Application Of Sewage Sludge To Agricultural Lands

To determine the concentration of a pollutant reaching a target organism when sewage sludge is used in the production of agricultural commodities, the mathematical models consider the likely exposure to the target organism from soil, food, air, surface water, and ground water. The pathways included in the model are identified in Table IV-1.

TABLE IV-1.—PATHWAYS MODELED FOR THE LAND APPLICATION OF SEWAGE SLUDGE

Pathways	Description
1: Sludge-soil-plant-human.	Consumers in regions heavily affected by landspreading of sludge.
1F: Sludge-soil-plant-human.	Famland converted to residential home garden use in 5 years.
2F: Sludge-soil-human.	Farmland converted to residential use in 5 years with children ingesting soil.
3: Sludge-soil-plant-animals-human.	Farm households producing a major portion of their dietary consumption of animal products on sludge-amended soil.
4: Sludge-soil-animal...	Farm households consuming livestock that ingests soil while grazing.
5: Sludge-soil-plant-animal.	Livestock ingesting food or feed crops.
6: Sludge-soil-animal...	Grazing livestock ingesting soil.
7: Sludge-soil-plant	Crops grown on sludge-amended soil.
8: Sludge-soil-soil biota.	Soil biota living in sludge-amended soil.
9: Sludge-soil-soil biota-predator.	Animals eating soil biota.
10: Sludge-soil-airborne dust-human.	Tractor operator exposed to dust.
11: Sludge-soil-surface water.	Water Quality Criteria for the receiving water.
12A: Sludge-soil-air-human.	Farm households breathing fumes from any volatile pollutants in sludge.
12W: Sludge-soil-ground water-human.	Farm households drinking water from wells.

In assessing the amount of pollutant exposure that an individual receives from food, the Agency assumed that the MEI obtains a substantial portion of his diet from agricultural crops that are grown or from animals that are raised on sludge-amended soils. Approximately 2.5 percent, on an average, of the MEI's vegetables, grains, and animal products is assumed to be raised on sludge-amended soils depending on the pathway. This compares to the 0.025 percent for an average American consumer. In assessing the amount of pollutant exposure from inhalation and from ingestion of water or soil, the Agency assumed the MEI resides on the property receiving the sludge.

All pathways were evaluated for at least some of the pollutants in Table III-4. Limitations in available data prevented the Agency from evaluating each pollutant in every pathway. "The Technical Support Document for Land Application" (Reference Number 57) includes a matrix that shows the pollutant loading rates for each pathway. That pathway for a pollutant which results in the most stringent numerical limits is the pathway selected by the Agency for assessing the exposure to the MEI and for establishing the proposed numerical limits. That pathway is referred to as the "critical pathway".

All pathways, except those involving ground water and air (Pathways 12W and 12A), assume the mixing of sludge with 15 centimeters (i.e., 6-inch plow depth) of the surface soil layer (having a mass of 2 million kilograms per hectare). This allows conversions between pollutant concentrations in soil (in mass of contaminant per unit mass of soil) and pollutant loadings rate (in mass of contaminant per hectare of land).

After first determining the pollutant concentration in the soil that would be allowed (i.e., the maximum pollutant concentration in the soil that, when taken up by a plant and eaten, does not produce undue risk) for a particular pathway, the model determines the allowable pollutant loading limit in one of two ways. For metals, the model determines the cumulative pollutant loading limit, the total quantity of metal consistent with no undue risk. This equals the allowable pollutants concentration in the soil multiplied by the mass of the soil in the top 15 centimeters of a hectare of land. The Agency assumed that metals remain in the sludge-soil matrix and that, over time, metals do not become more biologically available to plants.

For organics, the model determines an annual pollutant loading limit (in kilograms per hectare per year) by considering the rate of loss or decay. The model assumes that the quantity of an organic pollutant lost per year is directly proportional to the quantity present. With steady annual applications, the concentration of a pollutant gradually approaches a plateau at which the quantity lost each year equals the quantity applied. The annual pollutant loading rate is determined such that the concentration levels off at the allowable soil concentration when sewage sludge is applied over a long period of time.

For the plant toxicity and soil biota pathways (Pathways 7 and 8), the Agency specified an allowable pollutant concentration in the soil, which is the concentration that will not cause plant and soil biota toxicity. This value was derived from scientific data relating plant and soil biota toxicity to soil contaminant levels. Thus, the allowable pollutant load for these pathways is that load which, after dilution with 15 centimeters of soil, does not exceed the threshold value.

For the pathways intended to protect livestock from toxicity (Pathways 5 and 6), the Agency evaluated livestock toxicity data to estimate the maximum allowable pollutant concentration in the feed or sludge-soil mixture that would not be toxic to an animal. Livestock includes all herbivores found in the agricultural or forest setting, including domesticated grazing animals, birds, rodents, etc. The Agency assumed that the livestock only consumed feed grown on sludge-amended pastures. In the pathway involving the uptake of a pollutant from the soil into the feed crop (Pathway 5), the allowable pollutant concentration in the soil is the quotient of the allowable pollutant concentration in the feed and the estimated plant uptake factor (partition coefficient).

In the pathway involving direct ingestion of the contaminated soil by an animal (Pathway 6), eight percent of the animal's diet is assumed to be sludge-amended soil that is incidentaly ingested by livestock while grazing. Here, the allowable pollutant concentration in the soil is the allowable feed concentration divided by the fraction of the diet that is soil.

For the pathway involving predators of soil biota (Pathway 9), the Agency evaluated toxicity data to estimate a pollutant concentration in soil biota that would not be toxic to birds. For this pathway, the predator's diet is assumed to be composed entirely of soil biota from the sludge-amended soil. The allowable pollutant concentration in the soil is the quotient of the allowable pollutant concentration in soil biota and an estimated soil biota uptake factor (or partition coefficient).

The surface run-off pathway (Pathway 11) is intended to protect beneficial use of surface waters by determining the pollutant concentration in the soil that would not exceed a Water Quality Criterion for a pollutant if the soil enters a relatively small stream. The rate at which the soil enters the stream is based on the Universal Soil Loss Equation and a sediment delivery ratio. Water Quality Criteria are designed to protect human health, assuming exposure through consumption or drinking water and resident fish, and to protect aquatic life. The pathway was not a critical pathway and therefore was not used as a basis of the numerical limits for any of the pollutants.

In contrast to the pathways described above, the majority of the pathways are intended to protect only human health. These include Pathways 1F, 2F, 3, 4, 10, 12A, and 12W, which are discussed below in ascending order of complexity.

Pathway 10 evaluates the potential for adverse effects from dust inhalation by a tractor driver during tillage operations. The pollutant concentration in the soil is not permitted to exceed the National Institute of Occupational Safety and Health (NIOSH) workplace air quality criteria if significant quantities of soil become airborne. Using the assumption that the total airborne dust does not exceed the NIOSH criterion, this pathway is not a limiting pathway for any pollutant.

The dust inhalation pathway is the only pathway that uses NIOSH criteria. For all other human exposure pathways, the maximum allowable intake is based on the following EPA health effects criteria: a reference does (RfD) for non-carcinogens; a risk specific dose for carcinogens; a daily dietary intake derived from the drinking water standard; or a drinking water standard (maximum contaminant level—MCL).

The Agency evaluated the inadvertent ingestion of soil by children in Pathway 2F. It is assumed that children would come into contact with the sludge-amended soil when the land was converted to residential use 5 years after the final application of sludge. It is also assumed that a sludge-soil mixture is ingested at a rate of 0.1 gram per day for 5 years. The allowable pollutant concentration in the soil is the quotient rate of pollutant ingestion that will not adversely affect a child and the rate of soil ingestion.

The Agency evaluated human exposure from the consumption of plants grown on sludge-amended soil in Pathways 1 and 1F. Both pathways determine an allowable pollutant concentration in the soil based on (1) the allowable intake; (2) an individual's typical daily consumption of several classes of sludge-grown vegetables, legumes, and grains; (3) the fraction of different crops assumed to be grown on sludge-amended soil; and (4) the uptake of a pollutant by each class of crop (uptake coefficient). Pathway 1 is intended to correspond to the exposure of a consumer in a region where sludge is used widely in the production of agricultural crops. It assumes that 2.5 percent of a consumer's intake of grains, vegetables, potatoes, legumes, and garden fruits comes from sludge-amended soil. Pathway 1F involves a home garden scenario, with as much as 60 percent of a consumer's intake coming from grains, vegetables, and potatoes grown on sludge-amended soil. It is assumed that the agricultural land is converted to residential home garden use 5 years after the final application of sludge. Essentially the same partitioning of a pollutant between soil and crop is used for both pathways. The numerical results of modeling these pathways indicate that the home garden pathway (1F) results in more stringent numerical limits than the regional consumer pathway (1) for all pollutants evaluated.

The Agency evaluated human exposure from the consumption of animal products in Pathways 3 and 4. Both assume that approximately 40 percent of the meat, dairy products, and eggs consumed by a farm household is produced on sludge-amended soil.

The first animal product pathway (Pathway 3) assumes that the pollutant reaches the animal through feed crops. The allowable pollutant concentration in the soil is the quotient of the allowable pollutant concentration in the feed crop and a crop uptake factor (partition coefficient). The allowable pollutant concentration in the feed crop is determined from (1) the human intake that can be allowed without causing undue risk, (2) typical consumption rates of various classes of animal products, (3) the percentage of each class of animal product assumed to be raised on sludge-amended soil, and (4) a set of uptake factors relating the pollutant concentration in each animal product to the pollutant concentration in the feed consumed by the animal.

The other animal product pathway (Pathway 4) only involves animals that graze. This pathway assumes that eight percent of the grazing animal's diet consists of a sludge-soil mixture. The allowable pollutant concentration in the soil is the allowable feed concentration divided by the fraction of the animal's diet that is sludge-amended soil. The allowable feed concentration is determined as in Pathway 3, with some differences in the fraction of each food class assumed to be grown on sludge-amended soil.

In model Pathway 12A, the Agency evaluated the exposure of a farm household inhaling vapors of any volatile pollutants that may be in the sludge when it is applied to the land. This pathway is considered for six chemicals: benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chlordane, DDT, dimethylnitrosamine, and polychlorinated biphenyls. The Agency did not apply the vapor pathway to benzene, lindane, trichloroethylene, or toxaphene because these chemicals would volatilize in wastewater treatment processes before sludge disposal—either during wastewater aeration or during sludge processing and de-watering. In addition, the vapor pathway was not applied to relatively non-volatile metals.

The vapor pathway assumes that the total amount of chemical spread in each year would vaporize during that year. Thus, the allowable annual pollutant loading rate is equal to the flux (mass of chemical per unit area per unit time) that may be allowed to enter the atmosphere without exceeding the allowable pollutant concentration in the air. This concentration corresponds to the RfD, risk specific dose, or an MCL. A plume model is used to relate the flux to the resulting pollutant concentration in the air. The allowable flux is determined by (1) the allowable pollutant concentration in the air, (2) the size of the sludge application site, (3) the assumed distance of an individual from the site where the air concentration must be attained, (4) the wind speed, and (5) the degree of atmospheric mixing. The wind direction is assumed never to change, so that the MEI always remains in the center line of the plume.

In model Pathway 12W, the Agency evaluated the exposure of individuals who would obtain their drinking water from ground water located directly below a field to which sludge had been applied. The leachate concentration formed in the sludge-amended soil layer is related by a partition coefficient to the pollutant concentration in the soil. In moving down through the unsaturated zone, the peak leachate concentration is reduced by the modeled processes of vertical dispersion (primarily caused by detention of sorbed pollutant), chemical degradation, and metal precipitation. The unsaturated zone transport model, CHAIN, and (for metals) the geochemical model, MINTEQ, are used here. These models are described more fully in the section on monofill models.

The allowable pollutant loading rate is thus determined from the MCL (that must be met at the ground water interface with no allowance for dilution), the rate of decay of a pollutant, and other factors that affect either the time period for decay or the dispersive smoothing of the peak concentration. These other factors include the recharge or infiltration rate, hydraulic characteristics of the soil, depth to ground water, and the chemical partition coefficient. For some metals, the net ground water electromotive potential (Eh) and ground water pH influence precipitation.

Distribution and Marketing

The Agency derived the numerical limits for the distribution and marketing (D&M) of sewage sludge in a manner analogous to land application. Fewer pathways were considered, however, because the Agency assumed that animals would not be raised on the sludge-amended soil and that the sludge-amended area would not be large enough to affect ground water or the air above the site. The pathways evaluated are shown in Table IV-2, and were described in the previous section.

TABLE IV-2.—PATHWAYS MODELED FOR D&M

Pathway	Description
1: Sludge-soil-plant-human.	Residential home garden.
2: Sludge-soil-human	Child's indigestion of soil.
7: Sludge-soil-plant	Phytotoxicity.
8: Sludge-soil-soil biota	Soil biota toxicity.
9: Sludge-soil-soil biota-predator.	Animals eating soil biota.
11: Sludge-soil-surface water.	Water quality criteria for the receiving water.

For metals, the D&M pollutant loading limits are identical to the land application rates for the human exposure pathways involving home garden crops and soil consumption (i.e., D&M Pathways 1 and 2 are identical to previously described land application Pathways 1F and 2F, respectively). For organics, the limits for these pathways are slightly more stringent in D&M than in land application because D&M assumes immediate residential use whereas in land application there is a 5-year period between the final sludge application and residential use, allowing for the decay of organic pollutants.

The D&M model pathways evaluating plant toxicity, soil biota, and avian predators (Pathways 7, 8, and 9, respectively) are identical to the corresponding land application pathways for all pollutants. The D&M model algorithm for surface runoff (Pathway 11) produced slightly less stringent limits than land application because of minor differences in assumptions about the size of the affected area.

Technical Uncertainties and Issues in the Exposure Assessment Models for Land Application and D&M

The models used in assessing the risks and in developing the proposed limits for the land application of sludge involve a number of uncertainties and technical issues. The land application model is a complex model made up of a large number of pathways and parameters. This section identifies the key technical points, parameters, and assumptions on which the Agency is particularly interested in receiving comment. The "Technical Support Document on Land Application" (Reference number 57) contains a detailed discussion of the derivation of the model assumptions and parameter values. A more detailed discussion of many uncertainties in the modeling framework can be found in the comments of the SAB. Table IV-3 indicates the land application and D&M model parameters and assumptions that the Agency believes are most important and therefore most worthy of public review and comment.

TABLE IV-3 KEY PARAMETERS AND ASSUMPTIONS FOR AGRICULTURAL LAND APPLICATION AND D & M PATHWAYS

Pathway [1]	Pollutants of greatest concern [1]	Key parameters and assumptions
1 Sludge-Soil-Plant-Human	None	None.
1F Sludge-Soil-Plant-Human	Cd [1]; possibly HCB, Pb.	Plant uptake; assume metal bioavailability unchanging over time; organic pollutant's decay rate and time period for decay; percentage of diet affected; toxicity to humans.
2F Sludge-Soil-Human	None	Soil ingestion rates.
3 Sludge-Soil-Plant-Animal-Human	HCB [1]; possibly DDT [1], PCB [1], Toxaphene.	Plant uptake; organic pollutant's rate; percentage of diet affected; toxicity to humans.
4 Sludge-Soil-Animal-Human	None	Mixing with 15 cm soil.
5 Sludge-Soil-Plant-Animal	Se [1], Mo [1], Cd, Zn.	Plant uptake; assume metal bioavailability unchanging over time; background (Mo) concentration in feed; toxicity to livestock.
6 Sludge-Soil-Animal	None	Mixing with 15 cm soil.
7 Sludge-Soil-Plant	Cu [1], Zn [1], Ni [1]	Background soil concentration assumes metal bioavailability unchanging over time; toxicity to plants.
8 Sludge-Soil-Soil Biota	Cu	Toxicity to soil invertebrates.
9 Sludge-Soil-Soil Biota-Predator	Pb [1], Zn; possibly Aldrin/ Dieldrin [1].	Uptake rate in soil invertebrates; assume metal bioavailability unchanging over time; toxicity to birds.
10 Sludge-Soil-Airborne Dust-Human	None	None.
11 Sludge-Soil-Surface Water	None	None.
12A Sludge-Soil-Air-Human	Possibly BaP [1], BEHP [1], Diethylnitrosamine [1].	Assume volatilization more rapid than decay or leaching; wind speed and atmospheric mixing; assume wind direction unchanging; toxicity to humans.

TABLE IV-3 KEY PARAMETERS AND ASSUMPTIONS FOR AGRICULTURAL LAND APPLICATION AND D & M PATHWAYS—Continued

Pathway [1]	Pollutants of greatest concern [1]	Key parameters and assumptions
12W Sludge-Soil Ground Water-Human	Cd, TCE [1]; possibly Toxaphene [1].	Partition coefficient; organic pollutant's decay rate; soil type; depth to ground water; ground water; ground water Eh, pH; toxicity to humans.

[1] Indicates critical pathway for that pollutant.

Reasonable Worst-Case Assumptions And Parameter Values

As discussed elsewhere in the preamble, the numerical limits are intended to protect individuals, plants, and animals from "reasonably anticipated adverse effects of each pollutant". In some cases, the value for a parameter is based on a worst or a near-worst combination of values (e.g., the toxicity values for plants and animals). In other cases, the value is an average or median value (e.g., the assumed background level of metals in the soil). Stringing together a long series of worst-case parameters and assumptions is not appropriate because there is no reasonable expectation that all worst-case conditions would occur simultaneously in any real situation. It is likewise inappropriate to use only average values since a significant portion of real situations are likely to be worse. Although EPA believes that the proposed models build in an appropriate degree of protection, the Agency is particularly interested in receiving comments on the parameter values used for land application and D&M, especially the plant and animal toxicity values. These values have not been peer reviewed for use in the model. In addition, the Agency is soliciting comments on its assumptions about the rate at which crops absorb a pollutant, soil pH, and background metal concentration.

Soil Incorporation

The Agency assumed that the sludge is incorporated into the top 15 centimeters of the soil. For pathways involving plant absorption of a pollutant, the actual depth of soil incorporation should make relatively little difference, since the mean concentration in the root zone is likely to be more important than the distribution of the pollutant within the root zone. However, for pathways involving direct ingestion of soil, the assumed depth of incorporation has greater importance, as discussed later.

Background Metals In Soil

For metals, the Agency used an estimated nationwide median concentration for agricultural lands as the background level of metals in soil. In some cases, the background concentration of a metal is a significant fraction of the maximum allowable soil concentration.

The ability of plants to absorb metals in the soil was assumed to be the same as their ability to absorb metals in sewage sludge. If higher background concentrations of metals were assumed, those numerical limits based on plant toxicity would be more stringent for copper, zinc, and nickel. However, in some cases, the higher background concentrations of metals would exceed the allowable pollutant concentration in the soil. The Agency is soliciting additional data and information on the background concentration of metals associated with agricultural soils.

Behavior of Metals

For the terrestrial Pathways 1–9, the Agency assumed that once the metal is applied, it remains on the land indefinitely. No accounting is made for removal by (1) soil erosion, (2) leaching, (3) volatilization, or (4) absorption of the plant and removal of the harvested portion of the plant. The half-life of the upper 15 centimeters of soil is generally on the order of a century. Most metals are expected to leach out of the top 15 centimeters of soil more slowly than they erode from the site. However, the Agency has not evaluated whether this would also be true in the case of selenium and molybdenum. The Agency has not evaluated the losses of metals through volatilization or through crop harvesting. Thus, EPA is uncertain if its assumption that metals remain on the land would make a significant difference in the numerical limits included in today's proposal. The Agency is much more concerned, however, about the potential error in its assumption that the biological availability of metals does not change over time. While the Agency believes that bioavailability may decrease over time, the Agency did not consider its data adequate to determine the extent of such a decrease and, consequently, did not include this as a modeled factor.

Behavior of Organic Contaminants

For organic pollutants, the model calculates an annual pollutant loading rate (in kilograms per hectare, per year—kg/ha/yr). The allowable annual pollutant loading rate is the loading rate that just balances the decay rate of the pollutant (in kg/ha/yr) when the concentration of a pollutant in the soil reaches the allowable pollutant concentration in the soil for the pollutant. Once this balance is achieved, land application may be carried out indefinitely without exceeding the allowable pollutant concentration in the soil. Therefore, the decay rate coefficient for an organic pollutant is a key parameter in determining the allowable annual loading rate for that pollutant. The effect of decay is to reduce the overall amount of the pollutant in the soil. If a high decay rate is assumed, the allowable annual pollutant loading rate is higher than if a low decay rate is assumed. The time period over which sludge is applied to the land is usually not important to the allowable pollutant loading rate, particularly if sludge is applied for more than 10 to 15 years. However, when the Agency estimates a zero decay rate, as it did for DDT, the assumed time period (which varies by pathway) is important in severely limiting the allowable pollutant loading rate.

Uptake by Plants

In calculating the numerical limits, the Agency assumed that the pollutant concentration in crops is linearly related to the pollutant concentration in soil. There is some evidence that pollutant concentrations in crops may tend to level off with repeated sludge applications. EPA's theoretical framework for modeling plant uptake included equations for both linear and non-linear uptake. Although non-linear uptake is considered more realistic, EPA only used linear uptake factors because the Agency lacks sufficient data to generate nonlinear uptake curves. The Agency is soliciting data that could be used in determining the appropriate shape of plant uptake curves.

Ingestion of Soil by Animals

Ingestion of soil by animals is considered in Pathways 4 and 6, for land application. EPA assumed that a relatively large amount of soil would be ingested by grazing animals (around eight percent of the diet), although higher values have sometimes been reported. The Agency is uncertain if the value used is appropriate for long-term exposure and is, thus, seeking comment.

The Agency is also seeking comment on the assumed dilution of sludge witb 15 centimeters of soil when the sludge is applied to pastures. Since the sludge applied to pastures is not incorporated into the soil (as it is for row crops), our assumption relies on climatic conditions and biological factors to assure mixing to the 15-centimeter depth. When grazing, animals often pull up shallow roots with the foliage. If the sludge has not been mixed thoroughly with the soil, grazing animals may ingest greater concentrations of a pollutant than those assumed in the model. Consequently, the Agency is considering depths of less than 15 centimeters in the model for pastures and seeks public comment on the appropriate depth that the Agency should use in calculating pollutant limits.

Ingestion of Soil by Humans

Ingestion of soil by young children is evaluated in Pathway 2 for both land application and D&M. The Agency assumed the quantity of soil ingested by children to be 0.1 gram per day. The Agency considers this to be a good estimate of the mean value (Reference number 22). Because all studies of soil ingestion by children are short-term measurements, there is no way to estimate (long-term) time-average soil ingestion by a child either with PICA behavior or who inadvertently ingests soil. The observed variability between children overstates the true variability of long-term exposure.

While the use of an average soil ingestion rate, rather than the use of an ingestion rate associated with a PICA child (0.5–5.0 grams per day) might be construed as under-protective, other factors suggest that the Agency's analysis may be over-protective. First, the entire 0.1 gram of soil ingested per day was assumed to be composed of sludge-amended soil. In real situations, only a portion of the 0.1 gram per day is likely to be from sludge-amended soil. Second, it is unlikely that a child would ingest 0.1 gram of a sludge-soil mixture every day. Third, and possibly most important, the biological availability of sludge-soil-bound pollutants was assumed to be equal to that of the pollutants in food and drinking water. There is evidence that desorption from the soil particles is a very slow process, generally requiring more time than available to material that is traversing the alimentary canal. Such desorption would have to take place before the contaminant could cross the membranes into the blood stream.

The modeling assumes dilution of the sludge with 15 centimeters soil. EPA has not specifically evaluated the long-term ingestion of pure sludge because the Agency believes that the sludge and soil will be mixed together by natural weathering processes. Therefore, long-term ingestion of 0.1 gram of pure sludge per day is not a reasonable expectation.

Animal Uptake from Feed and Forage Crops

The Agency considered the uptake of pollutants by herbivorous animals from feed or forage (grown on sludge-amended soil) in Pathways 3 and 5 for land application only. The Agency assumed that the pollutant concentration in animal tissues is a linear function of the concentration in the feed, that the animals feed solely on crops or forage grown on sludge-amended soil, and that the bioavailability of the pollutant in the feed is the same as the pure pollutant. EPA is requesting comment on the appropriateness of the values used for the uptake of pollutants by herbivores.

Human Exposure from Diet

The quantity of each of eight food groups in the human diet assumed in the analysis is taken from the Pennington data base for the age and gender group with the highest daily consumption (Reference number 28). While the assumed diet contains an average mix of meat, fruits, legumes, grains, dairy products, etc., the consumption rates are higher than would be expected for a single individual over a lifetime.

Assumptions about diet composition affect pathways differently. A more herbivorous diet would produce greater adverse effects for Pathway 1 (exposure through plants), but less stringent effects in Pathways 3 and 4 (exposure through meat and animal products). A more carnivorous diet would produce the opposite effect.

For today's proposal, the Agency has used the Pennington data base rather than the Tolerance Assessment System (TAS) data base used in pesticide registration actions for calculating the percentage of different food groups in the average adult's diet. The data used to support today's proposal result in slightly more stringent numerical limits than would the TAS diet. The Agency is considering use of the TAS system data base in calculating the numerical limits in any re-evaluation of today's proposal and in future rulemakings.

More important than the diet composition, however, is the assumption about the percentage of diet from sludge-amended soil. Pathway 1F for land application and Pathway 1 of D&M involve home garden scenarios. They assume that nearly 60 percent of an individual's lifetime consumption of grains, potatoes, and vegetables is grown on sludge-amended soil. The Agency has some data to support the amount of potatoes and vegetables grown in home gardens, but has little data to support the amount of grain grown in home gardens. The Agency is requesting comment on the percentage of home grown food in an MEI's diet.

Land application Pathways 3 and 4 involve scenarios of farm households consuming, over a long period of time, 40 percent of their own meat and animal products raised on sludge-amended soil. The Agency is requesting comment on the appropriateness of this assumption.

Plant and Animal Toxicity

The toxicity of pollutants (particularly metals) to plants and animals, based on Pathways 5, 6, 7, 8, and 9, plays a key role in setting numerical limits. The derivation of the toxicity thresholds for these pathways are discussed in Part VIII of the preamble. Comments on these thresholds would be particularly valuable.

Exposure to Contaminant Vapors

Pathway 12 contains two pathways, ground water ingestion and vapor inhalation. The sum of exposures to the MEI from both routes is not permitted to exceed an exposure equivalent to a MCL, a RfD, or a risk-specific dose.

The vapor pathway assumes that the entire quantity of pollutant applied to the land is vaporized during the ensuing year. This assumption simplifies the analyses and avoids the need to predict the vaporization rate, a process likely to be controlled by the rate of pollutant diffusion through the soil. The Agency has no evidence to support the assumption that certain pollutants are vaporized within a year. Indeed, its suspects that the true rate would be significantly lower. The Agency is requesting comment on the assumed rate of vaporization, particularly for benzo(a)pyrene, bis(2-ethylhexyl)phthalate, and dimethylnitrosamine. The Agency is also soliciting comment on its decision not to evaluate the vaporization of benzene, lindane, toxaphene, and trichloroethylene.

Once vaporized, the downwind pollutant concentrations are predicted with a plume model. The MEI is assumed always to remain at the centerline of the plume. Parameter values for wind speed and atmospheric mixing are those for the worst combination of circumstances. Consequently, the Agency is uncertain if the construct of the model or the parameter values used in the model are appropriate for assessing long-term exposure.

Ground Water

The ground water model was operated to determine the cumulative load of each pollutant that could be applied to the land without causing the leachate to exceed the MCL (or allowable drinking water concentration) at the interface with the saturated zone or water table. As long as the metal's cumulative limit is not exceeded, the leachate at the ground water interface will not exceed the MCL, whether the entire load is applied at once or spread out over many years. Theoretically, the calculated cumulative limit for this pathway should be valid for a few decades (for the more soluble metals) and up to several centuries (for the less soluble metals). Beyond this time period, however, the cumulative limit could be exceeded without causing the leachate to exceed the MCL, if the pollutant were applied at extremely low rates.

The modeled scenario couples a permeable, sandy loam soil, low in natural organic matter, with a high water table that is one meter below the surface. The Agency is uncertain whether such a scenario is reasonable.

For both metals and organics, one of the key chemical parameters is the partition coefficient (the metal concentration in soil solids divided by the metal concentration in the liquid at equilibrium). The partition coefficients for the metals were rather low compared to other partition coefficients that have been used previously (Reference numbers 10 and 18). Despite these low partition coefficients, however, metal limits for this pathway do not restrict the land application of sludge.

For organics, the other key chemical parameter is the decay rate coefficient. The Agency estimated the decay coefficient for trichloroethylene to be zero. Although trichloroethylene is expected to decay, there is evidence that a major product would be stable vinyl chloride. Vinyl chloride has the same risk as trichloroethylene.

Monofills

EPA evaluated two exposure pathways for sludge monofills: (1) Pollutant infiltration to ground water and subsequent ingestion from drinking water, and (2) vaporization from the fill material and subsequent inhalation. The analysis considers the long-term exposure that an MEI would receive from drinking two liters of ground water per day and from inhaling 20 cubic meters of air per day at the property boundary of the monofill. The Agency calculated the combined water and air exposure to the MEI and compared the combined exposure to a MCL, RfD, or risk specific dose. As described below, the analytical framework for the ground water model has four components: (1) A calculation of contaminated leachate pulse duration, (2) a model of pollutant behavior and movement in the unsaturated zone, (3) an evaluation of metal solubility in ground water, and (4) a model of pollutant behavior and movement in the saturated zone.

The analysis begins with assumptions on the monofill size and fill thickness, the pollutant concentrations in the sludge, the pollutant concentrations in the leachate, and the net recharge (infiltration) rate. The duration of time, T (years), over which the fill releases a metal pollutant to unsaturated zone (leachate pulse duration) is then calculated from the following factors: the metal concentration in sludge, CS (milligrams per kilogram); the sludge solids content, SS (kilograms per liter); the fill thickness, D (meters); the assumed leachate concentration, CL (milligrams per liter); the ground-water recharge rate, R (meters per year); and the excess liquid in the original sludge volume, EL (liters per liter). The result is:

$$T = ((CS \times SS/CL)) - EL \times D/R$$

The EL term merely adjusts the recharge water budget for excess water in the sludge. For degradable organic pollutants, the above calculation is modified to account for the rate of decay within the fill, as described in the support documents (Reference numbers 58 and 66).

The above calculation of the leachate pulse duration assumes that CL remains constant over time until the sludge is completely depleted of the pollutant, thereby modeling the leachate pulse as a mathematical square wave. For any particular organic pollutant, the leachate concentration is determined by a solid/liquid partition coefficient and the concentration CS, in the sludge.

The leachate pulse is then used in the unsaturated zone model, CHAIN (Reference number 61). CHAIN assumes a steady rate of percolation through the unsaturated zone and calculates the concentrations in the leachate as affected by sorption to the underlying soil and decay (of organic pollutants). The effect of sorption is to retard the movement of the pollutant through the soil profile and to elongate and flatten out the leachate pulse, thereby reducing the peak concentration. For both metals and organics, sorption to soil is determined by a solid/liquid partition coefficient. The effect of decay is to reduce the overall amount of pollutant in the leachate. For organic compounds, decay includes the processes of hydrolysis and anaerobic biodegradation.

In evaluating exposure to the MEI, the depth to ground water is assumed to be zero over Class I ground water and one meter over Class II and Class III ground water. The definitions of Class I, Class II, and Class III ground water are explained in Part IX of the preamble. CHAIN is bypassed in assessing exposure to an MEI for monofills located over Class I ground water, but is used for assessing exposure to an MEI when a monofill is located over Class II or Class III ground water.

At the bottom of the unsaturated zone, the peak concentrations of metals in the leachate pulse, attenuated as calculated by CHAIN (where applicable), are then adjusted for solubility constraints, based on the calculations of MINTEQ (Reference number 13). The model does not actually operate the MINTEQ code, but rather incorporates the results of previous runs of MINTEQ at various conditions of pH and Eh. The MINTEQ solubility adjustments are applied only to the six metals (arsenic, cadmium, copper, lead, mercury, and nickel). At the low pH and high Eh used in the exposure assessment analysis, MINTEQ predicts that copper would be the only metal to precipitate in amounts that would reduce greatly the ground-water concentration.

The flux of pollutants entering the aquifer in the area beneath the monofill is then input (as a square wave at the peak concentration) to the saturated zone fate and transport model, AT123D (Reference number 65). This model calculates the behavior and movement of the contaminant plume, as affected by advection (ground water flow), diffusion and dispersion (mixing), sorption, decay, and distance from the sewage sludge unit to the property boundary of the monofill or 150 meters (whichever is less). For Class II and Class III ground water, the MCL must be met at the property boundary of the monofill or 150 meters, whichever is less. The effect of diffusion and dispersion is to spread the contaminant plume vertically and horizontally, thereby further reducing the peak concentration. AT123D is only operated for Class II and Class III aquifers. In Class I aquifers, the leachate must meet the MCL upon entry to the aquifer.

The components of the model (leachate pulse—CHAIN—MINTEQ—AT123D) are operated in an iterative trial and error mode to determine the sludge concentration that produces a peak concentration equal to the MCL at the point of compliance.

The Agency evaluated exposure to pollutant vapors even though de-watered municipal sludge is unlikely to contain significant quantities of highly volatile material. Most volatile pollutants would vaporize before sludge disposal, particularly during wastewater aeration or during sludge dewatering. The model used here (Reference number 67) has two components: (1) Calculation of the flux of volatile pollutants into the atmosphere, and (2) determination of the peak air concentration at the property boundary.

The model is formulated so that the vaporization flux depends on the initial concentration of a pollutant in the sludge and on the monofill's cover material. During the time the wastes are assumed to be uncovered, the rate of vaporization is controlled by the rate of diffusion into the air (as opposed to diffusion up through the sludge). The flux is thus formulated to depend primarily on the wind speed and Henry's Law constant (concentration of the pollutant in air divided by the concentration of the pollutant in water, at equilibrium).

During the time that the fill is temporarily or permanently covered, the rate of vaporization is formulated to depend on the rate of diffusion up through air-filled pores in the cover material. The rate thus depends primarily on the cover material's porosity and thickness and on the Henry's Law constant.

The mean flux from the monofill is determined by considering the areas of the monofill expected to be uncovered and temporarily or permanently covered at any time, as described in the "Technical Support Document for Landfills" (Reference number 58).

The concentration at the centerline of a plume downwind of the monofill depends on the size of the monofill, the distance to the point of compliance at the property boundary, the wind speed, and the degree of atmospheric mixing. The wind direction is assumed never to change, so that the MEI always remains in the centerline of the plume.

The predicted vapor exposure is combined with the predicted drinking water exposure and then compared to the exposure allowed by the MCL, RfD, or risk specific dose.

Technical Uncertainties and Issues in the Analysis of Monofills

There are a number of uncertainties and issues in modeling the exposure of an MEI to the pollutants in sewage sludge that is placed in a monofill. The modeling involved is relatively complicated, and the validity of some of the model's assumptions and parameter values is uncertain. For the two pathways that the Agency has modeled, Table IV–4 presents the most significant assumptions and parameters.

The Agency's SAB has questioned several aspects of the modeling framework and suggested it may result in unrealistic over-estimates of exposure and more stringent numerical limitations than necessary. The Agency is soliciting comment on the modeling framework and the parameter values used in the model.

TABLE IV–4.—KEY PARAMETERS AND ASSUMPTIONS FOR MONOFILLING

Pollutants of pathway	Greatest concern	Key parameters and assumptions for pollutants of concern
Ground water	As, Cd, Pb, Benzene, BEHP, TCE	Assume all pollutants are leachable. Assume metal's leachate concentration independent of sludge concentration. Partition coefficient. Organic pollutant's decay rate. Soil type. Depth to ground water. Assume square wave input to ground water. Ground water Eh, pH. Distance to fenceline. Drinking water MCL.
Vapor	Diethyl nitrosamine, BEHP	Assume vaporization controlled by atmospheric diffusion for unburied fill and by pore diffusion for buried fill. Assume vaporization unimpeded by sorption or decay. Henry's Law constant. Wind speed and atmospheric mixing. Assume wind direction unchanging. Allowable air concentration.

Pathways Considered

Four pathways of exposure to the MEI from monofilled pollutants were originally considered: (1) Drinking of ground water containing pollutants that leached from the monofill, (2) inhalation of vapors, (3) inhalation of particles suspended from the open face (unburied portion) of the fill, and (4) run-off to streams. After some preliminary analysis, the Agency found that the third and fourth pathways were unlikely to be important.

The SAB, however, suggested the movement of contaminated ground water into surface waters as a fifth pathway. While the Agency doubts that the risks from such a pathway would exceed those from drinking the ground water directly, it is considering some future evaluation of the pathway.

Leachate Strength Upon Exiting the Fill

The total dry weight concentration of any pollutant in sludge (in mg/kg) can be related to the concentration of the pollutant sorbed to sludge solids, the concentration of a pollutant dissolved in the sludge liquid, and the percent liquid contained in the whole sludge. As water percolates from the land surface into the sludge fill, the liquid in the sludge fill is displaced downward into the underlying soil as leachate. The new liquid percolating into the fill then reaches equilibrium with the sludge solids.

The Agency assumed here that all sludge pollutants will eventually be solubilized if they are not first degraded. All sorption is thus considered to be readily reversible. The Agency suspects, however, that the analysis may over-estimate the mobility of pollutants in sludge and thereby over-estimate the amount of exposure.

The leachate pulse leaving the fill is modeled as a square wave. Over time, the leachate flux (leaving the sludge and entering the soil) is assumed to maintain a constant value until the pollutant is depleted from the sludge, at which time the leachate flux would be zero. If the pollutant were reversibly sorbed to solids, it could be expected that, over time, the leachate concentration flux would gradually die off to zero. Nevertheless, based on numerical simulations, the Agency believes that a square wave flux and a gradually dying-off flux produce similar results once the leachate has traveled about one meter into the unsaturated zone.

In calculating numerical limits, the dissolved concentration in the sludge and in the leachate from the sludge is related to the sorbed concentration in the sludge by a chemical partition coefficient. The Agency was not always consistent in its modeling of sorption and it intends to re-evaluate the partition coefficients applied, particularly for metals. The Agency may have under-estimated the sorption of several metals to sludge and slightly over-estimated the sorption of source organics to sludge. A more complete discussion is provided in the "Technical Support Document For Landfills" (Reference number 58). The Class I ground water limits are most affected by the Agency's assumptions about sorption to solids.

Effect of Monofill Liners

The Agency did not explicitly intend for the analysis to account for the effect of liners in restricting the movement of pollutants out of the fill. The SAB recommended that the analysis consider liners, although the Agency believes that liners are generally not used in sewage sludge monofills. The Agency did not specifically act upon the SAB recommendation on liners. Nevetheless, the rule does allow for numerical limits to be calculated using site-specific values for soil type and recharge rate. The Agency is requesting comment on whether or not this is a satisfactory means of accounting for the effects of liners when calculating site-specific numerical limits.

Use of CHAIN

CHAIN assumes a steady rate of water percolating down through the unsaturated zone. This allows a relatively efficient iterative analytical solution. However, the assumption of steady flow tends to under-estimate the travel time (and thus the amount of decay) and to over-predict the pollutant concentration.

The SAB recommended the use of the unsteady flow model, PRZM, because of its better resolution of transient events. The Agency, however, is not sure whether better resolution of transient events (although important for short-term analyses) has much value in the analyses of long-term exposure used in this proposal, or whether the inaccuracy introduced by CHAIN (relative to PRZM) is significant compared to other uncertainties and inaccuracies in the models.

MINTEQ

The model does not actually operate the MINTEQ computer code, but rather incorporates the results from running the model at several pollutant concentrations for six different combinations of pH and Eh for arsenic, cadmium, copper, lead, mercury, and nickel. Other pollutants are not simulated by MINTEQ.

In the six combinations of pH and Eh considered, pH has the value of either 6 or 7, and Eh has the value of either −200, +150, or +500 millivolts. The national numerical limits are based on a pH of 6 and Eh of +500. For case-by-case applications of the model, the Agency is uncertain if the above ranges of pH and Eh cover the range of ground water conditions likely to be encountered.

Input to AT123D

The concentration at the bottom of the unsaturated zone (output from CHAIN), when plotted over time, has a Gaussian-like shape (i.e., a rounded central peak tapering off to long tails). For input to AT123D, this smooth curve is converted to a square wave, having a concentration equal to the CHAIN output peak concentration.

The duration of this square wave is formulated to be the duration from that point when the concentration output from CHAIN first reaches one percent of the peak concentration, through the period of elevated concentration, until the concentration drops back to one percent of the peak. The Agency checked this assumption and found that it injected some 2.5 times more contaminant into ground water than the amount reaching the bottom of the unsaturated zone. For non-degrading chemicals, this also means that 2.5 fold more chemical is input to ground water than was disposed of in the landfill.

The Agency believes that, to track the mass of pollutant, it may be more accurate for the duration of the square wave to be equal to the time between the moment when the Gaussian curve first attains 10 percent of the peak and the time when it drops back to 10 percent of the peak (when converting a Gaussian curve into a square wave having the peak concentration). The Agency may change this aspect of the model and is soliciting comment on appropriateness of this change.

Output From AT123D

Users of this model have sometimes found anomalous results. Rather than steadily decreasing with distance, the peak concentration predicted at various distances from a landfill may first increase and then decrease with distance. The Agency is uncertain of either the reason for this anomaly or its overall significance. The Agency is requesting comment on the source and significance of this problem.

Orientation of the Monofill With Respect to the Ground Water Flow

For case-by-case application of the model, the Agency intends to fix the orientation of the monofill as a square monofill at the edge of the aquifer, regardless of the actual site characteristics. If the monofill area were a highly elongated shape, the orientation of the fill with respect to the ground water flow would increase or decrease the ground water concentration. The Agency is soliciting comment on whether it should consider the actual orientation of the monofill in case-by-case determinations of pollutant limits.

Time-Variable Exposure

The predicted concentrations vary over time, whether at the bottom of the saturated zone (i.e., the compliance point for Class I ground water) or at the property boundary (or 150 meters from the sludge disposal unit—the compliance point for Class II and Class III ground water).

Since the peak concentration of a pollutant is not permitted to exceed the allowable concentration, the model calculates a concentration that will not exceed an MCL at any time. For carcinogens with no MCL, the numerical limits are calculated so that the peak concentration does not exceed the 70-year mean concentration corresponding to a risk specific dose. The degree to which the peak concentration exceeds the 70-year mean concentration depends on how rapidly the concentration varies through time, which, in turn, depends primarily on the chemical partition coefficient and the distance involved. Therefore, public comment is requested on whether the Agency should determine the numerical limits for carcinogens using the 70-year mean concentration rather than the peak concentration.

Vaporization Flux

The flux of a pollutant from the monofill into the air depends on the cover over the fill. For uncovered fill, the Agency assumed that the rate limiting process is the diffusion rate of a pollutant from the air-sluge interface into the bulk volume of the air. The Agency is uncertain that the rate limiting process has been correctly identified. The principles set forth in some of the Agency's technical guidance (Reference numbers 10 and 21) indicate that diffusion of a volatile pollutant from within the sludge out to the air-sludge interface should be expected to be the rate limiting process. If the rate limiting process were not correctly identified, the vaporization flux would be over-estimated. The Agency is requesting comment on the vaporization formulation and is particularly seeking alternative formulations for consideration.

For covered fill, the rate is formulated assuming that the rate limiting process is the movement of pollutant up through air-filled voids in the cover material. While the Agency believes that this is reasonable, the SAB has criticized the approach for not considering the retarding effects of sorption and degradation. The Agency is seeking comment and will consider any alternative formulations suggested.

The model does not keep a mass balance account of the total quantity of pollutant vaporized. The model is capable of vaporizing more pollutant than was originally placed in the monofill. In addition, the quantities leached to ground water include the quantities vaporized, thus resulting in some double counting of exposure. The Agency is considering modifying the model to correct these problems.

Atmospheric Plume Modeling

The atmospheric plume model calculates the peak concentration at the centerline of the plume. The MEI is assumed always to remain in the centerline of the plume. The Agency is requested comment on the appropriateness of this assumption and suggestions for other assumptions.

The wind speed (1 meter per second) and atmospheric stability parameters (as described in Reference number 66) are intended to represent the worst combination of conditions. While they may be appropriate for an event, the Agency is uncertain whether they are reasonable for representing long-term conditions. The Agency is soliciting recommendations for appropriate values for the long-term atmospheric conditions.

Model Validation

The Agency has applied modeling approaches that it generally believes are reasonable. The Agency cautions, however, that the ability of the models to accurately simulate actual field situations accurately has not been verified. As noted above, questions remain about the adequacy of some aspects of the model framework and the appropriateness of some of the parameter values. Thus, the Agency is soliciting comment on all aspects of the model used to calculate the numerical limits for the disposal of sludge in monofills.

Incineration

The Agency used a single exposure pathway, inhalation of the incinerator emissions, in analyzing exposure to the MEI. The Agency considers the disposal of incinerator ash to be adequately regulated under 40 CFR Parts 257, 258, and 261 through 68. The disposal of scrubber water is subject to National Pollutant Discharge Elimination System requirements. Generally scrubber water is recycled into the Publically Owned Treatment Work influent. One remaining pathway, exposure to emitted contaminants that may settle on land to water, will be evaluated in the future, as the Agency acquires more data and further develops evaluative models.

In developing today's proposal, the Agency evaluated the inhalation of sludge incinerator emissions of arsenic, cadmium, chromium, lead, nickel, and total hydrocarbons. Total hydrocarbons are used as a surrogate for all organic pollutants and will be discussed in Part IX of the preamble.

The Agency performed air quality modeling to determine the emission rates (mass per unit time) that can be allowed without imposing undue risks to an MEI in the vicinity of the incinerator. For total hydrocarbons, the allowable emission rate determined by modeling is the numerical limit. For metals, an allowable sludge concentration is derived from the allowable emission rate.

The Agency previously evaluated the inhalation of beryllium and mercury during development of National Emission Standards for Hazardous Air Pollutants (NESHAPs), which specify allowable emission rates. For this rule the Agency is taking the NESHAPs values to be the allowable emission rates of beryllium and mercury for sludge incinerators.

The analysis of the inhalation of incinerator emissions employs atmospheric dispersion modeling to relate emission rates to ground level exposure concentrations. As discussed below, the allowable emission rate is determined from (1) the allowable ambient air quality concentration at ground level (the risk specific concentration), (2) the stack height and other physical characteristics of the site, and (3) the meteorological conditions of the site. The allowable sludge quality is then determined by the above allowable emission rate, the rate of sludge incineration, and emission control efficiency.

The allowable ambient air concentration is set to correspond to a risk specific dose for carcinogenic metals (arsenic, cadmium, chromium, and nickel), assuming that the MEI inhales 20 cubic meters of air per day and that indoor and outdoor air concentrations are essentially equal. Lead is set at 25 percent of the National Ambient Air Quality Standard. The rationale for this value is discussed later in the preamble.

The allowable ambient air concentration for total hydrocarbons is based on (1) statistical relationships between the concentration of total hydrocarbons and the concentrations of specific organic pollutants emitted by the four sludge incinerators that were tested and (2) the assumed cancer potency of the specific organic pollutants, as discussed later in the preamble.

Three models are used in today's proposal for incineration: ISCLT, LONGZ, and COMPLEX I (Reference number 44). ISCLT is intended for urban or rural situations where the terrain elevations do not exceed the stack height. It takes account of the aerodynamic effect of building downwash, which is likely to be significant for many sludge incinerators with short stacks. The other two models do not evaluate building downwash, but are more appropriate in situations where terrain elevations exceed the stack height. Such terrain is termed complex terrain. LONGZ is intended for complex urban terrain, while COMPLEX I is intended for complex rural terrain.

All three models require data on the incinerator, the surrounding terrain, and the meteorology of the site where the incinerator is located. Incinerator data include stack height, stack exit diameter, gas flow, and gas temperature. Meteorological data include joint frequency distributions of wind direction, wind speed, and atmospheric stability. The location of the MEI is not specified beforehand, but is set at the location predicted by the model to have the highest long-term average concentration.

In assessing the exposure to the MEI, ISCLT was used because of its ability to simulate building downwash. Since the MEI location for facilities with significant downwash tends to be close to the incinerator, inability to simulate complex terrain accurately was not considered a serious shortcoming. Side-by-side comparisons of the three models indicated that ISCLT predicts higher concentrations than LONGZ or COMPLEX I, even in complex terrain.

Evaluation of the effect of model parameters on the results indicated that stack height was a key parameter. Consequently, the dispersion factor (maximum long-term exposure concentration per unit rate of emission) varies with stack height. To generate a regression relationship between dispersion factor and stack height, a number of facilities having various stack heights were modeled. Although the stack diameter and gas velocity also varied among these facilities, these parameters were not important and had little effect on the regression relationship. Other parameters were held constant and were applied to all facilities: wind characteristics of Atlanta, Georgia (which had the worst combination of parameters in any U.S. city examined); flat terrain; gas temperature (38 degrees Celsius); building height (5.5 meters); and building effective diameter (39.5 meters) (Reference number 27).

The metals emission control efficiencies assumed in assessing the exposure to the MEI correspond to the worst 10 percent of EPA's data on sewage sludge incinerators. These control efficiencies are as follows: arsenic, 96 percent; cadmium, 65 percent; chromium, 96 percent; lead, 67 percent; and nickel, 95 percent. Control efficiencies are not assumed for organic compounds. Instead, total unburned hydrocarbons are to be used to control organic emissions.

Technical Uncertainties And Issues In The Analysis Of Incineration. The risk analysis for incineration employs a commonly used air modeling approach, coupled with readily measurable input data. Nevertheless, there remain a few technical issues, which are described below.

Worst-Case Conditions. In determining the relationship between MEI exposure and stack height, the Agency used the meteorology of Atlanta, Georgia, the worst case of 18 sites evaluated. Emission control efficiencies for metals correspond to the worst 10 percent of EPA's data on sludge incinerators. Other less important parameters were based on the typical values.

The MEI is assumed to remain at the location of maximum concentration for 70 years. The emissions are assumed to be 100 percent respirable and absorbed by the MEI. Indoor air quality was assumed to be no better than outdoor air quality.

Deposition Of Particulate Pollutants. The current analysis assumes that all emissions remain airborne, thus maximizing their potential for inhalation by the MEI. The SAB, however, recommended that the analysis account for human and ecosystem exposure to incinerator emissions deposited on the ground.

EPA is developing a methodology to perform such an analysis, and will consider it for future application. The methodology involves predicting deposition onto soil and vegetation, further movement of settled pollutants through environmental media, bioaccumulation, human exposure, and ecological effects.

Short Term Variations. The methodology used in this proposal predicts long-term exposure for the average operating conditions at an incinerator. The SAB has suggested that the analysis also consider short-term fluctuations. The Agency considers it unlikely that potential short-term effects could be of greater concern than the potential chronic or long-term health effects considered here. However, if adequate data become available to support an analysis of short-term fluctuations, they will be evaluated.

The Agency continues to investigate the effect of regularly occurring start-up and shut-down events on the long-term average emission control efficiency. The Agency's initial investigations of this suggest that the effect may not be particularly important.

PART V: HUMAN HEALTH CRITERIA

Over the years, the Agency has proposed, and either promulgated or published as guidance, criteria to protect public health and the environment from the adverse effects of specific pollutants. Where such criteria are available, these criteria are used in the exposure assessment models to derive numerical limits. EPA is seeking public comment on the manner in which the Agency is proposing to use the criteria in today's proposal.

As previously explained, the human health criteria that were used in establishing numerical limits for monofills are the maximum contaminant levels (MCLs) for drinking water. Where MCLs have not yet been promulgated in final form, proposed MCLs have been used to establish health-based limits for ground-water contamination. When MCLs are revised, the new drinking water standards will be adopted for this purpose. In the incineration equation, EPA used the National Emissions Standards for Hazardous Air Pollutants for mercury and beryllium, and the National Ambient Air Quality Standards for lead. Water Quality Criteria were used in the appropriate pathways of exposure in the land application model.

Criteria for Non-carcinogens

Where the Agency has not published human health criteria for a non-carcinogenic pollutant, the Agency is proposing to use a reference dose (RfD) listed in the Agency's computerized Integrated Risk Information System (IRIS). Information on access to the data in IRIS is listed in Part XIII of the preamble.

An RfD is a threshold below which adverse human health effects are unlikely to occur. The RfD is directly analogous to a previously used EPA-term "acceptable daily intake" (ADI). The Agency prefers the term RfD rather than ADI to avoid the implication that doses below the threshold are always acceptable, while doses above the threshold are always unacceptable.

The RfDs listed in IRIS are based on an intra-Agency review of the latest scientific information used in the Agency's risk assessments. EPA derives the RfD threshold by evaluating toxicity data for humans (where available) or animals. If multiple studies with different animal species are available, the most sensitive species is often selected. From such data a "no observed adverse effect level" (NOAEL) is identified for the critical toxicological effect or end point. The NOAEL is the highest dose of a chemical at which there is not a statistically or biologically significant increase in frequency or severity of an adverse effect when individuals in an exposed group are compared to individuals in a control group. The RfD typically is set 100–1000 fold below a NOAEL, depending on the quality of the data available.

The Agency recognizes that the actual threshold value at which adverse human health effects may occur could be an order of magnitude higher or lower than the value listed in IRIS. While exposure above the RfD increases the probability of adverse effects, it does not produce a certainty of adverse effects. Similarly, while exposure at or below the RfD reduces the probability, it does not guarantee the absence of adverse effects. The procedure used to establish the RfD does not permit the Agency to estimate what fraction of the population would exhibit effects for exposure above, at, or below the RfD.

RfDs were used to derive an acceptable daily dietary intake (DDI) for the land application and distribution and marketing equations. To derive the acceptable DDI of a pollutant from food and animal products raised on sludge-amended soils, the Agency subtracted the background intake from the RfD. The background values were average values listed in the literature for toddlers and adults and include intake from drinking water, food other than food grown or raised on sludge-amended soils, air, and, in the case of lead, household dust. Because the Agency has not established an RfD for arsenic, the MCL for arsenic was used to derive an acceptable DDI.

Derivation of Lead Limitations for Land Application

EPA is concerned about the health implications of exposure to lead. It is the Agency's objective to minimize lead exposure, particularly for susceptible subpopulations. When sewage sludge is applied to agricultural land, individuals are exposed to lead from food or food products grown on sludge-amended soil.

In land application, the human health pathway is not the most stringent one for the control of lead. An ecological pathway is the most stringent one. Nonetheless, due to the paramount concern about the human health impacts of lead, the following discussion describes in detail how the Agency derived the lead limits based on human impacts. Not only will this promote public discussion and informed comment, it will also demonstrate how the Agency's methodology works for a given pollutant.

By 1990, EPA estimates that the average daily total intake of lead will be approximately 30 micrograms (μg) for children and adults in the United States. Although food is the source of 50 to 75 percent of the overall lead intake for the average adult and of 30 to 45 percent for the average child, only 0.02 percent of this food is grown on sludge-amended soil. Therefore, the portion of overall lead intake attributable to food from sludge amended soil is negligible (30 μg x. .75 x .002 = 0.0045 μg) even before Federal regulation of lead in sewage sludge. For comparison purposes, the proposed drinking water MCL if 5 μg/ per liter which allows an individual to intake 10 μg/per day (assuming an average individual drinks 2 liters of water per day). This level is 2,000 times higher then the average exposure from lead in sludge applied to agricultural land.

EPA believes the concentration of lead in sewage sludge applied to agricultural land should be limited. Despite its small contribution to daily lead intake, further reduction will promote EPA's policy of lowering blood lead levels. The Aggregate Risk Analysis estimates that at a baseline there are 920 women, children, and white men (the Aggregate Risk Analysis explains why only white men were tabulated) who would be at risk of adverse effects as a result of the application of sewage sludge to agricultural land with current concentrations of lead. The overwhelming majority of these are men with hypertension. The same analysis estimates there could be 38 cases of adverse health effects related to this sludge exposure (see Table VIII-1 in Part VIII of the preamble). These demonstrate the potential for reductions in human health impacts through control of lead levels in sewage sludge applied to agricultural land. The adverse health impacts could also increase if there is an increase in land application of sewage sludge consistent with EPA's Policy on Beneficial Reuse.

Consistent with the statutory directive that the Agency protect against "reasonably anticipated adverse effects" (see section 405(d)(3) of the CWA), EPA conducted, here as elsewhere, an analysis using a combination of reasonable worst-case assumptions to calculate the lead limit. This involved modeling how lead travels from sludge applied to land, through the food-chain, to a human endpoint.

The additive effect of this combination of reasonable worst-case parameters produces a lead limitation that is sufficiently protective of the most exposed individual (MEI) while also accounting for potential data inadequacies. These lead limitations will protect the general population by lowering the total exposure to lead from food grown on sludge-amended soils. However, the method does not drive the limits to levels necessary for protection in every conceivable worst possible circumstance.

The actual methodology involves a number of steps. Since EPA has not established an RfD for lead, it examined the health effects from lead that are generally correlated with blood lead levels to select the human endpoint most sensitive to lead exposure from sewage sludge. Lead exposure across a broad range of blood lead levels is associated with a continuum of pathophysiological effects, including interference with heme synthesis necessary for formation of red blood cells, anemia, kidney damage, impaired reproductive function, interference with vitamin D metabolism, impaired cognitive performance, delayed neurological and physical development in newborns and elevations in blood pressure among adults.

There are several options available for this sensitivity parameter. White middle-aged men (40–59), young children (0–2), and pregnant women (as exposure surrogates for the fetus) are all subpopulations especially sensitive to the toxic effects of lead. Relative to pregnant women, delays in early mental and physical development of fetuses and infants have been associated with maternal blood lead levels. Because the biokinetics of lead during pregnancy have not been well elucidated, the available data are inadequate to quantitatively predict fetal lead exposure under various exposure scenarios. In young children, lead impacts include impairment of mental and physical development, including loss of hearing and reduced attention span in school. For white, middle-aged men, several studies have found a small, but consistent, relationship between blood lead levels and blood pressure. The blood pressure increases may be associated with some increased risk for more serious cardiovascular disease events, such as strokes and heart attacks, especially if blood lead levels are chronically elevated (Reference number 45).

Although children absorb more lead from food, they are not maximally exposed to lead in sewage sludge. Children do not typically consume food grown on sludge-amended soils to the extent that adults do. Since adult males consume more food than women and children, they are more exposed to, and may be most affected by, changes in lead concentrations in sludge that is applied to agricultural lands. Therefore, for this parameter, EPA selected middle-aged men as the human endpoint most sensitive to lead effects.

Step two in the process is to select a blood lead level of concern. In recent rulemakings, the Agency has selected a level of 10 μg of lead per deciliter of blood as a level of concern for health effects which warrant avoidance in infants and children. Research on white males 40 to 59 years old (Reference number 30) found significant associations between blood lead levels and blood pressure after accounting for the other known factors previously associated with elevated blood pressure. This research showed that, with little change in the coefficient, the relationship also held when tested against every dietary and serological variable measured in NHANES II data, a data base on health and nutrition in the U.S. population (Reference number 30). There remains considerable uncertainty as to the location of a blood lead threshold, if any, for a blood pressure change and the mechanisms by which these changes occur. Therefore, the Agency has not yet determined an appropriate blood lead level to serve as a target for the protection of adult men from elevated blood pressure associated with exposure to lead. However, for purposes of this analysis only, EPA assessed the potential effects of this proposed regulation on adult men based on a blood lead level of 10 μg/dl. If the Agency determines that the level of concern is lower than 10 μg/dl, we will re-evaluate the impacts of this proposal and may choose a different limit on lead in sludge which better reflects the appropriate blood lead level of concern.

The third step in the process is to choose a baseline lead exposure level from all sources other than food grown on sludge-amended soils. The August 1988 Draft Report, "Review of the National Ambient Air Quality Standards for Lead: Exposure Analysis Methodology and Validation" (Reference number 82), included estimates of average lead exposure levels under various air lead concentrations. The report projected a 1990 baseline average blood lead level for white middle-aged men of 3.9 to 4.9 μg/dl. These levels result from exposure to all media including air, drinking water, food other than food grown or raised on sludge-amended soils, dust, and dirt.

It must be noted that these calculations are for an average exposed individual in a large population. Baseline exposure to lead results in blood lead levels that are lognormally distributed. To more completely characterize risk, we must examine blood lead distribution around the average baseline. Given a mean baseline lead in middle-aged men of 4.4 μg/dl and a geometric standard derivation of 1.37 (from NHANES II), approximately 10 percent of the population would be over 6.7 μg/dl and 1.0 percent would be over 9.2 μg/dl. Because of the Agency's concern for those individuals who are exposed to above average lead levels at the baseline (individuals most exposed to lead), EPA selected 8.0 μg/dl as the baseline blood lead exposure level. This corresponds approximately to the 95th-percentile of the distribution.

Step four is to determine the allowable daily intake of lead for sludge that is still protective of the blood lead level of concern. To derive the ADI, the Agency subtracted the baseline blood level exposure level (8 μg/dl) from the blood lead level of concern (10 μg/dl). The Agency then calculated what amount of lead intake from food grown on sludge-amended soils would translate into 2 μg/dl.

Not all of the lead in food that is eaten is absorbed by the body. A method to convert dietary lead intake to blood lead level is described in the Draft Exposure Report and is based on experimental studies, in which dietary supplements were administered to volunteers, and duplicate diet studies. Two studies are identified as most useful in estimated a dietary lead/blood lead relationship (see Reference numbers 83 and 84). For middle-aged men, the coefficient of increase of blood lead level and lead intake attributable to consumption of lead in food is 0.032. Dividing 0.032 into 2 yields of 62.5 μg of lead per day allowable intake due to consumption of lead in foods raised on sludge-amended soils. To be conservative, the Agency chose to limit the allowable intake of lead from sludge to 20 μg per day rather than 62.5 μg.

Step five requires the selection of an individual who is most exposed to sludge (MEI). Approximately 0.02 percent of national agricultural land is treated with sludge each year. With an assumption of complete national mixing of food, an average individual's diet of fruits, vegetables, and meat products contains no more than 0.02 percent of foods grown on sludge-amended lands. To be protective, we assume to MEI receives over 100 times more of his food supply from sludge-amended soils than the average individual. The model attributes 2.5 percent of the MEI's diet to food from sludge treated soils due to potentially high consumption from roadside stands.

Step six is to establish, for each step in the pathway of exposure through the environment, an allowable concentration of lead in the soil and in the plant. The concentrations are based on reasonable worst-case assumptions that speed the transport of lead through the environment and that magnify the bioaccumulative effects of lead in plants and animals. The approach and values used are detailed in Part IV of the preamble and in the "Technical Support Document: Land Application and Distribution and Marketing of Sewage Sludge" (Reference number 57).

Step seven is to establish a lead limitation that would not exceed the allowable DDI. In this case, the model calculated, for the human health pathway, a cumulative pollutant loading rate for lead of 176 kilograms per hectare (kg/ha). However, the model calculated a non-human health cumulative pollutant loading rate of 77 kg/ha. Therefore, the human health pathway was not the most stringent for this pollutant. Because the environmental or non-human health limitation is more stringent, the limit for lead will be even more protective of human health.

It is important to note the relationship between the proposed limitation and current requirements. Thirty-two States now limit the application of lead to soil. The rates range from 200 kilograms of lead per hectare to 2520 kilograms of lead per hectare. The median value is 530 kilograms of lead per hectare. Current EPA guidance suggests that lead should not be applied at a cumulative pollutant loading rate in excess of 500-2000 kg/ha. The proposed lead limit of 125 kg/ha will result in very significant reductions, more than 80 percent.

The Aggregate Risk Analysis projects the number of people exceeding blood thresholds would drop from 920 to 249 after regulation for a benefit of 671. Likewise, the lead cases due to land application would drop from 38 to 10.

Because of the reasonable worst-case conservative nature of this methodology, EPA believes the proposed regulation is very protective of human health impacts from lead. However, we invite comment on the methodology and our selection of parameters. The Agency is interested in whether the public believes EPA has been sufficiently protective or whether EPA should have been more conservative. For example, comment is sought on the advisability of selecting 15 μg per day instead of 20, as the allowable daily intake of lead from sludge, in Step 4. Conversely, the Agency also seeks to know if the public feels it has been too conservative (e.g., in Step 4, EPA could have used the 62.5 μg per day of lead produced by our analysis as the allowable daily intake.

As described above, this human pathway analysis is based on evaluating middle-aged men as the human endpoint most sensitive to lead exposure from sludge. The limitation derived from this methodology will not only protect that MEI but, of course, will also protect the general population and other sensitive subpopulations. Of the 920 people estimated at the baseline to be at risk of adverse health effects resulting from lead in sewage sludge applied to agricultural land, less than 30 are women or children. The proposed regulation will reduce that number to less than 10. Nonetheless, we invite comment on whether the proposed limitations are sufficiently protective for the specific subpopulations of children 0 to 2 and pregnant women.

As mentioned earlier, there is the potential for an increase in the application of sewage sludge to agricultural land. Such an increase could increase exposure to lead from sewage sludge. In fact, our impact analysis projects there will be a 10-percent decrease in agricultural land.

EPA is also interested in comments on the impact of these limitations on the beneficial reuse of sludge and on the potential inter-media transfer of lead risks. Some municipalities have suggested that our analysis understates the impact and will preclude land application of sludge in most cases. If this is the result, increased amounts of sludge will be incinerated. This could reduce a greater lead exposure and increased numbers of individuals adversely affected by land. On the other hand, reduction of lead in gasoline may have resulted in lower amounts of lead in sludge (at treatment plants with combined sewers). Therefore, tight limits on lead in sludge may not preclude or reduce land application or increase incineration of sewage sludge. EPA is particularly interested in data on these matters that commenters could provide.

Criteria For Carcinogens

As discussed in the "Final Guidelines for Carcinogen Risk Assessment" (51 FR 33992, September 24, 1986), the Agency classifies a pollutant's potential for exhibiting carcinogenic hazards by considering the weight of evidence indicating that a pollutant is a carcinogen. The classes of carcinogens are:

- Group A—human carcinogen based on sufficient epidemiological data;
- Group B1—probable human carcinogen based on sufficient animal data with suggestive human data;
- Group B2—probable human carcinogen based generally on sufficient animal data without suggestive human data;
- Group C—possible human carcinogen based on more limited animal data;
- Group D—not classifiable as a carcinogen due to insufficient data; and
- Group E—evidence of non-carcinogenicity.

Twenty-one of the pollutants for which the Agency is proposing standards have been classified as carcinogens. Table V-1 list the twenty-one pollutants with their associated weight of evidence designations.

TABLE V-1.—CARCINOGENS

Pollutant	Weight of evidence	Unit risk estimate $(Q_1^*)^{-1}$ (mg/kg/day)
Aldrin	C	30.4
Arsenic [1, 2]	A	15.0
Benzene	A	0.029
Benzo(a)pyrene	B-2	11.5
Beryllium [2]	B-1	2.6
Bis(2-3thylhexyl) phthalate	B-2	0.0091
Cadmium [2]	B-1	6.1
Chlordane	C	1.61
Chromium VI [2]	A	41.0
DDD/DDE/DDT	B-2	0.34
Dieldrin	C	30.4
Dimethylnitrosamine	B-2	25.9
Heptachlor	B-2	3.37
Hexachlorobenzene	B-2	1.67
Lindane	B-2	1.33
Nickel [2]	A	0.84
PCBs	B-2	7.7
Toxaphene	B-2	1.13
Trichloroethylene	B-2/C	0.011

[1] Arsenic is considered a skin carcinogen through ingestion of drinking water.
[2] These compounds are considered carcinogenic when inhalated.

For each pollutant classified as a carcinogen, the Agency quantitatively estimates, the upper-bound cancer potency (unit risk estimate Q_1^*) for the pollutant. A pollutant's potency is a measure of its ability to increase the risk of contracting cancer over a life time, expressed per unit of daily dose. For Group A pollutants, the cancer potency was based on epidemiological data. For all others, potency was estimated from animal test data. The Agency's upper-bound potency estimates are shown in Table V-1.

Estimates of cancer risks resulting from given levels of exposure are subject to great uncertainty. Extrapolation of carcinogenicity from animals to humans involves uncertainties due to differences in physiology and metabolism. Extrapolation from high doses generating a detectable cancer response to low doses corresponding to environmental contamination involves uncertainties in the shape assumed for the dose-response curve.

For the Table V-1 pollutants, the Agency has extrapolated the response at high doses to the predicted response at low doses assuming the linearized multi-stage model. Compared to other available extrapolation models, the Agency's model generally produces higher estimates of cancer potency and risk. The proposed numerical limits would be higher, possibly by one or two orders of magnitude, if a different extrapolation model had been used. The uncertainties are most pronounced for pollutants showing indications of cancer-promoting action but not cancer-initiating action. Such pollutants include DDT.

Of the available cancer dose-response models, none is recognized as producing the most accurate results. EPA does not believe that procedures yet exist for making "most likely" or "best" estimates of risk. Rather, the Agency believes that its procedures produce a plausible upper limit for risk. Such an estimate, however, does not necessarily give a realistic prediction of risk. The true risk may be as low as zero.

In determining the appropriate dose to use in the exposure assessment models for carcinogenic pollutants, EPA uses the quotient of an incremental risk and the potency value, Q_1^*. The incremental risk is defined as the probability of an individual contracting cancer following a lifetime of exposure to the maximum modeled long-term ambient concentration. Estimates of maximum individual lifetime cancer risk are usually expressed as the probability represented as a negative exponent of 10. For example, one additional cancer case in an exposed population of ten thousand is written as 1×10^{-4}, in an exposed population of one in one hundred thousand is written as 1×10^{-5}, and in an exposed population of one in one million is written as 1×10^{-6}.

The incremental risk cannot be construed as an absolute measure of the risk to the exposed population because of the uncertainties described above. Furthermore, a case does not indicate the severity of the outcome. An additional cancer case does not necessarily mean a terminal illness. Therefore, such estimates are best viewed as relative estimates of the likelihood of cancer.

The Agency usually evaluates risk targets ranging from 1×10^{-6} to 1×10^{-4} in making regulatory decisions. Risk levels of 1×10^{-6} to 1×10^{-4} are generally considered acceptable depending on (1) the pollutants involved, (2) the weight of evidence that the pollutants are human carcinogens, (3) the uncertainties in the analyses, (4) the certainty and severity of the risk posed by the pollutants or activities, (5) the reversibility of the health effects, (6) the number of people exposed to the pollutant, (7) the advantages of the activity, (8) the risks and advantages of any alternatives, and (9) the requirements of the statute under which the pollutants or activities are to be regulated. Risks of less than 1×10^{-6} (i.e., 1×10^{-7}) are very small and these lower estimates increase in uncertainty. Because of the uncertainties of the models and analyses, EPA may build in margins of safety through either the parameters it uses in the models or the risk target it selects as a basis for its regulatory decisions.

PART VI: ENVIRONMENTAL CRITERIA

Section 405(d) of the Clean Water Act (CWA) requires standards that protect human health and the environment. To ensure that the numerical limits protect not only human health, but also the environment, the Agency examined the pathways through which plants and animals would be exposed to a pollutant when sewage sludge is applied to agricultural and non-agricultural land or distributed and marketed. The Water Quality Criteria published under authority of section 304(a)(1) of the CWA were used as the end point for determining a pollutant concentration that would generally ensure water quality adequate to support fresh water organisms. The guidelines that the Agency uses to develop criteria for aquatic organisms are published in 45 FR 79341, November 30, 1980.

Similar criteria have not been developed for the terrestrial target organisms. EPA could not follow the Water Quality Criteria guidelines in developing criteria for terrestrial organisms because studies have not been conducted on a sufficient variety of species for the Agency to follow the guidelines. Data are generally available for only domestic or commercially valuable spcies, not for wild plants and animals. Therefore, in selecting an environmental criterion for terrestrial organisms, the Agency used the threshold pollutant values, reported in the scientific literature, that were identified with reductions in growth, reproductive health, lifespan, and other symptomatic manifestations of toxicity. The species most sensitive to a pollutant were selected. Where sufficient data were available, the Agency set the allowable exposure at the geometric mean of (1) the lowest observed level of exposure that causes an adverse effect in a species (LOAEL) and (2) the highest observed level that did not cause an adverse effect in that species (NOAEL). Where it was not possible to bracket the LOAEL and NOAEL, the maximum safe dose for a species was used instead.

The Agency identified pollutant concentrations that would not exceed a value toxic to herbivorous animals exposed to pollutants by ingesting the sludge when grazing or by eating feed crops grown on sludge-amended soils. Toxicity values for cattle or sheep were used as the basis of the numerical value for the grazing animal. Toxicity values for swine, cattle, sheep, or chickens, depending on the pollutant, were used for animals eating feed crops. These values were in turn inserted into the model to develop a numerical limit for the particular pathway of exposure to ensure that grazing and non-grazing herbivorous animals would be protected.

To protect soil biota, the Agency used toxicity thresholds for earthworms and grubs, although earthworms are generally the most sensitive species and the species for which the most data are available. However, data were evaluated for a broad range of soil biota, including microorganisms and small invertebrates living in or on the soil.

In selecting a toxic threshold for insectivorous mammals or birds consuming soil biota as a large portion of their diet, EPA used the predator of the soil biota having the highest bioconcentration factor for a particular pollutant to develop the lowest dietary concentration causing an adverse effect on a predator. Generally the most sensitive species were birds, although data for insectivorous mammals, such as moles, were also evaluated. The Agency is making the assumption that by using the highest available pollutant uptake slope in soil biota and the lowest available dietary threshold in domestic birds, the numerical limits will protect untested wild species as well.

In developing the threshold values for phytotoxicity, the Agency attempted to use the highest quality data available. Over the years, research on sludge used in the production of agricultural commodities demonstrated a hierarchy in data quality to predict field or "real world" conditions of pollutant uptake in plants and phytotoxicity. Generally, experiments conducted in fields using sewage sludge that already contains the heavy metals for study produce the most relevant data. Next in the hierarchy are experiments in which plants are grown in pots using sludge that already contain the heavy metals for study. A third level of data are derived from experiments in which salt solutions of the metals that are being studied are spiked into sludge which is then used to grow plants in pots. Response curves for plant uptake from such studies result in concentrations of trace elements and impacts on plant growth that are much higher and more severe than the use of data from the more representative field study.

The Agency selected data from the first category, if available. If data in this category were not available, data from the second category were selected. Only if data in the first two categories were not available, did the Agency select sludge-salt data. The proposed numerical limits for nickel and zinc are based on the phytotoxicity pathway and are derived from sludge-salt data. The Agency invites comment on the use of sludge-salt data when sludge field data are not available.

In developing threshold values for phytotoxicity, the Agency derived the values on the basis of the geometric mean of the LOAEL and the NOAEL in the species most sensitive to a pollutant. Depending on the pollutant, the most sensitive species were generally leafy green vegetables, root crops, or legumes. The studies from which data were taken were generally those in which the soil pH was 6 or greater because this is the usual condition that maximizes crop productivity.

The numerical limits included in today's proposal are based on the most limiting pathway of exposure. The phytotoxicity pathway was the limiting pathway for chromium, copper, nickel, and zinc for both land application (agriculture) and distribution and marketing. Toxicity to predators (ducks) eating soil biota (worms) was the limiting pathway for lead in both land application (agriculture) and distribution and marketing. Toxicity to farm animals eating harvested feed grown on sludge-amended soils was the limiting pathway for molybdenum and selenium. For all other pollutants in land application (agriculture) and distribution and marketing, the limiting pathways of exposure were those affecting humans.

The "Technical Support Document for Land Application of Sewage Sludge" (Reference number 57) lists the values selected and the rationale used in selecting those values. The Agency invites the public to review the values listed in the Technical Support Document and to recommend other values where appropriate. The Agency is particularly interested in receiving data and information on toxicity values for wild plants and animals to supplement the data on which the environmental criteria were established.

PART VII: AGGREGATE EFFECTS ASSESSMENT

Introduction

EPA assessed the nationwide incidences of disease that could be identified and attributed to the use or disposal of sewage sludge. These aggregate effects were used in evaluating the overall risk of current practices and the benefits of four regulatory alternatives discussed in Part VIII of the preamble.

In assessing the adverse human health effects of exposure to sewage sludge-borne pollutants, the Agency developed estimates of the following: (1) Maximum upper-bound individual carcinogenic risk posed by a practice; (2) incidence (i.e., cases per year) of cancer; and (3) number of people exposed to concentrations of non-carcinogenic pollutants that exceed the reference dose (RfD) or other Agency established health effects-based threshold levels. The Agency also employed an innovative methodology to calculate the potential number of people exposed to lead and cadmium above the health-based thresholds.

Estimated aggregate human health effects are provided for sewage sludge that is applied to agricultural lands, applied to non-agricultural lands, distributed and marketed, placed in monofills, and incinerated. The Agency used the same exposure methodologies in estimating the aggregate effects on the population as a whole that it used in assessing exposure the most exposed individual, plant, or animal (MEI).

To estimate the aggregate effects of sewage sludge use or disposal, the Agency applied the exposure assessment models somewhat differently from the way they were used to assess exposure to the MEI. In assessing exposure to the MEI, the Agency used a reasonable combination of worst-case exposure assumptions with upper-bound toxicity estimates. In the aggregate assessment, the Agency evaluated a range of parameters and often focused on average or typical assumptions for the exposure models. However, because the Agency used upper-bound estimates of carcinogenicity, the resulting aggregate cancer cases are upper-bound estimates.

Sewage Sludge Quality

To estimate human health impacts from sewage sludge use or disposal practices, data are needed on the distribution of pollutant concentrations in sludge among all publicly owned treatment works (POTWs). However, since there are, at present, no data on sludge quality for individual POTWs, the Agency relied on data from EPA's "40 City Study". The Agency developed three separate sludge quantities (50th-, 90th-, and 98th-percentile concentrations) using a logarithmic regression procedure based on the assumption that the POTW pollutant means are lognormally distributed across POTWs. This procedure is based on fitting a regression line to the data that expresses the relationship between the logarithms of the plant means and the percentile of distribution. The estimated sludge concentrations were assigned to the actual inventory of POTWs according to the relative contribution of the industrial component of the wastewater flow, as reported by the POTW.

The uncertainties in sludge quality for organic pollutants affect the predicted human health effects. Because the Agency's analysis of the human health effects of organic pollutants relied on the "40 City Study" data, the analysis may underestimate the effects. With improved sampling and analysis protocols, the Agency may observe increased levels of the organic pollutants for which numerical limits are proposed, as well as additional organic pollutants in sewage sludge, thereby increasing the estimates of potential human health effects.

As previously explained, the Agency is gathering additional data on the concentration of organic pollutants in sewage sludge as part of the National Sewage Sludge Survey. When the data from this survey become available, EPA will re-evaluate the aggregate effects of organic pollutants. The Agency will publish the results of the survey in the "**Federal Register**" and will invite the public to comment on the data and analyses.

Cancer Cases

Aggregate cancer cases are derived assuming a linear non-threshold relationship between dose and risk. Annual cancer incidence attributed to a pollutant of a given carcinogenic potency is directly related to two factors. These are the size of the population considered and the average exposure within the affected population. The predicted incidence of cancer is an upper-bound prediction of the number of new cancer cases per year in the U.S. population that are attributable to sludge use and disposal. The actual incidence may be substantially less than predicted here and, in fact, may be zero. The incidence estimates are not, and should not be construed as, a predicted death rate.

Non-Cancer Health Effects

Aggregate non-cancer risks are expressed in terms of the number of people who are chronically exposed to a concentration of a pollutant that exceeds a fixed reference value. Exceeding the RfD implies a risk of an adverse health effect, but does not predict the occurrence of such an effect. For land application, distribution and marketing, monofilling, and incineration, the Agency compared the predicted time-averaged exposure to an RfD or other health effect-based threshold value.

The number of people exposed to a given reference value depends not only on the population size and mean exposure, but also on the variability of chronic exposure within the population (coefficient of variation). For pollutants other than lead and cadmium, the exposure predicted from sludge use or disposal was simply added to a mean or typical background exposure and then compared to the RfD. The variability (i.e., coefficient of variation) of background exposure and human response within the population was not considered because it could not be estimated reliably. As previously discussed, exposure to concentrations that exceed an RfD implies increased risk but does not imply that an adverse health effect will occur. Because the Agency does not have the data to use a dose-response curve in generating RfD thresholds other than for lead, it cannot predict the incidence of a specific noncancer health effect. The Agency expects the incidence of such health effects to be less than the number of people who exceed an RfD threshold.

Cadmium And Lead Predicted Exposures

The Agency used a different approach for predicting adverse health effects from cadmium and lead from that used for other non-cancerous pollutants. For these two pollutants, sufficient data are available to support improved methods. Estimating health effects from cadmium or lead involves predicting the concentration of the pollutants in body tissue of exposed individuals. In turn, this "body burden" is affected by levels of environmental exposure. For cadmium, body burden is measured as the concentration (micrograms) of cadmium accumulated in a gram of kidney tissue ($\mu g/g$). For lead, it is measured as the concentration (micrograms) of lead in a deciliter of blood ($\mu g/dl$). For both metals, data are available to describe background levels of tissue concentrations in the U.S. population, to link levels of environmental exposure to expected increments in these tissue concentrations, and to link tissue concentrations to possible or expected health consequences. Separate health effects and background blood lead distribution data (population means and coefficients of variation) are available for men, women, and children. Adverse fetal effects from lead have been detected statistically for women with blood lead as low as 10 $\mu g/dl$. Neurological and developmental effects have been detected in children with blood lead between 10 and 15 μg/dl. For white men of age 40–59, blood level increases (even for levels as low as 7 μg/dl) have been found to be associated with increased blood pressure. Therefore, "threshold" values of 7, 10, and 10 to 15 μg/dl were selected to represent blood lead levels above which adverse effects might be anticipated for men, women, and children, respectively.

Similarly, data are available describing cadmium concentrations (population means and coefficients of variation) in kidneys separately for smokers and non-smokers in the U.S. Adverse health effects from cadmium have been observed in adults with kidney cadmium levels exceeding 200 μg/g. Therefore, a "threshold" value of 200 μg/g was used in estimating potential health effects from cadmium.

From these data, the Agency calculated the number of people with cadmium and lead levels exceeding the threshold values because of background exposures from sources other than sewage sludge. The Agency then predicted the incremental increase in the levels of cadmium and lead in the kidney or blood that could be attributed to sewage sludge use and disposal practices. The number of people exceeding the thresholds was again calculated as a function of the predicted population mean, assuming the same coefficient of variation. This latter calculation includes both the number of people who originally had levels of lead or cadmium exceeding the thresholds and the number of people whose blood or kidney levels would exceed the thresholds as a result of sludge use or disposal.

To determine the number of people who exceeded the thresholds for cadmium and lead because of sewage sludge use and disposal, the Agency subtracted the original number of people whose levels actually exceeded the thresholds from the number of people whose blood levels were predicted to exceed the thresholds after sewage sludge use and disposal. The key parameters in this analysis are background mean tissue concentrations, coefficients of variation, incremental increase in body burdens of cadmium and lead caused by sewage sludge use and disposal practices, and the cadmium or lead levels that may cause a health effect.

The "threshold" approaches described above were used to predict the number of exposed individuals potentially vulnerable to adverse health effects from sludge-related exposure to cadmium or lead. Not all of the individuals with cadmium or lead levels above the selected thresholds, however, would be expected to experience actual health impacts.

In assessing health risks from lead, the Agency used additional techniques to estimate the number of individuals likely to suffer the effects under consideration. For example, the relationship between mean blood lead level in the white male population and expected blood pressure increases (diastolic pressure greater than 90 mm Hg) in that same population was determined using results from semi-log regressions of diastolic blood pressure versus blood lead and from a logistic regression of high blood pressure versus blood lead. As expected, the number of individuals whose blood pressure actually increases as a result of lead exposure from sludge is smaller than the number of individuals whose blood lead levels exceed 7 μg/dl as a result of sewage sludge use and disposal. Similar methods were used to estimate other health effects from lead exposure and the results were used to supplement those from the "threshold" approaches.

Other Risks

The aggregate effects analysis does not address exposure from pathogenic organisms or from pathways that were not examined in the exposure assessment models (e.g., the effects of ingesting plants on which incinerator emissions have fallen). As discussed earlier in the preamble, the Agency is developing exposure assessment models for pathogens and for indirect pathways of exposure from sewage sludge incinerators. When these models are complete, EPA will expand its aggregate assessment analysis to evaluate the effects of these other risks.

The assessment does not quantify ecological effects or farm economic losses caused by plant or animal toxicity, even though some numerical limits in today's proposal are based on plant and animal toxicity values. Methodologies and data are not yet available to accurately estimate the ecological impacts from the use and disposal of sewage sludge.

The remaining portion of this discussion briefly describes the factors that are considered and the key assumptions that are made in the aggregate effects (i.e., incidence) analysis for each end use and disposal method. Generally, only a few pollutants contribute to the total adverse human health effects predicted for each method. These pollutants are identified and the incidence of human health effects from current use and disposal methods are projected.

Agricultural Land Application

Available data indicate that approximately 16 percent (i.e., 1.2 million dry metric tons) of all sludge is applied to agricultural and non-agricultural land. The Agency estimates that about three-fourths of this is used on agricultural land, with substantially more being used on pastures and feed crops than on crops intended for human consumption. Based on Agency estimates, there are 2,623 POTWs that apply sewage sludge, or distribute sewage sludge for application, to the land. Of these, 2,020 apply sewage sludge, or distribute sewage sludge for application, to agricultural lands.

In estimating the aggregate effects from the consumption of food grown on sludge-amended soil, the Agency evaluated the following pathways:

- Sludge-Soil-Plant-Human
- Sludge-Soil-Plant-Animal-Human
- Sludge-Soil-Animal (direct ingestion)-Human
- Sludge-Soil-Surface Water-Human
- Sludge-Soil-Ground Water-Human

In projecting the aggregate human health effects from applying sewage sludge to agricultural lands, risks associated with pathways of exposure involving air were not examined because the exposure assessment models did not show that these pathways would be significant sources of exposure.

The Agency has no data on how harvested crops and food products from different areas of the country are mixed into the national market place and distributed throughout the United States. Consequently, the Agency assumed complete national mixing of food products grown on sludge-amended soil, thus equally exposing the entire U.S. population. The complete mixing assumption has no effect on predicted cancer incidence because cancer incidence is determined by the average dose within the population. The complete mixing assumption tends to underestimate the number of persons who may exceed non-cancer RfDs because an average dose across the population is much less than an RfD. However, where a few individuals are exposed to a larger than average dose, this larger dose may be sufficient to cause an increase in the body burden to a level that exceeds the RfD, depending on the existing body burden of the individual.

Assuming that sludge is spread on land or ordinary productivity at a rate of 11 metric tons per year, the Agency estimates that, overall, 0.02 percent assumed for the average U.S.

consumer's diet is food grown on sludge-amended soils, which is substantially less than the 2.5 percent assumed for the MEI's diet.

Another difference between the aggregate analyses and exposure assessment analyses is that the Agency assumed a national average diet using the Tolerance Assessment System (TAS) in the aggregate analyses. As discussed earlier, the Agency is considering the use of the TAS diet for the exposure assessment model.

For the two exposure pathways involving plant uptake of pollutants from soil, the coefficients used to estimate the pollutant concentration in various types of crops per unit concentration in soil represent a key set of parameters. For the exposure pathways involving animal uptake from plants and directly from soil, the coefficients used to estimate the pollutant concentration in various animal products per unit concentration in the feed or soil are key parameters. In both cases, the Agency used the same values in the aggregate assessment that were used in the exposure assessment models. However the coefficients, particularly for metals, may overestimate the effect because the total metal in the soil was used, rather than the soluble or bioavailable fraction (i.e., portion of the metal that is absorbed by the plant).

One important limitation of the assessment of exposure through food is that projected effects are estimated only for sewage sludge applied in a single year. Multi-year applications were not evaluated. Thus, the effects would be underestimated for pollutants that remain in the soil for long periods of time without decomposing, especially the heavy metals.

Aggregate exposure through surface water contamination was estimated by applying the pollutant runoff modeling approach used in the MEI exposure assessment models. To obtain the aggregate pollutant runoff, the runoff per hectare predicted for typical sludge application was multiplied by the number of estimated sludge-amended hectares in each State. This aggregate runoff was assumed to be diluted into the estimated total surface water flow for each State. Aggregate human exposure was estimated assuming 2 liters per day intake by surface water users and 10.6 grams per day intake of fish from State waters. The degree of averaging used in this approach has no effect on the predicted cancer incidence, but does tend to reduce the predicted maximum risks and the predicted incidence of exceeding an RfD.

Aggregate exposure through ground-water contamination was estimated by applying the previously discussed CHAINMINTEQ-AT123D approach. The area affected by each site was taken to be a 90 degree wide slice radiating 3 kilometers outward from the sludge-amended site. The ground-water concentration within this entire area was taken to be the maximum concentration predicted (over time) to occur at the centerline of the plume at a distance of 1.5 kilometers from the site. The population within this area was estimated assuming an average density of 0.13 ground water users per hectare (119 million ground water users distributed over the area of the United States).

Using the methods described above, the Agency projected that application of sludge to agricultural lands could result in maximum individual carcinogenic risks, summed across the 25 pollutants regulated under this practice, of 9×10^{-5} and in an upper-bound cancer incidence of less than one case per year (0.17). The Agency projects that 921 people would exceed an RfD, and that all but one case is due to lead. The number of adverse lead effect cases resulting from this exposure is estimated to be 38.

Non-Agricultural Land Application

The Agency estimates that 276,000 dry tons of all sludge is applied to the land in non-agricultural uses. Such land may be set aside for disposal, forest, or devastated land undergoing reclamation.

The Agency estimated aggregate effects from human exposure to the pollutants through the following pathways:

- Sludge-Soil-Surface water-Human
- Sludge-Soil-Ground water-Human

For both pathways the Agency used the same approach as described for agricultural land application. By this means, the Agency estimated that application of sludge to non-agricultural land could result in maximum individual cancer risks, summed across the 25 pollutants regulated in this practice, of 2×10^{-8} and an upper-bound cancer incidence of less than one case per year (0.1). The Agency projects that 60 people will exceed a RfD because of lead. The number of cases resulting in adverse effects from this exposure is expected to be 3.5.

Distribution and Marketing

The Agency estimates that about nine percent (i.e., 705,000 dry metric tons) of all sludge generated is distributed or marketed by approximately 106 facilities. About 25 percent of this is used in residential settings—half was assumed to be applied to home vegetable gardens and half to ornamental shurbs, flowers, and lawns.

The Agency estimated aggregate risks from human exposure to the pollutants through the following pathways:

- Sludge-Soil-Plant-Human (home gardening)
- Sludge-Soil-Human (children ingesting sludge-amended soil)

For home gardens, the Agency assumed an application rate of 11 metric tons per hectare. The exposed population was estimated to be 2.7 million individuals who garden and consume their own produce. For this exposed population, the following percentages of diet were assumed to consist of food grown on the sludge-amended soil: 27.0 percent of root and leafy vegetables, non-dried legumes, garden fruits, and corn; 15.0 percent of potatoes; and 7.0 percent of dried legumes. The soil-to-plant coefficients used in the aggregate assessment were identical to those used in the exposure assessment models for a home gardener. In evaluating children's sludge ingestion, the Agency assumed that a home gardener would mix the sludge into the soil to a depth of 15 centimeters. Children were assumed to ingest a sludge-soil mixture at a rate of 0.1 grams per day over a 5-year period.

Using the above methodology, the Agency projected that exposure through food grown in home gardens amended with sewage sludge products could result in maximum individual carcinogenic risks, summed across the 22 pollutants regulated in this practice, of 9×10^{-5} and in virtually no cancer cases (0.02 cases per year). Again lead was the primary pollutant causing 1552 persons to exceed the RfD. Most of this exposure (1,546 out of 1,552) results from food and most directly affects white adult males (1,463 of the 1,546), increasing their risk of elevated blood pressure. The number of cases resulting from 1,552 persons exceeding the RfD for lead is 95.

Monofills

Data available to the Agency indicate that 49 POTWs dispose of a total of 101,000 dry metric tons of sludge per year in monofills (approximately two percent of all sludge generated). To predict potential effects from these monofills, the Agency used the same fate and transport model for the aggregate assessment that it used for MEI exposure. The computer model used for the ground-water pathway was SLUDGEMAN, which consists of an unsaturated zone model, CHAIN, the geochemical model, MINTEQ, and the saturated zone model, AT123D. The model for landfill vapor loss was based on a methodology adopted by EPA in 1987. It considers the landfill operating period with uncovered wastes, with shallow temperature cover, and with permanent cover.

The Agency did not model all 49 facilities because there were insufficient site-specific data. Rather, the Agency used a number of generic scenarios to account for the 49 facilities. The modeled scenarios included the following parameters: five POTW sizes (0 to 0.2 million gallons per day (mgd), 0.2 to 1.0 mgd, 1.0 to 10 mgd, 10 to 60 mgd, and 60 plus mgd), sludge pollutant concentrations that corresponded to the 50th-, 90th-, and 98th-percentiles from the "40 City Study" and nine hydrological and geological variables estimated (using the guidelines of the National Water Works Association, 1985, Reference number 25) to correspond to site-specific characteristics, where possible. Each facility was assigned to one of the modeled scenarios based on its size, percent industrial flow, and location.

The populations affected by each of the 49 facilities were estimated as follows. For the volatilization pathway, the Graphic Exposure Modelling System was used to obtain 1980 Census data and derive populations in 11 ring distances up to 10 kilometers from each landfill site. These populations were then scaled down to reflect only the downwind populations (i.e., those with potential for vapor exposure).

For the ground-water pathway, the Agency identified the locations of drinking water wells within 4 kilometers of each monofill and determined the number of persons serviced by those wells. For monofills in Utah and New Hampshire, the Federal Reporting Data System was used. For the remaining sites, State or regional authorities supplied the data. To account for the unidirectional flow of ground water, only those populations within the quadrant of directional ground-water flow were assumed to be at risk of exposure.

By this means, the Agency projected that exposure to the 18 pollutants evaluated for sludge disposal in monofills could result in a maximum individual carcinogenic risk, summed across all pollutants, of 3×10^{-3} and virtually no cancer cases (0.02 cases per year). The Agency projects that two people would exceed the RfD for cadmium and that 390 people would exceed the RfD for lead as a result of drinking water from wells in close proximity to monofills. The number of adverse lead effect cases from those with blood lead levels exceeding the RfD is estimated to be 26. The Agency believes that it may have applied the models in a manner that substantially over-estimates the mobility of some pollutants, particularly lead, out of monofills and into ground water, thereby over-estimating the risks. The Agency intends to re-evaluate its modeling assumptions.

Incineration

Approximately 21 percent (i.e., 1.65 million metric tons) of all sludge is estimated to be incinerated by 169 POTWs that operate 282 incinerators. Each POTW was assigned to one of 10 model incinerators. The model incinerators represent several characteristics of the facility (such as stack height and sludge feed rate). One facility in each of the 10 groups of incinerators was modeled to determine its air dispersion characteristics by using the computer model, ISCLT, and supplemented, where appropriate, by LONGZ and COMPLEX I to account for terrain effects in urban and rural settings, respectively (see Reference number 46). This produced predicted dispersion factors in 24 concentric rings from 0.1 to 50 kilometers for each of the 10 modeled incinerators. These dispersion factors indicate the exposure concentration per unit rate of emission.

Additionally, there are 25 POTWs, generating 0.4 million dry tons of sewage sludge, that are currently using ocean disposal. Because of recently enacted legislation banning all ocean disposal of sewage sludge, these POTWs will have to shift to alternative methods. Incineration appears to be one of the likeliest disposal methods to be chosen by these 25 POTWs. It is by no means certain that all these POTWs will choose to incinerate their sludge; however, the ocean ban legislation is so recent that many POTWs do not even have preliminary plans in place. For analytical purposes, therefore, it has been assumed that all 25 POTWs will incinerate their sludge. This scenario is considered as the baseline practice for these POTWs. As such, the risk of incinerating the sludge generated by the 25 POTWs have been included in the baseline risk of incineration.

The Agency projects that if the 25 POTWs incinerate their sewage sludge, the POTWs would operate an additional 34 incinerators. The 25 POTWs were also assigned to model facilities based on the most likely type of facility that they would construct.

Metal control efficiencies varied significantly across the tested facilities. For an "average," the Agency used the 25th-percentile control efficiency of the four tested facilities as the expected efficiency. For assessing the exposure to the MEI, the Agency used the 10th-percentile of all sewage sludge incinerator test data (see Reference number 56).

For organic constituents, EPA took a different approach. Rather than starting with a sludge concentration and emission control efficiency, the analysis for organics begins with an emission rate. EPA started with an emission rate for organics because some of the organic compounds in the emissions are formed during the sludge combustion process. These products of incomplete combustion may account for a majority of the constituents in the emissions of an incinerator and for the risk from incinerator emissions.

The Agency analyzed data from four sewage sludge incinerators (three multiple hearth incinerators and one fluidized bed incinerator) that were recently tested to derive organic emission rates. The mean organic emission rate from the three multiple hearth incinerators was used as the organic emission rate of all the multiple hearth and electric arc incinerators in the United States. The actual organic emission rate from the one fluidized bed incinerator tested was used as the organic emission rate of all the fluidized bed incinerators in the United States.

For each of the 316 incinerators, the Human Exposure Model was used to estimate the populations residing within the 0.1 to 50 km concentric rings. The population was assumed to be exposed to the maximum concentration in each ring when the incinerators are operating under normal conditions. Thus, each of the 316 incinerators was assigned an air dispersion factor derived from a similar facility and the population surrounding the facility. From these data, population exposure and risks could be estimated in each concentric ring around each facility. Total population exposure and the effects of exposure at each facility and at all facilities combined were then determined.

In this way, the Agency projected that exposure to seven metals and total hydrocarbon emissions from sewage sludge incinerators could result in a maximum individual carcinogenic risk, summed across all pollutants, of 5×10^{-2} and an upper-bound estimate of 12 cancer cases per year. The Agency projects that incineration of sewage sludge would cause 794 people to have blood levels exceeding the RfD for cadmium and 129,835 to have blood levels exceeding the RfD for lead. The projected number of people adversely affected from exposure to levels of lead above the RfD is 5,976.

Summary

Table VII–1 summarizes the results of the aggregate effects assessments conducted for sewage sludge that is applied to land, distributed or marketed, monofilled, and incinerated.

TABLE VII–1.—AGGREGATE HUMAN HEALTH EFFECTS FROM CURRENT SEWAGE SLUDGE USE AND DISPOSAL

	LA-AG	LA-NON-AG	D&M	Monofills	INC.	Totals
Facilities/sludge:						
Number of POTWs	2,020	603	106	49	194	[1] 2,972
Volume of sludge (100s dry metric tons)	926	276	705	101	1,651	[2] 4,083
Analysis:						
Pollutants	25	25	22	18	8	31
Environmental pathways examined	14	2	6	2	1	
Baseline Aggregate Effects:						
Cancer cases	0.17	0.01	0.02	0.02	12	12.3
Exceeding threshold:						
Lead	920	60	1,552	390	129,835	132,751
Cadmium	1	0	1	2	794	798
Lead cases	38	3.5	95	26	5,976	6,138.5
MEI risk	9×10^{-6}	2×10^{-6}	9×10^{-4}	9×10^{-3}	5×10^{-2}	

[1] Does not include the estimated 2400 POTWs that dispose of their sewage sludge on the surface of the land.
[2] Does not include the estimated 200 dry metric tons of sewage sludge that POTWs dispose of on the surface disposal sites.

PART VIII: ALTERNATIVE REGULATORY APPROACHES

Introduction

This part of the preamble discusses the alternatives that the Agency considered in developing today's proposal. EPA is soliciting public comments on these approaches and welcomes suggestions for other appropriate approaches that the Agency should consider in establishing standards for the use and disposal of sewage sludge.

Over the years, EPA has developed different regulatory approaches depending on the legal requirements of a particular statute, surrounding issues, uncertainties, and information bases. Other EPA statutes covering the same pollutants or activities have very different legal requirements from section 405(d) of the CWA. The following discussion examines how different statutes mandate the way in which EPA is to establish regulatory requirements.

The U.S. Court of Appeals in the *Vinyl Chloride Decision* (*Natural Resources Defense Council, Inc. v. EPA*, 824 F.2d 1146, D.C. Cir., 1987) ruled that under Section 112 of the CAA, the Agency must use a two-step process in making regulatory decisions for National Emission Standards for Hazardous Air Pollutants (NESHAPs). The court ruled that the first step is to define an acceptable risk based only on health factors and then to define a regulatory limit. In defining a regulatory limit, the Agency may consider cost, technological feasibility, and other relevant factors in providing an ample margin of safety, as long as the regulatory limit does not exceed the acceptable level of risk. As indicated in the Benzene Notice (53 FR 28496, July 28, 1988), depending on the policy approach selected by the Agency, EPA would set carcinogenic risk levels for NESHAPs between 1×10^{-6} and 1×10^{-4}.

Under the Safe Drinking Water Act (SDWA), the Agency first defines a goal to limit the concentration of the pollutant in drinking water (for carcinogens, the concentration goal is zero). After setting a goal, the Agency sets an enforceable standard (maximum contaminant level—MCL) based on feasibility. Under the SDWA, the enforceable standard may not necessarily achieve the goal set for the pollutant, but is established at a level that is safe for human health. The carcinogenic risk levels for drinking water MCLs generally range from 1×10^{-6} to 1×10^{-4}.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA) explicitly provide for balancing health and costs in decision making. The risk levels established under FIFRA range from 1×10^{-6} to 1×10^{-4}, depending on the type of exposure involved. Applicator exposure is generally in the range of 1×10^{-4} and dietary exposure is generally in the range of 1×10^{-6}. The regulatory limits under TSCA are driven by a balancing of economic analyses and exposure analyses, with the exposure analyses taking into consideration adverse health effects other than carcinogenicity.

Under the Resource Conservation and Recovery Act (RCRA), Subtitle D (non-hazardous wastes), the Agency sets standards to protect human health and the environment based on the reasonable probability that municipal solid waste landfills (MSWLFs) will cause adverse effects. The standards are established taking into consideration the "practical capability" of the facilities. The Agency is proposing that States establish ground-water protection standard remedies for carcinogens in the range of 1×10^{-7} to 1×10^{-4} (see 53 FR 33314, August 30, 1988).

However, under Subtitle C of RCRA (hazardous wastes), there is no provision for the consideration of costs or the practical capability of a facility to meet the standards. The standards developed by the Agency under RCRA Subtitle C are those that are necessary to protect human health and the environment. The Agency will soon propose standards that prohibit hazardous waste incinerator emissions for metals from exceeding a summed carcinogenic risk level of 1×10^{-5}.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) directs the Agency to set standards for cleanup by taking into consideration the relative degree of risk to human health and the environment. Under CERCLA, the Agency has set standards based on carcinogenic risk levels of 1×10^{-7} to 1×10^{-4}, with 1×10^{-6} as the point of departure for the analysis.

As shown, each statute is unique. Therefore, the regulatory approach and limits developed under one statute may not be appropriate for those developed under another statute. Before comparing regulatory requirements, the legal requirements of the authorizing statute must be examined.

In developing a regulatory approach, one of the principles guiding EPA was to propose reasonable standards. Section 405(d)(2)(D) of the CWA requires the Agency to establish management practices and numerical limits that are "adequate to protect public health and the environment from any reasonably anticipated adverse effects of each pollutant." The Agency examined the effect of long-term pollutant exposure when sewage sludge is used or disposed of under conditions that could: (1) Increase the toxicity and potency of a pollutant in the environment; (2) speed the movement of a pollutant into and through the environment; or (3) intensify the adverse effect the pollutant may have on human health or the environment.

This approach accounts for potential data inadequacies, but does not protect against every conceivable worst-case situation. For example, we assume that a monofill may be located in sandy soil rather than in heavy clay soil because pollutants move faster through sandy soils than through clay soils. We also assume that 2.5 percent of the diet of the most exposed individual (MEI) comes from food grown on sludge-amended soil. By comparison, an average individual's diet contains only 0.025 percent of food grown or raised on sludge-amended soil. In applying sewage sludge products to the home garden, we assume that the homeowner mixes the product into the soil or that climatic forces, particularly rain, filters the sludge product into the soil profile. This assumption means that in evaluating the effect of a child inadvertently ingesting dirt when playing in a garden, EPA analyzed the effect of a child eating a sludge-soil mixture rather than pure sludge. The Agency analyses also assumed that a child, from the ages of one through five, inadvertently ingests 0.1 gram per day of a sludge-soil mixture rather than the 0.5 to 5.0 grams per day for a child exhibiting PICA behavior.

EPA believes that the combination assumptions protects individuals from events that are likely to occur and meets the statutory provision to protect public health and the environment from "reasonably anticipated adverse effects of a pollutant". In taking such an approach, the Agency recognizes that some risks may not have been fully evaluated or may remain after regulation. Individuals who do not follow label instructions (e.g., prevent children, particularly those exhibiting PICA behavior, from mouthing sewage sludge), or those who illegally grow or take all of their food stuffs from land where the growing or taking of food is prohibited (e.g., forests where sludge has been applied), may receive higher doses of a pollutant than the level used in developing the numerical limits for the proposed rule. However, we expect that few, if any, individuals will receive higher doses of a pollutant than the doses used to establish the standards.

Alternative Approaches for Establishing Numerical Pollutant Limits

In developing a regulatory approach for establishing the management practices and numerical limits (standards) that would safeguard public health and the environment, the Agency examined the use or disposal methods and the probability that individuals would be exposed to pollutants from these methods. EPA identified the type of the risks involved, (e.g., breathing air with higher levels of pollutants, drinking water with pollutant levels exceeding the MCLs for drinking water, etc.) and also examined the possibility of special populations at greater risk (e.g., small children playing in gardens where sewage sludge products had been applied, the effect of lead on adult males). The Agency also examined whether individuals voluntarily incurred the risks. For example, risks associated with breathing more contaminated air by individuals living in close proximity to an incinerator are involuntarily-incurred and, therefore, more unacceptable than risks associated with using a properly labeled sewage sludge product in a garden. Finally, before developing alternative approaches, EPA used exposure assessment models to project the effect on an individual receiving a maximum dose throughout an average lifespan of 70 years. Aggregate effects analyses were used to project the incidence of adverse health effects from sewage sludge use or disposal on the population as a whole (i.e., the resulting number of cancer cases, carcinogenic risk, number of lead cases, and the number of people exposed to concentrations of non-carcinogenic pollutants above a reference dose—RfD).

In considering a regulatory approach, EPA primarily focused on two types of risks—risks to individuals receiving the maximum dose and risks to the population as a whole. Using the models and methodology discussed in Parts IV and VII of the preamble, EPA projected that the incremental individual carcinogenic risks from the five disposal practices range from 2×10^{-8} for land application to non-agricultural land to 5×10^{-2} for incineration (see Table VIII-1). The analyses show that, based on incremental carcinogenic risk, the five use or disposal methods employed by 5,367 facilities may contribute 12.3 cancer cases annually. However, the Agency could not project the type and severity of these cases. EPA also projected that out of 132,751 people whose blood lead levels exceeds the RfD, 6,138.5 would exhibit adverse lead effects, primarily due to elevated blood pressure in adult males. Most of this exposure is attributed to the incineration of sewage sludge. These analyses show that, depending on how sewage sludge is used or where sewage sludge is disposed of, individual exposure may be high, particularly in the case of lead.

The Agency developed four regulatory approaches for the use and disposal of sewage sludge. Each of the approaches places greater emphasis on reducing an individual's or other organism's exposure to a pollutant. However, the Agency examined both the individual and aggregate effect of each alternative to balance the uncertainties in the analyses. Because of the data available, greater emphasis was placed on the human health rather than the environmental effects. However, where environmental effects could be identified, even qualitatively, they were considered.

There are differences of opinion concerning the emphasis that should be placed on individual or aggregate risk. Some take the view that individual cancer risk is the most, or the only, important measure. Arguments that favor addressing individual risk maintain that no individual should be at high risk and that consideration of the number of people at risk leads to acceptance of higher individual risk when few people are exposed. Furthermore, the latter approach leads to the inequity of having the acceptable risk to an individual depend on the number of people similarly exposed. The limitation of using maximum individual risk alone is that the measure does not indicate how many people may be affected. It only relates the carcinogenic risk to the MEI.

Arguments in favor of examining the aggregate risk are that incidence is an appropriate measure of total public health impact. Therefore, incidence is a good indicator of whether an approach adequately protects public health.

For a rule, such as today's proposal, that covers both carcinogenic and non-carcinogenic pollutants, there is another disadvantage of using only an MEI or an aggregate analysis as a single measure of whether an approach adequately protects public health and the environment. As discussed earlier, methodologies and data do not yet exist, except for lead, to correlate differing levels of exposure to non-carcinogenic pollutants with incidences of an effect. The only measure is the number of people exposed to a level above a Rfd. This may have little meaning for individual risk. While any exposure to carcinogens is considered a case, the same assumption can not be made for non-carcinogens.

In addition, the Agency typically weighs the aggregate effects estimates along with maximum individual or average cancer risk estimates when evaluating a particular category of like risks (i.e., the number of individuals exposed to a particular pollutant from a particular type of facility). Some observers question the relevance of adding risks, in a rule such as today's proposal, when risks from different types of pollutants present different types of risks (i.e., inhalation, ingestion, etc.) from different types of sources (i.e., incineration, land application for agricultural purposes, etc.).

Table VIII-1 and the following discussion describe the factors considered in developing the standards for today's proposal. The first two approaches accept the aggregate effects of current sludge quality. Approach III is directed solely to protecting the MEI and Approach IV uses a combination of MEI exposure and aggregate effects of current sludge quality.

Although the combination of approaches in Option IV is the Agency's selection for purposes of the proposal, it is not the only possible combination. Commenters should review the proposal keeping in mind that there is flexibility to choose among the different regulatory strategies (the aggregate risk approach and the MEI risk approach) depending on such factors as evaluation of new information and the reassessment of incremental risk of sewage sludge use and disposal methods. For example, an alternative option might be to take an MEI risk approach for incineration and select an aggregate risk approach for all other use or disposal methods. The Agency specifically invites comment on this possible approach in addition to those discussed in more detail.

For the purpose of today's proposal, the aggregate risk approach is based on "existing sludge quality"—defined as the 98th percentile pollutant concentration shown in the "40 City Study." The 98th-percentile pollutant concentrations are calculated from a regression analysis of the values of each pollutant in the "40 City Study." The Agency selected the 98th-percentile concentration to prevent potential deviations from the pollutant concentrations in the "40 City Study" and to prevent increases in any risks associated with current methods of sewage sludge use and disposal. This will ensure that sludge quality does not get worse and therefore assure the continuing validity of the risk assumptions underlying the Agency's regulatory control decisions. There could, of course, be alternative ways to define the "existing sludge quality" basis of the aggregate risk approach. One would be to use a different data base, such as the National Sewage Sludge Survey currently underway. A second would be to select a different pollutant concentration level as one determined to be adequately protective (i.e., the 95th, 99th, or 100th-percentile pollutant concentrations). Are there other data bases or percentile concentrations that the Agency should consider?

The Agency is soliciting comments on the suitability of using these approaches as the basis of setting standards for the use or disposal of sewage sludge. The benefits and costs of each option are discussed in detail in the Regulatory Impact Analysis. Note that the numbering of options 3 and 4 in the Regulatory Impact Analysis is different from those in the discussion below and in Table VIII-1. To avoid confusion the reader should focus on the content of each option's requirements when comparing this discussion with that in the Regulatory Impact Analysis.

TABLE VIII-1.—APPROACHES CONSIDERED FOR SETTING STANDARDS

Number of facilities affected	Volume of sludge affected in dry metric tons	Number of people exposed	Risk
Land application: 2623 Distribution & marketing: 106 Monofills: 49 Incineration: 169	Land application: 1,202 Distribution & marketing: 706 Monofills: 101 Incineration: 1,651	Land application: 226 M Distribution & marketing: 2.7M Monofills: 204,900 Incineration: 51 M	Land application: MEI cancer risk: $9x10^{-5}$—$2x10^{-6}$ Cancer cases: 0.21 Lead cases: 41.5. Distribution & marketing: MEI cancer risk: $9x10^{-6}$ Cancer cases: 0.02 Lead cases: 95. Monofills: MEI cancer risk: 3x10 [illegible] Cancer cases: 0.02 Lead cases: 26. Incineration: MEI cancer risk: $5x10^{-2}$ Cancer cases: 12 Lead cases: 5,836.

TABLE VIII-1.—APPROACHES CONSIDERED FOR SETTING STANDARDS—Continued

Number of facilities affected	Volume of sludge affected in dry metric tons	Number of people exposed	Risk
I: Use existing regulations	II: Use the 98th-percentile pollutant concentrations to supplement existing regulations	III: Use the exposure assessment models for all use/disposal methods	IV: Use the exposure assessment models and the 98th-percentile pollutant concentration
Description:			
Hazardous sludges regulated under 40 CFR Parts 261-268 and sludge with > 50 ppm of PCBs under 40 CFR Part 761	Hazardous sludges regulated under 40 CFR Parts 261-268 and sludge with > 50 ppm of PCBs under 40 CFR Part 761	Hazardous sludges regulated under 40 CFR Parts 261-268 and sludge with > 50 ppm of PCBs under 40 CFR Part 761	Hazardous sludges regulated under 40 CFR Parts 261-268 and sludge with > 50 ppm of PCBs under 40 CFR Part 761
Retains pollutant limits from existing regulations	Retains pollutant limits from existing regulations	Uses the exposure assessment model in setting numeric limits for all use/disposal methods, except when sewage sludge is incinerated, use the NESHAPs for Hg and Be and .25 of the NAAQS for Pb as the basis for the numeric limit	When the potential for high individual exposure is likely or when there are significant scientific uncertainties, use the exposure assessment models and when the potential for human exposure is low, use 98th percentile pollutant concentration from the 40 City Study.
Supplements existing regulations with the toxicity characteristic pollutant concentrations in setting numeric limits	Supplements existing regulations with the 98th percentile pollutant concentrations from the 40 City Study in setting numeric limits	Allows site-specific data and modeling to determine case-by-case numeric limits that would not exceed human health or environmental criteria	When sewage sludge is incinerated, use the NESHAPS for Hg and Be and .25 of the NAAQS for Pb as the basis for the numeric limit.
			Allows site-specific data and modeling when using the exposure assessment models to determine case-by-case numeric limits that would not exceed human health or environmental criteria.
Land application: Pollutant limits:			
Cancer: TC pollutant limits, 40 CFR Part 761 (PCBs) or 40 CFR Part 257 (PCBs)	98th percentile conc. 40 CFR Part 761 (PCBs) or 40 CFR Part 257 (PCBs)	1 x 10^{-5}	1 x 10^{-4} or 98th percentile conc.
Non-cancer: TC pollutant limits or 40 CFR Part 257 (Cd)	98th percentile conc. or 40 CFR Part 257 (Cd)	Based on Rfd or DDI	Based on RfD or DDI, or 98th percentile conc.
Management practices: As required by 40 CFR Part 257 & 40 CFR Part 761	As required by 40 CFR Part 257 & 40 CFR Part 761	Protect public health and/or prevent gross abuse of the environment	Same as III.
Distribution & marketing: Pollutant limits:			
Cancer: TC pollutant limits, 40 CFR Part 761 (PCBs) or 40 CFR Part 257 (PCBs)	98th percentile conc. 40 CFR Part 761 (PCBs) or 40 CFR Part 257 (PCBs)	1 x 10^{-5} and 1 x 10^{-6}	1 x 10^{-4}
Non-cancer: TC pollutant limits	98th percentile conc.	Based on RfD or DDI	Based on Rfd or DDI.
Management practices: As required by 40 CFR Part 257 and 40 CFR Part 761	As required by 40 CFR Part 257, 40 CFR Part 761 and labels	Requires labels listing management practices that protect public health and/or prevent gross abuse of the environment	Same as III.
Monofills: Pollutant limits:			
Cancer: TC pollutant limits, 40 CFR Part 761 (PCBs)	98th percentile conc. 40 CFR Part 761 (PCBs)	1 x 10^{-5}	1 x 10^{-4}.
Non-cancer: TC pollutant limits	98th percentile conc.	MCL	MCL.
Management practices: As required by 40 CFR Parts 257, 258	As required by 40 CFR Parts 257, 258	Protect public health and/or prevent gross abuse of the environment	Same as III.
Incineration: Pollutant limits:			
Cancer: TC pollutant limits 40 CFR Part 761 (PCBs)	98th percentile conc. 40 CFR Part 761 (PCBs)	1 x 10^{-5}	1 x 10^{-5}.
Non-cancer: TC pollutant limits .25 NAAQS for Pb and NESHAPS for Hg, Be	98th percentile conc. .25 NAAQS for Pb and NESHAPS for Hg, Be	.25 NAAQS for Pb and NESHAPS for Hg, Be	.25 NAAQS for Pb and NESHAPS for Hg, Be.
Management practice: As required by 40 CFR Part 60 Subpart O (NSPS)	As required by 40 CFR Part 60 Subpart O (NSPS)	As required by 40 CFR Part 60 Subpart O (NSPS) and others that protect public health and/or prevent gross abuse of the environment	Same as III.

TABLE VIII-1.—APPROACHES CONSIDERED FOR SETTING STANDARDS—Continued

Number of facilities affected	Volume of sludge affected in dry metric tons	Number of people exposed	Risk
Land application: After regulation:			
Cancer cases reduced: 0	0.06	0.18	0.06.
Lead cases reduced: 0	4.5	42	21.
Number of POTWs out of compliance: 0	54	2623	278.
Incremental compliance costs (in $ Million): $4.1	$9.9	$244.3	$15.2.
Distribution & marketing: After regulation:			
Cancer cases reduced: 0	0	0.02	0.02.
Lead cases reduced: 0	0	62	56.
Number of POTWs out of compliance: 0	0	35	35.
Incremental compliance costs (in $ Million): $0.5	$0.6	$25.4	$7.8
Monofill: After regulation:			
Cancer cases reduced: 0	<0.01	0.02	0.02.
Lead cases reduced: 0	0	26	26.
Number of POTWs out of compliance: 0	7	49	49.
Incremental compliance costs (in $ Million): $0.2	$0.9	$25.5	$25.5.
Incineration: After regulation:			
Cancer cases reduced: 2.8	2.8	0.8	9.4.
Lead cases reduced: 5,121	5,134	4,889	5,163.
Number of POTWs out of compliance: 96	97	122	122.
Incremental compliance costs (in $ Million): $21.9	$22.1	$103.8	$103.8.

TC=Toxicity Characteristic.

Approach I: Use Existing Regulations (Aggregate Approach)

The first approach considered by the Agency was to use existing regulations to establish numerical limits and management practices. In establishing numerical limits for sewage sludge that is incinerated, the Agency would use the NESHAPs for mercury and beryllium in 40 CFR Part 61, Subparts C and E, respectively, 25 percent of the National Ambient Air Quality Standards (NAAQS) for lead, and the particulate limitations and monitoring requirements in 40 CFR Part 60, Subpart O. In addition, the Agency would have also used numerical limits for cadmium and polychlorinated biphenyls (PCBs) and the pathogen reduction process requirements in 40 CFR Part 257 when sewage sludge is applied to the land. Under this approach, if existing regulations do not address a particular pollutant, EPA would have used the toxicity characteristic pollutant concentrations in 40 CFR Part 261 to determine if a sludge was hazardous. Therefore, standards for sewage sludge with hazardous concentrations of pollutants would not be established in Part 503. All approaches considered by the Agency similarly exclude sewage sludge with hazardous concentrations of pollutants from the Part 503 standards. As discussed later in Part IX of the preamble, for purposes of Section 405, EPA is regulating hazardous sludge under the requirements in 40 CFR Parts 261 through 268 and sludge with 50 ppm or more PCBs under the requirements in 40 CFR Part 761.

The first approach was rejected immediately by the Agency because it would misuse the toxicity characteristic concentrations. The toxicity characteristic concentrations were developed to identify chemical concentrations in wastes that, if placed in improperly managed MSWLFs have the potential of causing an unacceptably high level of ground-water contamination. The regulatory thresholds do not purport to define a concentration that would be safe if used for growing food or feed crops. The toxicity characteristic concentrations, if used in the exposure assessment models, would result in concentrations exceeding the human health criteria for the disposal practice. Therefore, if existing pollutant concentrations in sewage sludge were to increase to levels near the toxicity concentrations, the projected risks posed by the current use or disposal methods (except for incineration) would increase. Limiting emission levels of sewage sludge incinerators to 25 percent of the NAAQS for lead would require incinerators to install wet electrostatic precipitators (ESPs). At present, States are not controlling lead emissions from sewage sludge incinerators. Therefore, the controls for incinerators would reduce lead exposure cases by 5,155 and other carcinogenic cases due to metals by 2.8.

Approach II: Use The 98th Percentile Pollutant Concentration (Aggregate Approach)

The second approach considered by the Agency was to use existing regulations, as in the first approach. However, if existing regulations do not establish numerical limits, numerical limits corresponding to the 98th-percentile pollutant concentration in the "40 City Study" would be established. The 98th-percentile pollutant concentrations would be calculated from a regression analysis of the values of each pollutant in the "40 City Study" and would be used as a cap on allowable pollutant concentrations. This would preclude potential deviations from the pollutant concentrations shown in the "40 City Study" and prevent increases in any risks associated with current methods of use and disposal. In addition to management practices specified in existing regulations, such as pathogen reduction processes for the land application of sewage sludge in 40 CFR Part 257, the Agency would require that labels or information sheets accompany sewage sludge products that are distributed and marketed. These would inform users about the proper use of the product.

One advantage of such an approach would be few, if any, disruptions in the use or disposal of sewage sludge. For example, the Agency projects that only three percent of the sludge applied to agricultural lands would be disposed of in MSWLFs. Further significant lead reductions are not projected because the requirement limiting incinerator emissions to 25 percent of the NAAQS for lead is included in the first approach and carried forward in all approaches. A few more incinerators that fire sewage sludge with pollutant concentrations at the 98th-percentile concentration would have to be fitted with wet ESPs to come into compliance with the numerical limits. The Agency projects a total reduction of 2.9 cancer cases and 5,160 lead cases.

However, this approach does nothing to control the rate at which sewage sludge could be applied to agricultural crops. High rates of sewage sludge applied to land use for growing food-chain crops could result in residues that exceed the Food and Drug Administration's Action Levels and subject such crops to seizure. Furthermore, some of the pollutants at the 98th-percentile pollutant concentrations shown in the "40 City Study", if disposed of in monofills, would exceed the pollutant's MCL for drinking water. In addition, this approach does not significantly reduce the projected carcinogenic risk to an individual from sewage sludge disposed of in monofills (3×10^{-3}) or from incineration (5×10^{-2}).

Approach III: Use the Exposure Assessment Models for all Practices (MEI Approach)

The third approach that the Agency considered was to use the exposure assessment models in establishing numerical limits for all use or disposal methods. The exposure assessment models allow the Agency to limit not only the concentration of a pollutant in sewage sludge, but also the annual and cumulative loading rates for pollutants when sewage sludge is applied to land used for growing food-chain crops or distributed and marketed. This approach reduces the maximum individual exposure to carcinogens by one order of magnitude or more if the carcinogenic risk levels are within the range usually set by the Agency (i.e., 1×10^{-6} to 1×10^{-4}). There would not be significant decreases in cancer or lead cases because the Agency projects that more treatment works will incinerate their sewage sludge if they can no longer use their current use or disposal method. Incineration poses greater risks because (1) some of the products of incomplete combustion in the emissions are very carcinogenic; (2) metals are carcinogenic through inhalation, but not through ingestion; and (3) more individuals are exposed to higher levels of lead.

There would be more reductions in the number of cancer and lead cases if the Agency had assumed that the sewage sludge failing the numerical limits would be disposed of in MSWLFs in compliance with the proposed requirements in 40 CFR Part 258 (see 53 FR 33313, August 30, 1988) rather than incinerated. The Agency did not assume that all of the sewage sludge failing to meet the numerical limits would be disposed of in MSWLFs because, in some areas of the country, there is insufficient landfill capacity.

The disadvantage of using the exposure assessment models for all use or disposal methods is that such an approach significantly disrupts the way in which sewage sludge is used or disposed of; 2,829 of the 5,300 POTWs would fail to meet the numerical limits. The Agency projects that all of the sewage sludge applied to agricultural land would have to be incinerated, placed in NSWLFs, or composted. Similarly, all sewage sludge distributed and marketed or placed in monofills would need to be incineration.

Another disadvantage of this approach is that some methods would be over-regulated by protecting individuals from highly improbable risks. For example, it is unlikely that an individual would ever obtain all of his or her food from forests to which sewage sludge had been applied.

Approach IV: Use the Exposure Assessment Models and the 98th-Percentile Pollutant Concentration (Combined Aggregate and MEI Approach)

The final approach that the Agency considered, and the one on which the Agency is basing today's proposal, uses a combination of aggregate and MEI analyses (i.e., the second and third approaches). The Agency is proposing to use existing regulations, the NESHAPs for mercury and beryllium and 25 percent of the NAAQS for lead when sewage sludge is incinerated. EPA is also proposing to use the exposure assessment models to establish numerical limits, as in the third approach, when individuals are likely to be exposed to high levels of pollutants in sewage sludge or when there are significant scientific uncertainties about the effect of a particular sewage sludge disposal practice. As discussed in the next section of this part of the preamble, standards would be based on a higher carcinogenic risk (i.e., 1×10^{-4} and 1×10^{-5}) and 1×10^{-6}.

When individuals are unlikely to be exposed to the pollutants in sewage sludge, the Agency is proposing to set numerical limits that correspond to the 98th-percentile pollutant concentration in the "40 City Study". As in the second approach, the 98th-percentile concentration is a cap on the allowable concentration of a pollutant in sewage sludge that precludes significant deviations from the concentrations shown in the "40 City Study" to avoid increased risk from the disposal of sewage sludge.

The 98th-percentile pollutant concentration would apply to the application of sewage sludge to land uses for non-agricultural purposes (i.e., forests, reclaiming lands, etc.), a practice on which human dietary impacts are negligible. The 98th-percentile pollutant concentration would also apply to the disposal of sewage sludge on surface disposal sites, which are generally small, are located away from population centers, and are usually located on property owned by the treatment work. The Agency believes that there would be little, if any, likelihood of exposure to the pollutants from these two use and disposal methods.

The advantage of using the exposure assessment models along with the 98th-percentile pollutant concentrations is that the approach targets those methods of use or disposal that pose the most risk for reduction in risks. This significantly reduces the cancer and lead adverse health effects resulting from the disposal of sewage sludge. By implementing this approach, the Agency projects a reduction of 9.5 cancer cases and 5,266 lead cases.

As shown in Tables VIII–1 and more fully discussed in the Regulatory Impact Analysis, the proposed regulatory approach results in the greatest reduction in cancer and lead cases. There are more benefits in Option 4 than in Option 3 even though the carcinogenic risks are established at a less protective level in Option 4 (i.e., 1×10^{-4} and 1×10^{-5}) than in Option 3 (i.e., 1×10^{-5} and 1×10^{-6}) because, under Option 3, more POTWs that cannot meet the numerical limits with their current use or disposal methods switch to incineration. In Option 3, all 2,623 POTWs that land apply sewage sludge fail the criteria and 260 of these POTWs are expected to shift to incineration as a compliance strategy. Distribution and marketing shifts reduce the net benefits in Option 3 as compared to Option 4. Under Option 3, 35 POTWs that distribute and market sewage sludge are expected to incinerate their sludge, while under Option 4 only 10 POTWs are expected to do so. Although the controls placed on incineration greatly reduced the adverse health effects of incinerating sewage sludge, fewer benefits are realized because of the assumption that more sewage sludge will be incinerated.

As indicated above, our aggregate effects assessment identified greater risks from incineration even though the incinerators meet the numerical limits. The increase in the number of adverse health effect cases from incineration is due to several factors. First, the aggregate effects analysis in incineration accounted for a greater number of carcinogens that may be in the form of products of incomplete combustion in the emissions of an incinerator. Second, the metal pollutants (i.e., arsenic, cadmium, chromium and nickel) are carcinogenic through inhalation but are not carcinogenic through ingestion. Finally, more people have greater levels of exposure to lead near incinerators, thereby increasing the number of people who would exceed the threshold values.

The Agency anticipates that 509 out of 5,300 facilities will have to find alternative use or disposal methods. About 22 percent of sewage sludge applied to agricultural lands would have to be applied to non-agricultural lands or placed in MSWLFs. Similarly, the Agency estimated that approximately 30 percent of the sewage sludge distributed and marketed would be incinerated or placed in MSWLFs. All of the sewage sludge placed in monofills would have to be incinerated or placed in MSWLFs.

Another disadvantage of the proposed approach is that it focuses almost exclusively on human health effects, leaving the potential for toxicity values of non-agricultural plants and animals to be exceeded. Our analyses show that if 50 metric tons of sewage sludge (on a dry weight basis) were applied to a hectare of non-agricultural land and if the sewage sludge included concentrations of copper, zinc, and lead at their 98th-percentile value, the pollutant loadings of copper and zinc would exceed the assumed phytotoxicity value for plants (lettuce).

However, the Agency does not believe that the 98th-percentile pollutant concentrations will cause significant or widespread adverse environmental impacts in actual practice. Metal concentrations are likely to be less than those in the "40 City Study" because those data were collected prior to the implementation of pretreatment programs.

In addition, field studies in Michigan, Washington, Pennsylvania, Ohio, Illinois, West Virginia, Virginia, and Alabama strongly suggest that the application of sewage sludge to non-agricultural land will not cause significant or widespread adverse environment effects. These field studies indicated that when sewage sludge is used to stimulate tree growth in forests or to establish a vegetative cover on lands ravaged by strip mining or construction activities, most of the pollutants are bound or immobilized in the soil even when high rates of sludge (30 to 300 metric ton per hectare) are applied. Even in acidic forest soils, research at the University of Washington has found no problems with metals following sludge application (see Reference number 37). Studies have found that the pollutants do not leach below the soil profile into the ground water (see Reference numbers 9 and 33) or substantially elevate pollutant levels in plants or animals (see Reference number 2). The increased forage for wildlife in forests seems to outweigh any increase in the animals' trace metal body burden.

In addition, by establishing vegetative cover on drastically disturbed lands, the vegetative cover significantly reduces the heavy metals in runoff from previous mining activities (see Reference numbers 33 and 31). The vegetative cover also holds the soil on these marginal lands, thereby reducing high erosion rates and surface water quality impacts (see Reference number 33).

Concerns have been raised about the conversion of lands receiving sludge with the 98th-percentile pollutant concentrations to more sensitive uses with greater potential for human food-chain impacts, such as agricultural operations or residential uses. Before much experimental data were available, researchers hypothesized that, over time, after sludge was no longer applied, soil bacteria would break down the organic matrix of the organically-bound sludge and free metal ions. Then, supposedly, the free metal ions would become available and plants would absorb high levels of these metal ions (see Reference numbers 7, 17, and 6).

This hypothesis, however, has not been demonstrated in field studies done on crops grown on sludge-amended soils. Long-term observations show that the availability of metallic pollutants for absorption by the plant remained the same or decreased over time after sludge applications had ceased (see Reference numbers 34 and 66).

A sludge field study in Illinois, where annual applications were made for three consecutive years at agronomic rates, showed that when sludge application had stopped, the metal concentrations in a variety of crop tissues decreased rapidly with each successive crop (see Reference numbers 64, 70, 20, and 8). Based on these results, there is no reason to believe that metals derived from sewage sludge will become more available to a plant after application has ended.

Further, the Agency does not believe organic pollutants will pose significant problems. Most of the non-persistent trace organics readily volatilize and degrade in the presence of sunlight and soil microorganisms. The fate of non-persistent organic chemicals, applied to soil has been extensively studied, but usually as pure compounds and not in a sludge matrix. Trace amounts of these chemicals are strongly bound to soils, especially if organic matter is also present. Therefore, these organic chemicals are unlikely to leach to ground or surface waters or be taken up by plants (see Reference numbers 15, 6, and 1).

Samples of sludge-amended and control site soils have also been analyzed for persistent organic compounds. These studies indicate that sludge application did not significantly increase the levels of persistent organic pollutants over the background or control site levels (see Reference numbers 32 and 4).

Based on the aggregate effects analyses, the Agency believes the 98th-percentile pollutant concentration adequately protects public health and the environment, if the sewage sludge is used or disposed of in accordance with the requirements in the proposal. However, the Agency is soliciting comment on the approach.

Alternative Carcinogenic Risk Levels Considered

The Agency did not examine alternative RfDs for non-cancerous pollutants. For non-cancerous pollutants, the Agency establishes a threshold value (such as a blood lead level) above which some adverse health effects may occur. Available statistical information for most non-cancerous pollutants is not sufficient to determine the chance that one threshold value or another will produce a specific adverse human health effect. Alternative threshold values, RfDs, are examined when the Agency sets the threshold values. For this rule, EPA used the RfD listed in the Agency's Integrated Risk Information System (IRIS). Part XIII of the preamble describes how to access IRIS and obtain the studies used to establish an RfD for a pollutant.

However, the Agency did examine alternative carcinogenic risk levels in establishing numerical limits for the use or disposal of sewage sludge. Since any exposure to a carcinogenic pollutant poses some risk of developing cancer, numerical limits are established on the basis of an acceptable risk such as one chance in 10,000 (1×10^{-4}) of developing cancer. Rather than set a uniform carcinogenic risk target for the use and disposal methods covered by today's proposal, the Agency evaluated each method individually. This approach allowed the Agency to consider and isolate the risks posed by a particular method.

EPA has selected an incremental carcinogenic risk target of 1×10^{-4} for sewage sludge used in the production of agricultural crops, the distribution and marketing of sewage sludge products, and the disposal of sewage sludge in monofills. This target was selected because the analyses do not indicate significant carcinogenic risk (i.e., 0.22 cancer cases per year from these methods combined).

The Agency's analyses indicated that incineration poses more carcinogenic risk than do other use or disposal methods. Incineration may expose 51 million people to varying levels of carcinogenic risk resulting in 12 cancer cases. To reduce this carcinogenic risk and to compensate for examining only one pathway of potential exposure (i.e., the inhalation pathway—see discussion in Part IV on the indirect pathways of exposure), the Agency is proposing to regulate the incineration of sewage sludge such that the carcinogens in the emissions do not exceed an incremental unit risk of 1×10^{-5}. The unit risk estimate of 1×10^{-5} is comparable to the Agency's hazardous waste incinerator programs.

If incineration were regulated at a unit risk of 1×10^{-4} there would be 165 more lead cases and 6.6 more cancer cases. The Agency estimates that compliance costs would be reduced by approximately $62 million. The Agency specifically invites comments on the merits of selecting a 1×10^{-4} incremental carcinogenic risk target for incineration.

The Agency considered an incremental carcinogenic risk level of 1×10^{-6}. The option was rejected because, as explained above, our analyses indicate that such an approach would lead to the incineration of greater volumes of sewage sludge with a reduction in the health benefits. Furthermore, there is considerable uncertainty in projecting the number of cancer cases. When that number is already small (for other than incineration), there is increased uncertainty in projecting further reductions.

Carcinogenic risk targets are applied pollutant-by-pollutant in all use or disposal practices, except for the organic pollutants in the emissions of sewage sludge incinerators. As discussed in Part IX of the preamble, the Agency is setting a limit on the total hydrocarbon emissions from a sewage sludge incinerator rather than on each individual organic pollutant. Therefore, the Agency developed the weighted average risk specific concentration for the carcinogenic organic compounds listed in IRIS. This is comparable to setting a pollutant-by-pollutant risk specific concentration for the metals in incinerator emissions.

In setting carcinogenic risk targets pollutant-by-pollutant, rather than requiring the mixture of pollutants in sewage sludge to meet a specific risk target, there is potential for the summed risks of all the regulated pollutants to exceed the proposed risk targets of 1×10^{-4} and 1×10^{-5}. In examining the potential for the summed risk to significantly exceed the proposed risk levels, the Agency found it to be highly unlikely.

The Agency analyzed a total of 30 facilities using the "Descriptive Statistics on Contaminants in Municipal Sludge Based on the EPA 40-POTW Study" (Reference number 69) to determine the ratio of the total cancer risk of the pollutant mixture to the cancer risk from the worst or highest risk pollutant for each use or disposal practice. In most of the 30 sludge disposal situations considered, one pollutant dominated the risk. Only in three of the 30 situations did the worst pollutant account for less than half of the total risk. On the average, the risk from the mixture was 1.4 fold greater than the risk of the worst pollutant. This ratio varies case by case as shown in Table VIII-2. It has a range of 1.0–3.2, and a median value of 1.1. Thus, if the worst pollutant is regulated to a risk of 1×10^{-4}, the expected value of the risk of the mixture would be 1.4×10^{-4}

TABLE VIII-2.—RANDOMLY SELECTED PLANTS—RATIO OF TOTAL RISK FROM MIXTURE TO RISK FROM WORST POLLUTANT

	Plant No.	Ratio
Incineration (14 pollutants)	23	1.04
	25	1.38
	04	1.29
	18	1.24
	30	1.26
	35	1.17
	17	1.60
	28	1.08
	22	1.80
	40	1.78
Land Application (12 pollutants)	13	1.00
	01	1.36
	05	3.23
	06	2.28
	07	1.83
	38	1.00
	27	1.02
	28	1.00
	29	1.00
D&M (8 pollutants)	08	1.01
	36	1.00
	15	1.01
	29	1.19
	39	1.00
Monofill (10 pollutants)	13	1.04
	25	1.49
	32	2.32
	27	1.03
	22	1.05
Mean		1.35
Median		1.13
Range		1.00–3.23
Number of cases		30

These results were affected by the assumptions used when a pollutant was not detected. For some publicly owned treatment works (POTWs), available data allowed the Agency to use the detection limit when the pollutant was not detected. For other POTWs, the data only allowed the Agency to use zero when undetected. High values for the risk ratio tend to occur when the detection limit is used. For example, the high ratio of 3.23 (in land application) occurred for a facility where only one of the 12 pollutants was actually detected and the detection limits for the pollutants were used. The low value of 1.00 occurred where only one pollutant was detected. Therefore, EPA believes that the summed risk of all pollutants would not make a significant difference (i.e., raise the risk of a use or disposal practice from 1×10^{-4} to 1×10^{-3}). The Agency believes that setting numerical limits to meet a carcinogenic risk target on a pollutant-by-pollutant basis meets its statutory directive to establish limits for those pollutants that may interfere with the safe use or disposal of sewage sludge. Ensuring that pollutants do not exceed a summed risk would be very difficult. Numerical limits within a permit would have to be constantly re-adjusted to account for different pollutant concentrations in the sewage sludge. Such an approach would be inconsistent with the Agency's principle of developing a rule that can be implemented. However, the Agency is soliciting comment on its believe that setting numerical limits for carcinogenic pollutants on a pollutant-by-pollutant basis adequately protects public health.

Concerns have been raised, however, that treatment works would allow individual pollutant concentrations to increase to a point where each pollutant would not exceed the carcinogenic risk level, thereby increasing the overall risk of a use or disposal method. The Agency believes this is highly unlikely because industrial dischargers must meet categorical pretreatment standards promulgated under other sections of the CWA. In addition to the categorical pretreatment standards for industrial dischargers, local pretreatment programs may further limit the discharge of pollutants into POTWs.

Alternatives to National Numerical Limits

As discussed in Part IV of the preamble, the exposure assessment models are designed to predict the long-term human health and environmental effects of using or disposing of sewage sludge by the methods covered in this proposal. Sensitivity analyses were performed on the models to identify conditions that could reasonably be anticipated. In conducting the sensitivity analyses, the Agency found that varying certain parameters made a significant difference in a numerical limit for a pollutant, without a pollutant exceeding the human health or environmental criterion. Factors such as type of soil and the depth of the soil between the surface and the ground water attenuate the migration of a pollutant into and through the environment. Details on the sensitivity analyses may be found in the Technical Support Documents for each of the use or disposal methods (Reference number 56, 57, and 58).

The Agency considered, but rejected, regulating the use or disposal of sewage sludge on the basis of only a single numerical limit for all use and disposal methods. A single pollutant concentration protective nationwide could over-regulate a use or disposal method because different methods pose substantially different risks. Such an approach also fails to recognize that certain environmental settings are better suited to assimilate or ameliorate the effect of pollutants than others.

The Agency also considered developing a "tiered" regulatory approach for treatment works that could not meet the national numerical limits or that did not want to conduct site-specific modeling for all the parameters in the model. Such an approach would establish intermediate numerical limits based on varying a few model parameters at each tier. Treatment works would submit data for different parameters in the appropriate tier to the permitting authority and the permitting authority would verify that the treatment work's sewage sludge met the appropriate numerical limits.

One reason for rejecting the "tiered" regulatory approach was its complexity. Such an approach would be inconsistent with the Agency's principle of developing a rule that could be implemented easily. It would be impossible to include in the rule all possible variations occurring at a site. Another reason for rejecting the approach was that the Agency did not believe that treatment works would use the intermediate tiers. Rather than varying only a single parameter, the Agency felt it more likely that a treatment work would collect data on as many parameters as possible to determine if, by doing so, their sludge could meet the numerical limits of a disposal practice.

The approach that the Agency is proposing utilizes a combination of national numerical limits and case-by-case site-specific modeling. Depending on the disposal method, the Agency is establishing national numerical limits or providing an equation to calculate numerical limits. If a treatment work is unable to meet the national numerical limits, the permitting authority would calculate new numerical limits based on the physical conditions at a site that make a significant difference in a numerical limit. The parameters for which a treatment work may submit site-specific data are listed in the appropriate sections of the rule.

In some cases a treatment work may not need to collect data for all the parameters that may be varied in the model. The rule lists the values used in the models for the parameters that may be varied. Treatment works have the option of using the values that were used in the models or collecting, at their expense, site-specific data. The data would be submitted to the permitting authority to calculate a new numerical limit using the exposure assessment models developed for this proposal or other EPA-approved models. Information on the availability of the IBM PC compatible models used in establishing the numerical limits for this proposal is found in Part XIII of the preamble.

Recalculation of numerical limits based on site-specific data would be available to treatment works that dispose of their sludge in monofills or in incinerators. Site-specific adjustments in numerical limits would not be available for the land application or distribution and marketing of sewage sludge. Based on the sensitivity analyses, the Agency did not find any physical parameters in the land application model that made a significant difference in the pollutant limits. Site-specific modeling would not be available for the distribution and marketing of sewage sludge because it is impractical to collect data on all sites where the general public may apply sewage sludge.

The Agency is soliciting comment on the approaches that it considered in developing the framework for today's proposal. The specific requirements included in today's proposal, as well as alternatives considered in developing the requirements, are discussed in Part IX of the preamble.

PART IX: DESCRIPTION OF 40 CFR PART 503

This part describes the standards EPA is proposing for the use or disposal of sewage sludge. The standards include pollutant limits, management practices, and other requirements that define a level of control that owners or operators of treatment works and users or disposers of sewage sludge must attain over the use or disposal of sewage sludge to adequately protect human health and the environment. The pollutant limits, management practices, and other requirements are specific to the method of use or disposal employed by treatment works use. This part follows the organization of the proposed rule to facilitate review and understanding of today's proposal.

General Provisions (Subpart A)

Purpose and Applicability (§ 503.1)

EPA is proposing minimum requirements that owners or operators of treatment works and users or disposers of sewage sludge must meet when the sludge is ultimately used or disposed of. The use or disposal methods included in today's proposal are: (1) Application to agricultural or non-agricultural land, (2) distribution and marketing, (3) disposal in monofills, (4) disposal on surface disposal sites, and (5) incineration. The Agency has determined that the requirements in today's proposal adequately protect health and the environment from any reasonably anticipated adverse effects of each regulated pollutant.

Local Community's Choice of a Use or Disposal Method

Although the Agency prefers local communities to reuse their sewage sludge for its nutrient and soil conditioning properties, section 405(e) of the CWA reserves the choice of a use or a disposal method to local communities.

The pollutant limits EPA developed reflect the risk of each use or disposal method. In some cases, protection of public health and the environment require very stringent standards which would be very difficult for a local community to meet. For example, under the proposal, communities are unlikely to meet the limits that would allow them to dispose of sewage sludge in a monofill over a Class I ground water (i.e., an irreplaceable source of drinking water).

Section 503.1(b)(4) of the rule reiterates the statutory directive that the choice of any sewage sludge use or disposal method is a local one, as long as the treatment work, user, or disposer complies with the requirements in today's proposal.

Ocean Dumping Ban Act

EPA planned as part of its comprehensive sludge technical regulation to establish standards for the ocean disposal of sewage sludge which would adequately protect human health and the environment against any adverse effects of such dumping. The Marine Protection, Research, and Sanctuaries Act (MPRSA) establishes a comprehensive permit program for ocean-dumping activities. To implement its permitting requirement, Congress directed EPA to establish and apply criteria for reviewing and evaluating permit applications. These criteria include not only consideration of the effects of the proposed dumping on human health and the environment, but also on the need for the proposed dumping and the consideration of land-based alternatives to ocean disposal. Thus, the MPRSA requires EPA to weigh and balance a number of factors in determining whether or not to permit dumping.

The Ocean Dumping Ban Act of 1988, Pub. L. 100-688, November 18, 1988 prohibits any person from dumping sewage sludge into ocean waters after December 31, 1991. In addition, Congress limited ocean dumping during the interim period to those communities that were authorized to dump either under an MPRSA permit or court order as of September 1, 1988. Congress also prohibited dumping after August 15, 1989 unless an MPRSA permit has been obtained by that time. EPA is moving forward to issue permits for the limited universe of publicly owned treatment works (POTWs) eligible to continue dumping.

In addition, the Ocean Dumping Ban Act of 1988 also bans the ocean incineration of sewage sludge. EPA has consistently interpreted the MPRSA as requiring a permit for incineration at sea because it is a form of dumping. Therefore, because no permits for incineration of sewage sludge have been issued and incineration is not permitted under any outstanding court orders, the terms of the Ocean Dumping Ban Act of 1988 prohibit ocean incineration after the date of enactment, November 18, 1988.

EPA had contemplated that its Section 405 standards for ocean dumping would be an important element in the evaluation of environmental effects required by the MPRSA. In view, however, of the clearly expressed intention of Congress to eliminate the ocean dumping of sewage sludge by the beginning of 1992, EPA decided not to proceed further with development of ocean dumping standards. It is clear that any standards could not be promulgated until well after the date when the MPRSA permits must be in place and, thus, could not serve the stated purpose of providing environmental criteria for the assessment of ocean dumping applications.

Sludge Processing

The rule does not apply to the processing of sewage sludge before its ultimate use or disposal. Before ultimately using or disposing of sewage sludge, treatment works may use one, or a combination, of biological, chemical, physical, and thermal processes to increase the solids content of the sludge (i.e., by reducing its water content through heat or other processes) and to stabilize the sludge (i.e., by reducing or eliminating pathogenic organisms, odors, and volatile solids). Such processes improve the characteristics of the sludge for a particular disposal method and reduce the potential for public health, environmental, and nuisance problems. EPA requires the use of one or more of the treatment processes to reduce or kill pathogens before applying sewage sludge to land for agricultural and non-agricultural purposes, before distributing and marketing the sewage sludge, or before the disposal of sewage sludge in monofills or on surface disposal sites.

EPA is not specifying process operating methods or requirements for sludge entering or leaving a particular treatment process. The Agency believes that section 405(d) requires EPA to develop regulations for the final use or disposal of sewage sludge and that Congress did not intend for EPA to impose requirements on sludge processing as a part of the comprehensive regulation for sludge use and disposal. Rather, the Agency believes that section 405(d) requires EPA to establish a "standard of quality" against which treatment works can measure the quality of their sludge—its pollutant concentrations—and determine (1) if further processing is needed, (2) if additional treatment limits should be imposed on its industrial dischargers, or (3) if the community should identify alternative practices for the safe management of its sludge. If, however, comments on these proposed rules indicate sufficient justification for establishing standards for sludge processing, EPA will consider such comments for future rulemaking proceedings.

Relationship to Other Requirements (§ 503.2)

As required by section 405(f) of the CWA, the requirements proposed today are to be implemented through permits. The pollutant limits, management practices, and other requirements specified for a particular end use or disposal method are to be included in the POTW's or generator's permit. The implementing permit mechanisms and the State program management requirements are described in Part X of this preamble.

State Authority (§ 503.3)

Anyone using or disposing of sewage sludge is obligated to comply with the requirements proposed today. However, as provided in section 405(d)(5) and section 510 of the CWA, States may impose more stringent requirements than those included in today's proposal.

Exclusions (§ 503.4)

This section of the proposal lists the methods of sewage sludge use or disposal that are not covered by today's proposed rule. In this portion of the preamble, the Agency discusses its rationale for these exclusions.

Industrial Sewage Sludge

The proposed rule will not cover the use or disposal of sewage sludge that is generated by privately owned treatment facilities treating domestic sewage along with industrial waste and wastewater. Such sludge will continue to be covered by rules promulgated under Subtitle C of the Resource Conservation and Recovery Act (RCRA) (40 CFR Parts 261 through 268) or under Subtitle D of RCRA (40 CFR Parts 257 and 258).

The Water Quality Act amendments of 1987 expanded the coverage of section 405(d) to industrial manufacturing and private processing facilities that treat domestic sewage along with industrial wastes and wastewater. Although the legislative history of the Act clearly directs the Agency to impose requirements on any treatment work treating domestic sewage, and not just treatment works "primarily" treating domestic sewage (see 99th Cong. 2d Sess., H.R. Rept. 99-1004, October 15, 1986, p. 160), passage of the amendments in February, 1987 did not provide sufficient time to collect the data necessary to develop standards for such facilities in today's proposal.

At this time, the Agency does not have sufficient information on the characteristics of industrial sludge with a domestic sewage component to determine whether the models and data used to establish numerical limits for the use or disposal of municipal sewage sludge are appropriate for nonhazardous sludge generated by industrial facilities. The Agency recognizes the need to collect additional information on industrial wastes and on industrial waste disposal facilities as a basis for revising its regulations in 40 CFR Part 257 and for developing, if appropriate, additional regulations. As a first step in collecting additional information, EPA proposed, in a separate rulemaking, that industrial facilities notify the States and EPA of the volume of their sludge and the disposal methods and locations used (see 53 FR 33314, August 30, 1988). Once these and other data (e.g., viscosity, density, moisture content, and the organic carbon content of industrial sludge with a domestic sewage content) have been collected, the Agency will determine whether today's proposal should apply or whether additional regulations should be developed for industrial facilities that co-treat domestic sewage with industrial wastewater. The Agency anticipates that any additional requirements for industrial facilities treating domestic sewage along with industrial waste and wastewater would be developed under the joint authorities of sections 4004 and 4010 of RCRA and section 405(d) of the CWA.

Hazardous Sewage Sludge

The proposed rule will not establish standards for disposal of sewage sludge determined to be hazardous under 40 CFR Part 261. In previous **Federal Register** notices, EPA indicated it was considering excluding sewage sludge from regulation under RCRA Subtitle C once comprehensive sludge regulations were developed (see 51 FR 21658, June 1, 1986). The exclusion would be based in part on section 1006(b) of RCRA, which states:

> The Administrator shall integrate all provisions of this Act for purposes of administration and enforcement and shall avoid duplication to the maximum extent practicable, with appropriate provisions of the [CAA, CWA, FIFRA, SDWA, and MPRSA] and such other Acts of Congress as grant regulatory authority to the Administrator. Such integration shall be effected only to the extent that it can be done in a manner consistent with the goals and policies expressed in this Act and in other acts referred to in this subsection.

However, rather than regulating both hazardous and nonhazardous sewage sludge under section 405(d) of the CWA, EPA has concluded it is appropriate to regulate all hazardous wastes, including sewage sludge, under a program specifically designed for hazardous materials. The Agency believes that this provides the public with greater assurance of the consistent regulation and management of hazardous materials. It also provides a strong incentive for any treatment work with hazardous sludge to improve the quality of its sludge through effective pretreatment. Thus, the standards for the disposal of sewage sludge in today's proposal apply only to non-hazardous sludge.

In determining whether their sewage sludge is hazardous, treatment works are to use procedures promulgated under 40 CFR Part 261, Appendix II. If the sewage sludge is hazardous, treatment works generating the hazardous sludge must comply with the applicable requirements of 40 CFR Parts 260 through 268. The Agency has made the determination that compliance with the requirements in 40 CFR Parts 261 through 268 constitutes compliance with section 405(d) of the CWA.

In the Spring, EPA will promulgate amendments to 40 CFR Part 261. The amendments will include additional toxicants to be considered in defining a waste as hazardous and introduce a new leaching procedure, the Toxicity Characteristic Leaching Procedure (TCLP). The regulatory levels that will be in 40 CFR Part 261 are the regulatory levels that will be used in determining if sewage sludge is hazardous.

The pollutants covered by today's proposal and those covered by amendments to 40 CFR Part 261 are not identical. In this proposal, specific limits are established for 17 pollutants for which there are no toxicity characteristic regulatory limits. The 17 pollutants are listed in Table IX-A.1. There are also toxicity characteristic regulatory limits for pollutants that are not covered by today's proposal. The two lists are not identical because the programs under which the lists were developed start from fundamentally different perspectives. The toxicity characteristic regulatory limits are set for chemicals that are still used or manufactured and are likely to find their way to a landfill. The section 405(d) limits are established for those metals and organic compounds that are found in sewage sludge, whether or not the metals and organic compounds are still used in industrial processes. To the extent necessary, the Agency will expand the toxicity characteristic list of pollutants and the pollutants covered by today's proposal. Over time the lists of pollutants can be expected to overlap even more, but they are never expected to be identical.

Table IX-A.1—Section 405(d) Pollutants for Which There Are No Toxicity Characteristic Regulatory Thresholds:

Aldrin
Benzidine
Benzo (a) pyrene
Beryllium
Chlordane
Copper
Cyanide
DDT/DDD/DDE
Dieldrin
Dimethylnitrosamine
Molybdenum
Nickel
Polychlorinated biphenyls
Trichloroethlene
Zinc

Several municipal wastewater agencies believe that the proposed TCLPs would result in the classification of certain sewage sludge as hazardous. In 1986 and 1987, EPA tested 18 municipal sewage sludge samples using the new procedure and found that none failed. Although the results are preliminary and represent only a small percentage of the 15,000 POTWs, the Agency believes that municipal sewage sludge will generally pass the toxicity characteristic regulatory thresholds and be subject to the requirements in 40 CFR Part 503 rather than the requirements in 40 CFR Parts 261-268.

Incinerator Ash

The requirements proposed today do not cover the disposal of ash generated during the incineration of sewage sludge. Rules previously promulgated by the Agency in 40 CFR Part 261 through 268 and 40 CFR Part 257 and those proposed for 40 CFR Part 258 (see 53 FR 33314, August 30, 1988) adequately cover the disposal of incinerator ash. Sewage sludge to which incinerator ash has been added is covered by today's proposal.

Co-disposal of Sewage Sludge

Standards are not established in today's proposal for sewage sludge that is disposed of in a landfill with municipal solid waste. Rather, these standards are established in 40 CFR Part 258 which will include requirements for the disposal of sewage sludge in a municipal solid waste landfill (MSWLF). Compliance by treatment works with requirements of 40 CFR Part 258 when promulgated would constitute compliance with section 405. The standards were jointly proposed under the authorities of sections 4004 and 4010 of RCRA and section 405(d) of the CWA in 53 FR 33314, August 30, 1988.

To meet these standards, treatment works must ensure that the sewage sludge sent to MSWLFs is not hazardous, as defined by the regulatory limits in 40 CFR Part 261, and pass the Paint Filter Liquids Test.

As part of the August 30, 1988 notice, EPA made the determination that the proposed standards for MSWLFs meet the requirement of section 405(d) of the CWA that the Agency establish standards adequate to protect human health or the environment from any reasonably anticipated adverse effect of each pollutant. Section 405(d)(3) of the CWA provides that the Agency may promulgate design, equipment, management practice, or operational standards or combinations thereof if, "in the judgment of the Administrator, it is not feasible to prescribe or enforce a numerical limitation for a pollutant. * * *."

The Agency is proposing a single set of standards for a MSWLF in order to avoid imposing two distinct sets of requirements on a single facility. If the Agency had proposed separate requirements under the two applicable statutes, treatment works would not only have had to comply with whatever numerical limits were established under Part 503, but would also be responsible for ensuring that the MSWLF complies with the Part 258 standards. This would have placed an unfair burden on treatment works when other solid waste contributors were not held similarly responsible.

In lieu of holding treatment works responsible for the compliance of a MSWLF, the Agency is proposing today that treatment works send their sewage sludge to State-permitted facilities. EPA is soliciting comment on this requirement in recognition that few MSWLFs have State permits. The Agency is interested in the potential effect of this requirement on the 6,700 treatment works that send 41 percent (3.2 million dry metric tons) of all sewage sludge generated to MSWLFs.

Co-firing Of Sewage Sludge

Today's proposal will not apply to sewage sludge that is fired in an incinerator with other solid waste. This excludes four facilities that currently fire waste streams consisting of between three and nine percent sewage sludge (on a dry weight basis).

The New Source Performance Standards (NSPS) for sewage treatment plants (see 40 CFR Part 60, Subpart O) apply to facilities when 10 percent or more of their waste stream consists of sewage sludge (on a dry weight basis). However, this 10-percent threshold no longer appears appropriate.

The configuration of systems firing municipal refuse are quite different from those that fire only sewage sludge. Municipal waste combustors (MWCs) generally use mass burn, modular, or refuse-derived fuel systems. Facilities firing sewage sludge most commonly use multiple hearth and fluidized bed systems. A facility designed primarily for firing solid waste cannot efficiently fire more than a small amount of sewage sludge because the highly aqueous sewage sludge reduces the combustion temperature of the incinerator. If a municipal solid waste stream includes 10 percent sewage sludge, which is typically 80 percent water, the sewage sludge reduces the BTu value of the waste stream by 30 percent. Therefore, from a technological standpoint, it is ill-advised for typical MWCs to fire a large volume of sewage sludge.

Currently, the Agency is studying how best to regulate facilities co-firing sewage sludge with municipal solid waste. On July 7, 1987, the Agency issued an advanced notice of proposed rulemaking (52 FR 2599) on revisions to the NSPS for new or modified MWCs under section 111(b) of the CAA and on emission guidelines for existing MWCs under section 111(d) of the CAA. Section 111(b) applies to sources after a rule is proposed and Section 111(d) applies to existing sources.1At this time, the Agency has not determined how it will regulate facilities co-firing sewage sludge with municipal solid waste. In November 1989, the Agency anticipates that it will propose a NSPS for MWCs and will then address standards for sewage sludge in facilities that co-fire municipal solid waste with sewage sludge. Any recommendations or suggestions submitted as part of this rulemaking will be included in the Agency's deliberations on the NSPS for MWCs.

Deepwell Wet Air Oxidation System

The proposed rule does not apply to the location or operation of deepwell wet air oxidation systems. In these systems, sewage sludge flows down the center of two concentric verticle tubes and returns in the annular space. These verticle tubes (about a mile in length) are placed deep within the earth. Oxygen is injected into the liquid sewage sludge where, deep within the well, sufficient pressures and temperatures are reached to support the oxidation of the sewage sludge. This continuous flow system converts the organic waste into inert ash, carbon dioxide, and water. The effluent from these systems could be recycled back into the waste treatment plant or discharged in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. Because these are fully enclosed recycling systems, with no emissions to the air and controlled discharges, if any, to surface water, the Agency does not believe such systems are comparable to the use or disposal methods included in today's proposal. As these systems are developed further, EPA will evaluate if it would be appropriate to develop numerical pollutant limits for the liquid sludge placed in and oxidized in the wells.

Septic Tanks

Today's proposal will not apply to the location and operation of septic tanks. Septic tanks are also excluded from the definition of "treatment works" because of Congressional intention that only treatment and processing of septage be subject to section 405 regulation. However, the septage collected from septic systems is included in the definition of sewage sludge. Thus, septage must meet the requirements in today's proposal when it is ultimately used or disposed of.

Septage is frequently collected and delivered to treatment works for processing, generally to reduce the levels of pathogenic organisms. However, other septage is collected and applied to the land without further processing or without monitoring the levels of pathogenic organisms. Under today's proposal, sewage sludge, including septage, must meet the requirements in Subpart F, if it is applied to the land. The Agency is soliciting comment of the effect of these requirements on the use or disposal of septage.

Marine Sanitation Devices

Today's proposal would only apply to the pumpings from marine sanitation devices that are delivered to on-shore facilities for disposal. Generally the pumpings are collected in tanks at marinas and delivered to treatment works. Requirements in 33 CFR Part 159 specify requirements for the operation and maintenance of marine sanitation devices.

Definitions (§ 503.5)

The definitions included in this section of the rule are those generally applicable to all subparts of the rule. Each subpart includes special definitions that apply only to that subpart. Many of the definitions included in Subpart A are definitions that are included in section 502 of the CWA or have been included in numerous other Agency rules and will not be discussed here. The definitions discussed here amplify and reinforce the coverage of the rule.

Domestic Sewage

Domestic sewage is wastewater generated in households that is discharged to or otherwise enters a treatment work. Excluded from today's proposal is domestic sewage that privately owned treatment works treat along with industrial waste and wastewater.

Pollutant

Pollutant is defined as:

Those organic or inorganic substances or combination of substances, including disease-causing agents, which, after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through the food-chain, will, on the basis of information available to the Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in such organisms or their offspring.

This definition is similar to the definition of "toxic pollutant" included in section 502(13) of the CWA. The term, "toxic pollutant", is not used in today's proposal because, over the years, that term has become synonymous with the listed priority toxic pollutants included in section 307(a) of the CWA. EPA believes that Congress intended for the Agency to develop standards for a broader range of substances that might interfere with the use or disposal of sewage sludge, not just those priority toxic pollutants included in section 307(a).

Septage

In today's proposed rule, "septage" is included in the definition of "sewage sludge." Septage is defined to mean "* * * the liquid and solid material pumped from a septic tank, cesspool, or similar domestic sewage treatment system when the system is cleaned".

This means that the disposal of septage by any method that would be regulated under today's proposal (e.g., applied to land, placed in a monofill or surface disposal site) would be required to meet the applicable requirements in the same manner as any other sewage sludge. For example, where septage is land-applied, the person doing the application would need to identify the concentration of the pollutants in the septage regulated for land application (§ 503.13, Tables 1 and 2, for agricultural land; § 503.15, Table 3 for non-agricultural land) and calculate the allowable annual and cumulative loading rates using the methods described in Appendices B and C. They would also be subject to all applicable management practices for land application.

Users and disposers of septage (usually, septage haulers) would also be required to meet the same pathogen reduction requirements as other users and disposers of sludge. Current regulations for pathogen reduction (40 CFR Part 257) assumes that septage applied to land meets a Process to Significantly Reduce Pathogens if public access is controlled for 12 months and grazing by animals whose products are consumed by humans is prevented for one month. Today, for the reasons discussed in Subpart 7 of this part, EPA is proposing more stringent requirements for septage.

Today's proposal applies to the use and disposal of septage by one of the methods covered in this rule. It does not regulate the generation of septage (thus, owners of septic tanks are excluded from the definition of "treatment works"), or the siting, design, or operation of septic tanks. Nor does today's proposal regulate septage that is transported to treatment works. Such practices are regulated under the pretreatment program. The sludge generated by the receiving treatment plant would be subject to requirements proposed today.

The Agency is proposing to regulate septage in the same way as sewage sludge because of growing concern about the potential adverse effects of applying septage to land. In addition, the qualities of septage are similar to sludge (they are both a residual of wastewater treatment). Under today's proposed approach, the use and disposal of septage would be subject to the same requirements as the use and disposal of other sewage sludge. The Agency recognizes that this may require that septage haulers have their septage processed prior to applying the septage on the land. EPA is unsure about the extent and magnitude of any disruptions that today's approach may cause. Therefore, EPA invites comment on the proposed regulatory approach for septage use and disposal.

Specifically, the public is invited to comment on whether or not septage is sufficiently similar to sewage sludge and of sufficient concern to warrant the same regulatory approach, particularly in terms of the proposed pathogen and vector attraction reduction requirements. Other possible regulatory options might include developing separate standards specifically for septage disposal that are tailored to the particular concerns presented by septage (e.g., pathogens and a narrower list of pollutants) and that might be simpler to apply. For example, rather than requiring the sampling of the septage and the calculation of loading rates, the rule could simply set a loading limit for septage. EPA solicits comments on the desirability or feasibility of such an alternative approach. The Agency welcomes any suggestions concerning other possible approaches that the Agency should consider in regulating septage use and disposal.

Sewage Sludge

Today's proposal defines sewage sludge as any solid, semi-solid, or liquid residue removed during the treatment of municipal wastewater or domestic sewage. Sewage sludge includes, but is not limited to, solids removed during primary, secondary, or advanced wastewater treatment, scum, septage, portable toilet pumpings, Type III marine sanitation device pumpings, and sewage sludge products.

Scum is the material that floats upward and must be skimmed off the top of the wastewater treatment tanks. Scum shares many characteristics with the other residues generated during wastewater treatment and is typically disposed of with sewage sludge. Therefore, it is included in the definition of sewage sludge.

Septage, portable toilet pumpings, and Type III marine sanitation device pumpings are included in the definition of sewage sludge because they share the characteristics of sewage sludge, are generated from domestic sewage, and present the same human health risks (e.g., pathogenic organisms) as sludge from municipal treatment works.

Sewage sludge products are mixtures of sewage sludge and other materials, such as bulking agents (e.g., wood chips), frequently added to sewage sludge that is composted and then distributed and marketed. Such products are considered to be sewage sludge for the purposes of this proposal, no matter how small the percentage of sewage sludge in the product. The Agency is soliciting comment on this approach to determine if there are sewage sludge products that contain such a small percentage of sewage sludge that they no longer have the characteristics of sewage sludge.

Grit, screenings, or ash generated during the incineration of sewage sludge are not included in the definition of sewage sludge. Grit is the material, such as sand, small pebbles, and similar material, that settles out before primary treatment. Screenings are relatively large pieces of solid material that are caught on the screens at the headworks of the treatment plant. These waste streams are small, have vastly different properties from sewage sludge generated during wastewater treatment, are usually handled and disposed of separately, and are adequately regulated under solid waste programs.

Ash generated during the incineration of sewage sludge is not included in today's definition of sewage sludge. Incinerator ash, typically disposed of in landfills, like other ash material is sterile and dry. Incinerator ash does not have the same characteristics as other residues from wastewater treatment. As discussed above, incinerator ash will be regulated under RCRA (i.e., under Subtitle D if it is non-hazardous and under Subtitle C if it is hazardous). If, however, incinerator ash is mixed and disposed of with other sewage sludge (e.g., in land application), it will be regulated as sewage sludge.

Treatment Works

Treatment works include POTWs owned by State or local entities and federally owned facilities. All sewage sludge generated by these POTWs are covered by today's proposal, irrespective of the amount of industrial influent flowing into the treatment works.

Privately owned treatment works may include commercial processing facilities that treat domestic sewage. If privately owned treatment works treat domestic sewage exclusively, the sewage sludge generated is covered by today's proposal. However, if the privately owned treatment work treats domestic sewage along with industrial waste and wastewater, the sewage sludge is excluded from today's proposal. As discussed earlier, EPA is not prepared, at this time, to propose standards for the use or disposal of such sludge which, pending development of standards, continues to be subject to the requirements in 40 CFR Part 257 or 40 CFR Parts 261 through 268.

For the purposes of this rule, septic systems are excluded from the definition of treatment works. Although septic systems treat domestic sewage, the Agency has no intention of permitting individual owners of septic systems. As discussed above, the ultimate use or disposal of the septage pumped from septic tanks will be covered by today's proposal.

Land Application (Subpart B)

Applicability (§ 503.10)

The numerical limits, management practices, and other requirements in Subpart B apply to the spreading of liquid, de-watered, dried, or composted sewage sludge on or just below the surface of agricultural and non-agricultural land. The requirements also apply to any one who distributes or who uses sewage sludge meeting the numerical limits in this subpart. Sewage sludge which is distributed and marketed for use as a potting medium, or lawns, ornamentals and gardens in compliance with Subpart C is not subject to the requirements of this subpart.

Treatment works with good quality sludge are encouraged to reuse the sewage sludge for its nutrient and soil conditioning properties. Subpart B requirements protect public health and the environment while encouraging the beneficial use of sewage sludge by providing options on the level of pathogen reduction that must be achieved and on the pollutant concentrations that may be present in sludge applied to the land.

Treatment works may use any one of three levels of pathogen reduction when sewage sludge is applied to either agricultural or non-agricultural land as long as the treatment work or applier complies with the applicable restrictions on public access to the land and on growing crops or raising animals on the sludge-amended soil. In addition, two sets of numerical limits are included in this part. The applicability of these limits depend on whether the sewage sludge is used in the production of crops intended, directly or indirectly, for human consumption or for animals raised for human consumption. In this way, the Agency believes that it is encouraging the reuse of sewage sludge while also protecting public health from the adverse effects of pathogenic infections and of chemical contamination of the food-chain.

One key difference between the requirements of Subpart B and Subpart C (distribution and marketing) is the level of pathogen reduction to which a treatment work must process its sludge. Treatment works that distribute and market their sewage sludge to the general public must process their sludge to attain the Class A pathogen reduction standard—the highest level of pathogen reduction (i.e., reduce pathogens below levels of detection). Because sewage sludge that meets the Class A pathogen reduction standard does not pose a risk of an infectious dose, no access restrictions or restrictions on the growing or harvesting of food crops are imposed. Such restrictions would not be feasible for sewage sludge that is distributed and marketed to the general public. In contrast, the land application subpart allows treatment works the option of selecting alternative pathogen reduction standards, Classes B and C, as long as the landowner imposes public access and animal grazing controls and restricts the growing and harvesting of crops in accordance with the standards of the class of pathogen reduction selected.

Another difference between the requirements in Subparts B and C are the numerical limits for some of the organic pollutants and some metals when sewage sludge is applied to agricultural land and when sewage sludge is distributed and marketed. In both scenarios it is assumed that the sewage sludge is used in the production of crops intended for human consumption. The numerical limits for the application of sewage sludge to agricultural land are based on crops intended for direct human consumption or fed to animals intended for direct human consumption, whichever is the more stringent loading rate. For the organic pollutants, which tend to bioaccumulate through the food chain, the limiting numerical limit is based on crops fed to animals intended for human consumption. As explained in Subpart C, the distribution and marketing scenario is designed to protect a fruit and vegetable home garden, not a garden in which feed is raised for animals intended for human consumption. Therefore, the numerical limits for organic pollutants in distribution and marketing tend to be higher than those for agricultural land application.

The third major difference in the requirements between Subparts B and C is that for the requirements in Subpart B to apply, there must be an agreement between the treatment work and the distributor or applier of the sewage sludge to abide by the requirements in Subpart B, such as the access and use restrictions. If there are no agreements and sewage sludge is applied to the land, treatment works must comply with the requirements for the distribution and marketing of sewage sludge in Subpart C.

In developing the requirements for the land application of sewage sludge, the Agency assumed that, except for the applier, there would be little public contact with the sewage sludge itself or with the land receiving the sewage sludge. EPA also assumed that public access restrictions could be imposed on either agricultural or non-agricultural land for a period of time. The underlying premise in developing sewage sluge distribution and marketing requirements was that the sluge would be used in a home garden where there would be immediate and continuous human contact with the sewage sludge or with the land receiving it. Under such circumstances, the Agency could not restrict access.

As discussed earlier in the preamble, Part 503 does not apply to sewage sludge that is determined to be hazardous or to sewage sludge that contains Polychlorinated Biphenyls (PCBs) in conentrations equal to or greater than 50 parts per million (ppm). Such sludge is regulated under Subtitle C of RCRA and under the Toxic Substances Control Act (TSCA). Amendments to 40 CFR 761.20 (53 FR 24220, June 27, 1988) specifically exclude the land application of PCB-contaminated sewage sludge from the prohibition on using PCBs (regardless of the concentration), except in a totally enclosed manner, when the sewage sludge use is regulated under CWA and RCRA. This amendment codified the Agency's traditional practice of deferring to programs other than those of TSCA when regulating materials with less than 50 ppm of PCBs.

Specialized Definitions (§ 503.11)

In this section of the proposal, the Agency defines and clarifies terms that it uses throughout this subpart or in other definitions. Not all of the terms in § 503.11 will be discussed in the order in which they are listed in the rule.

Agricultural Land

The Agency estimates that approximately 25 percent of the sewage sludge that is generated by POTWs is applied to the land and that 77 percent of the sewage sludge applied to the land (approximately 926,000 million dry metric tons) is used to improve the condition and nutrient content of agricultural lands. The definition of agricultural land includes land on which crops or animals are raised for human consumption (e.g., pastures for the grazing of animals). This beneficial reuse of sewage sludge has been and continues to be an Agency priority.

The numerical limits, management practices, and other requirements for agricultural land are applicable if sewage sludge is applied to lands on which the applier grows his or her food or grows food for others. For example, the requirements for agricultural lands apply to pastures used for deer that are raised for subsequent sale or for deer hunts, whereas the requirements for non-agricultural land would apply to land where deer may graze as long as the hunting of the deer is prohibited.

Non-Agricultural Land

Non-agricultural land is defined as land on which neither food nor animal feed crops (including pastures) are grown. Example of non-agricultural lands include lands used for forests or turf farming, lands reclaimed for more productive purposes (i.e., lands devastated by fires, strip mining, etc.), and lands dedicated to sludge disposal.

The beneficial reuse of sewage sludge is not limited to the growing of food-chain crops. Sewage sludge applied to forest lands shortens wood production cycles and increases yields, especially on marginally-productive lands. Marginally-productive lands and lands suffering from poor soil stability and severe water and wind erosion can be stabilized and put to more productive uses through the application of sewage sludge and the establishment of a vegetative cover. For example, strip-mined areas and constructive sites have been reclaimed for use as wildlife sanctuaries and parks.

Lands dedicated to sludge disposal are usually owned or controlled by the treatment work. The objective of this practice is to employ the land as a treatment system by using soil to bind the metals and allow soil microorganisms, sunlight, and oxidation to destroy the organic matter in the sludge. Vegetative covers are established on these lands to preclude the runoff of sludge with soil and water. Although intensive management is required, this may still be less costly than other sewage sludge use or disposal practices in areas where land is available.

No food or feed crops may be grown or animals intended for human consumption raised on non-agricultural lands during the application of sewage sludge or for 5 years after the final application of sewage sludge. This should encourage treatment works to use the soil conditioning properties and nutrient contents of the sewage sludge without concern about the effect of higher pollutant concentrations on the food-chain.

Annual Pollutant Loading Rate

The annual pollutant loading rate is the amount of an organic chemical (in kilograms) that can be applied to a hectare of land (2.5 acres) in a 365-consecutive-day period. The annual pollutant loading rates apply to organic pollutants and is one of two pollutant limits for sewage sludge used in agricultural land. The other pollutant limit is the cumulative pollutant loading rate for metals.

Table 1 in § 503.13 of the proposed rule lists the annual pollutant loading rates for 15 organic pollutants covered by today's proposal. The annual pollutant loading rate, derived from the exposure assessment model, ensures that the amount of a pollutant reaching a target organism does not exceed the human health or environmental criterion for that organism. For humans, the criterion is a carcinogenic potency value ($Q_1{}^*$ value) because the 15 organic pollutants in Table 1 are all carcinogens. The $Q_1{}^*$ values are listed in the Agency's Integrated Risk Information System (IRIS). For plants and animals, the criteria are toxicity values derived from the scientific literature and are listed in the "Technical Support Document: Land Application and Distribution and Marketing of Sewage Sludge" (Reference number 57).

As discussed in Part IV of the preamble, a key assumption in establishing an annual pollutant loading rate is that organic pollutants decompose according to first-order kinetics. In other words, the quantity of a pollutant decomposing or lost each year is directly proportional to the quantity present in the soil. This means that when a pollutant is applied at a steady rate for many years, the soil concentration approaches a plateau at which the rate of loss equals the rate of application. The annual pollutant loading rate is established to ensure that the long-term pollutant concentration in the soil is below a concentration that would exceed a human health criterion (i.e., equal to an incremental carcinogenic risk of 1×10^{-4}) if the plant absorbing the pollutant is eaten. For pathways involving the direct ingestion of a sludge-soil mixture by children or by grazing animals, the model builds in the half-life of a pollutant, particularly for persistent organic pollutants such as PCBs.

The Agency has developed a procedure and an equation to determine the amount of a sludge that may be applied each year without exceeding the pollutants' annual loading rates. The procedure is spelled out in Appendix B of the proposed rule and is explained in connection with the discussion of the pollutant limits later in this subpart of the preamble.

Cumulative Pollutant Loading Rate

The cumulative pollutant loading rate is the maximum amount of a pollutant that can be applied to the land without exceeding a human health or environmental criterion when the pollutant reaches a target organism. An exposure assessment model is used to establish a cumulative pollutant loading rate for each of the 10 inorganic pollutants listed in Table 2 of § 503.13.

The exposure assessment model incorporates two key assumptions. The first is that the background metal concentration corresponds to an average background value for rural agricultural lands (Reference number 57). The second is that over a period of time, the metals adhere to the sludge-soil matrix and do not become more available to plants. The Agency also assumed that the amount of metal absorbed by a plant is a function of the total metal in the soil and that absorption by a plant is determined by the total metal in the soil.

The Agency recognizes that not all of the metal is in a form that can be absorbed by the plant. Only the leachable portion of the metal is available for absorption. Since there is insufficient data to determine the percentage of absorbable metal in a sludge-soil matrix, the Agency assumed that all of the metal is available to the plant. The Agency has initiated work to develop an index to correlate total metal in a sludge-soil matrix to the percentage absorbed by a plant. The percentage of the metal that is actually available for absorption by a plant could significantly affect the amount of metal that may be applied to the land without causing adverse human health or environmental effects, particularly if it is a small amount. The Agency is soliciting data on the dissolved and bound portions of metals in a sludge-soil matrix to assist it in determining the amount available to a plant.

The cumulative pollutant loading rate is the total amount of the pollutant, in kilograms per hectare (kg/ha), that can be added to the background concentration already in the soil without exceeding a human health or environmental criterion when the pollutant reaches the target organism. None of the 10 inorganic pollutants is a carcinogenic when ingested. Therefore, except for arsenic and lead, the Agency used the reference dose (RfD) from IRIS as the human health criteria. Arsenic and lead are not listed in IRIS.

In the case of arsenic, EPA derived a daily dietary intake (DDI) from the maximum contaminant level (MCL). For lead, however, the Agency believed that the existing MCL (50 micrograms per liter) was too high a threshold on which to base a DDI. Therefore, as explained earlier in Part V of the preamble, the Agency derived a DDI on the basis of the amount of lead which could be in food without an adult white male exceeding a blood lead level of 10 micrograms per deciliter (10 μg/dl). Using this approach limits the cumulative pollutant loading rate of lead to 176 kg/ha. However, an environmental pathway (bird eating earthworms) limits the cumulative pollutant loading rate to 125 kg/ha, which, as the more stringent limit, was used by the Agency. The numerical limit of 125 kg/ha is significantly lower than the median regulatory range of 530 kilograms per hectare in the 32 States that have established cumulative loading rates for lead. In these States, the cumulative pollutant loading rates range from 200 to 2520 kilograms per hectare. Current EPA guidance suggests that lead should not be applied at a cumulative pollutant loading rate in excess of 500 to 2,000 kg/ha. The proposed limit of 125 kg/ha will result in significant reductions. As noted earlier in the preamble, the Agency is soliciting comment on the impact of this limit on the beneficial reuse of sewage sludge and on the potential intermedia transfer of lead risks.

The Agency has developed a procedure and an equation to determine the number of years that sewage sludge can be applied to the land without exceeding the cumulative pollutant loading rates. The procedure and equation are spelled out in Appendix C of the proposal and are explained in connection with the discussion of the numerical limits.

Land Application—General Requirements (§ 503.12)

Sewage sludge applied to the land must be applied in accordance with the requirements in Subpart B of the rule. All individuals who apply sewage sludge to the land (as opposed to individuals applying a "sewage sludge product" that is distributed or marketed, see Subpart C) must comply with the requirements.

Agreements

Before sewage sludge may be applied to the land by anyone other than the treatment work, the treatment work must enter into an agreement with the distributor or applier of the sewage sludge. This agreement may be in the form of a performance agreement, a contract, or another similar instrument and must provide that the distributor or applier will meet the requirements in Subpart B of the rule. Thirty-eight States currently require agreements when sewage sludge is applied to the land.

The agreement between POTWs and distributors and appliers is a mechanism for ensuring the distributors and appliers are aware of the obligation, under section 405(e), to dispose of sewage sludge in accordance with the Section 405 technical standards. That obligation arises directly from the statute, not because of the existence of contractual relationship between the POTW and distributor or appliers. Moreover, the requirement to use and dispose of sewage sludge in accordance with the technical standards is directly enforceable by EPA under the statute. Section 405(e) makes it clear that it is unlawful to dispose of sludge for any use for which regulations have been established, except in accordance with the regulations.

The Agency is interested in specifying only the minimum number of elements needed in an agreement to assure compliance with the rule and will carefuly consider suggestions to add or delete any elements to simplify the agreement. The Agency is particularly interested in the effect the agreements would have on small farmers and whether the agreements would discourage the use of sewage sludge in farming operations.

General provisions to be included in written agreements for both agricultural lands and non-agricultural lands are discussed first, followed by the particular provisions directed at sewage sludge that is applied to agricultural lands and to non-agricultural lands.

1. *General Provisions.* All agreements, whether with a sewage sludge distributor or applier, are to provide the following information:

- Name and address of person(s) receiving and applying the sewage sludge;
- Location(s) and legal description of the site(s) to which the sludge will be applied;
- Size(s) of the sites (or portion thereof) to which the sludge will be applied, in hectares or acres;
- The nitrogen concentration of the sewage sludge;
- Amount of sewage sludge to be applied to each site, in metric tons;
- Class of pathogen reduction used in the sewage sludge and the applicable use and access restrictions set forth in

40 CFR 503.52 for that class of pathogen reduction;
• Vector attraction reduction used in treating the sewage sludge;
• Period of time after receipt within which the sewage sludge must be applied;
• Application method to be used (i.e., injection below the surface of the soil, spraying, surface application, etc.) and whether or not the sludge is to be incorporated into the soil; and
• Storage method to be used in case of inclement weather and public health and environmental protective practices to be used until the sludge is applied.

This agreement also must contain prohibitions on the following:
• Application of sewage sludge at rates in excess of the nitrogen requirements of the vegetation and at rates that would cause the excess nitrogen to leach to the ground water;
• Application of sewage sludge to the land if such application will cause or contribute to the harm of an endangered or threatened species of plant, fish, or wildlife, will result in the destruction or adverse modification of the critical habitat of the endangered or threatened species, will restrict the flow of the base flood, or will reduce the temporary water storage capacity of the floodplain;
• Application of sewage sludge to frozen, snow-covered, or flooded land, unless it will not cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirement of the CWA; and
• Application of sewage sludge to any land that is 10 meters (30 feet) or less from a surface water.

2. *Provisions For Agricultural Lands.* In addition to the general provisions, these agreements must also include the following requirements whenever sewage sludge is applied to agricultural lands:
• Concentration of the pollutants listed in Tables 1 and 2 of 40 CFR 503.13;
• Prohibition on applying sewage sludge in amounts greater than 50 metric tons per hectare (on a dry weight basis);
• Amount of sewage sludge, in metric tons per hectare, that may be applied in a 365-consecutive-day-period without exceeding the annual pollutant loading rates in Table 1 of 40 CFR 503.13 (using procedures in Appendix B of 40 CFR Part 503 to determine the appropriate whole sludge application rate); and

Number of years that sewage sludge may be applied to the land without exceeding the pollutant loading rates in Table 2 of 40 CFR 503.13 (using procedures in Appendix C of 40 CFR Part 503 to determine the number of years that sewage sludge may be applied to the land).

Note that if the quality of the sludge changes, the amount of sludge that may be applied to the land also changes. If sludge quality improves, more could be applied to the land, provided that the increment does not exceed the nitrogen requirements of the crops. However, if the sludge quality becomes worse, less sludge may be applied to the land to avoid exceeding the numerical limits in Tables 1 and 2 in § 503.13.

3. *Provision For Non-Agricultural Lands.* In addition to the general provisions, agreements must also establish the following requirements whenever sewage sludge is applied to non-agricultural lands:
• Concentrations of the pollutants in Table 3 of 40 CFR 503.15;
• Prohibition on growing food or feed crops on the land during the period when sewage sludge is applied to that land and for 5 years after the final application of sewage sludge;
• Prohibition on grazing animals on the land during the period when sewage sludge is applied to that land and for 5 years after the final application of sewage sludge;
• Requirement that a vegetative cover be established on the land; and
• Prohibition on public access to the land to which sewage sludge meeting the Class A pathogen reduction requirements has been applied, until a vegetative cover has been established.

Each of the provisions in the agreement relates to a specific requirement in the rule and will be discussed in connection with the requirement. The agreement will also require submission of all the information a treatment work will need to comply with the monitoring, record keeping, and reporting requirements included in today's proposal.

The Agency recognizes that the portion of the agreement dealing with agricultural lands does not address the issue of an individual who receives sewage sludge from more than a single source. If individuals were to receive sewage sludge from more than one source, potentially more sewage sludge could be applied in a year to a parcel of land than would be authorized by the annual pollutant loading rates in Table 1. Of greater concern, however, is that over time, an individual receiving sewage sludge from multiple sources could exceed the cumulative pollutant loading rates for the metals listed in Table 2.

The Agency does not know if individuals frequently receive their sewage sludge from more than one source. Some States do keep records of individuals receiving sewage sludge, and these States may be able to identify those individuals. EPA is interested in comments on whether the practice of receiving sewage sludge from more than one source is so prevalent that modifications should be made in the agreements to require that individuals identify all sources from which they are receiving or have received sewage sludge and notify the POTWs when they receive sludge from a new source.

Other General Requirements

Some of the general requirements in today's proposal are taken from the "Criteria For Classification of Solid Waste Disposal Facilities and Practices" (40 CFR Part 257). These requirements are to ensure that the land application of sewage sludge does not contribute to adverse human health or environmental effects. Specifically, today's rule proposes that sewage sludge applied to the land shall not cause or contribute to the harm of an endangered or threatened species and shall not result in the destruction or adverse modification of the critical habitat of such species. Other 40 CFR Part 257 requirements in today's proposal also include the following floodplain restrictions: (1) Sewage sludge shall not restrict the flow of a base flood (i.e., a flood that has a one percent or greater chance of recurring in any year or a flood of a magnitude equalled or exceeded once in 100 years); (2) it shall not reduce the temporary water storage capacity of the floodplain; and (3) washout of sewage sludge shall not pose a hazard to human health, wildlife, or land or water resources. Twenty-three States have similar floodplain restrictions.

As a supplement to these provisions, the Agency is proposing to prohibit the application of sewage sludge to frozen, snow-covered, or flooded land unless the applier demonstrates that the sewage sludge can be applied in a manner that will not cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirement of the CWA. There is every reason to assume that sewage sludge applied to frozen, snow-covered, or flooded lands would readily be transported off the site with the first melt or rainfall into a river, stream, or lake. Twenty-six States impose similar restrictions on the land application of sewage sludge. The Agency is interested in the experiences of those who have successfully applied sewage sludge to frozen, snow-covered, or flooded lands and the techniques that were used to prevent the sewage sludge from reaching a river, stream, or lake. Such information will assist the Agency in developing guidance on the type of demonstrations that should be made.

Agricultural Land—National Pollutant Limits (§ 503.13)

Pollutants

EPA is proposing numerical limits for a total of 25 pollutants when sewage sludge is applied to the land. Table III-1 in the preamble lists the pollutants that were originally evaluated. Nitrogen and phosphorus were not included. The Agency believes that if sewage sludge is applied in accordance with the nutrient requirements of the plant, nitrogen and phosphorus would not be applied in sufficient quantities to adversely affect ground water or surface water. The Agency may consider modeling nitrogen and phosphorus, if comments on the proposal suggest that good agronomic practices generally have not been followed, particularly for non-agricultural lands.

Table III-2 of the preamble lists the pollutants that do not interfere with the land application of sewage sludge at the concentration shown in "Fate of Priority Pollutants in Publicly Owned Treatment Works" (the "40 City Study"). The Agency determined that, even under the worst combination of circumstances, cyanide, fluoride, iron, and pentachlorophenol do not interfere with the land application of sewage sludge. As shown in Table 12 of § 503.72, the Agency would authorize removal credits for these pollutants when sewage sludge is applied to the land.

Table III-3 lists the pollutants that were originally evaluated, but for which numerical limits are not included in today's proposal due to insufficient data or because the Agency has not established a human health criterion for the pollutant. These pollutants may be considered in future rulemaking proceedings if sufficient information becomes available.

Tables 1 and 2 in § 503.13 of the proposed rule list the pollutants and numerical limits for sewage sludge application to agricultural lands. Table 3 in § 503.15 lists the pollutants and numerical limits for sewage sludge application to non-agricultural lands. The pollutants in Tables 1, 2, and 3 are among the pollutants that are eligible for removal credits when sewage sludge is applied to the land. Treatment works whose sludge meets the pollutant limits in these tables may issue removal credits to their industrial users if the treatment work is eligible to do so under the provisions in 40 CFR Part 403.

As discussed in Part VIII of the preamble, the Agency used a different approach in establishing numerical limits for sewage sludge applied to agricultural lands from that used for non-agricultural lands. In establishing the numerical limits for agricultural lands, the Agency used the exposure assessment models to limit the potential for individuals to receive a high level of pollutant exposure through their diet. For non-agricultural lands, where there is little likelihood that pollutants will reach individuals through their diets, the Agency used current sludge quality (i.e., the 98th-percentile pollutant concentration shown in the "40 City Study"), unless the exposure assessment models for agricultural lands calculated a higher numerical limit. In the latter case, the pollutant limit is based on the exposure assessment model.

Figure IX-B.1 shows how the pollutant limits, pathogen and vector attraction reduction requirements, and management practices determine whether or not sewage sludge may be applied to agricultural land. Each of these factors is discussed below.

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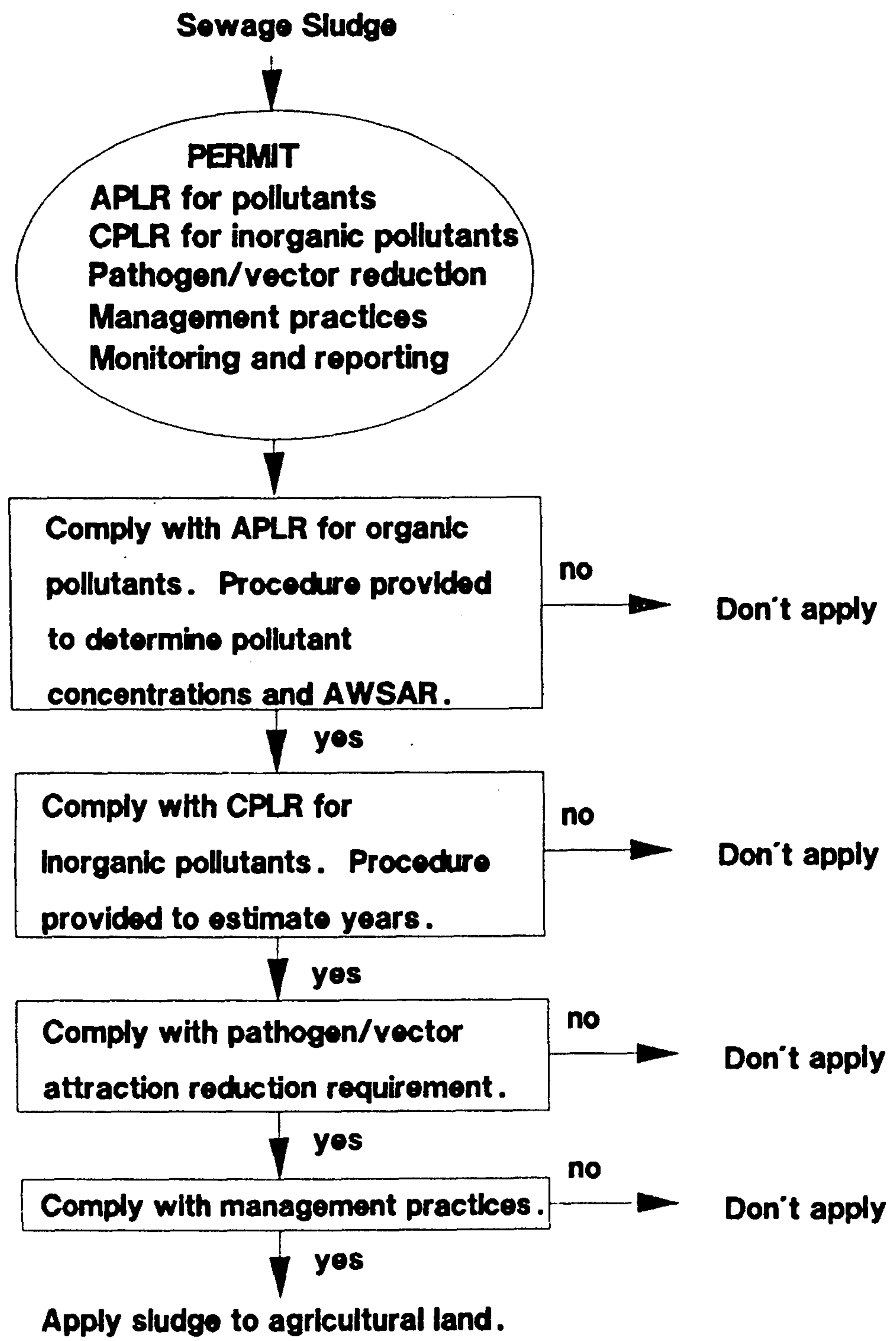
Figure IX–B.1

LAND APPLICATION (AGRICULTURAL LAND)



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Annual Pollutant Loading Rate

The annual pollutant loading rates for organic pollutants are listed in Table 1 of the proposal. The concentration of the organic pollutant in the sewage sludge controls the annual rate at which sludge may be applied to the land (i.e., the annual whole sludge application rate) because the annual pollutant loading rate remains constant with the annual whole sludge application rate. As the pollutant concentration increases, the annual whole sludge application rate decreases and vice versa. The annual whole sludge application rate is determined using the following equation:

$$APLR = C \times 0.001 \times AWSAR \quad (1)$$

Where:
APLR = Annual pollutant loading rate, in kilograms per hectare per year.
C = Pollutant concentration in sewage sludge, in milligrams per kilogram (dry weight basis).
AWSAR = Annual whole sludge application rate, in metric tons per hectare, per year (dry weight basis).
0.001 = Converts milligrams per kilogram times metric tons per hectare to kilograms per hectare.

To determine the pollutant concentration in sewage sludge the equation is rearranged as follows:

$$C = \frac{APLR}{0.001 \times AWSAR} \quad (2)$$

The annual whole sludge application rate would be determined by the pollutant concentration that gives the lowest whole sludge application rate. Appendix B of the rule explains in more detail the procedures for determining the annual whole sludge application rate and provides an example.

Cumulative Pollutant Loading Rate

The cumulative pollutant loading rate is listed on Table 2 of the proposal. To determine the number of years sewage sludge may be applied to the land, the following equation would be used:

$$Y = \frac{CPLR}{APLR} \quad (3)$$

Where:
Y = Number of years that sewage sludge may be applied to the land.
CPLR = Cumulative pollutant loading rate, from Table 2 of the proposed rule.
APLR = Annual pollutant loading rate, derive from equation (1) of this subpart of the preamble.

The pollutant with the lowest number of years at a given annual pollutant loading rate or annual whole sludge application rate determines the number of years for sludge application. Appendix C of the rule explains in detail the procedure for determining the number of years that sludge may be applied to the land and provides an example.

In Part IV of the preamble, the Agency discusses the key assumptions in the exposure assessment models and asks for public review and comment on the data used in developing the models. The data used in the models are tabulated in the "Technical Support Document: Land Application and Distribution and Marketing" (Reference number 57). Part XIII describes how copies of the exposure assessment models may be obtained.

The "Technical Support Document: Land Application and Distribution and Marketing" also contains a matrix showing the 14 pathways of exposure and the pathway for each pollutant that determines the pollutant limit. The pathway that results in the most stringent numerical limit is not always the pathway in which human health protection is the objective. In some cases, an animal or plant toxicity value may be the most stringent. Aldrin, dieldrin, and lead limits, for example, are derived based on the pathway in which predators eat soil biota. Chromium and zinc limits are derived from phytotoxicity values. The Agency believes that the pollutant limits should protect both human health and the environment, but recognizes that some may question whether factors other than human health should control the numerical limits in an agricultural setting. EPA is soliciting comment on this question.

Changes to Cadmium and PCBs

This proposal establishes numerical limits for cadmium and PCBs that are different from the limits in 40 CFR 257.3–5(a). Section 257.3–5(a) establishes annual and cumulative numerical limits for cadmium based on a soil pH of 6.5 or greater and varying milliequivalents of soil cation exchange capacity. As explained earlier, today's proposal does not establish an annual pollutant loading rate for cadmium because the rate at which a metal is applied to the land is less important than the total amount of the metal applied to a specific site.

The Agency is proposing a 18 kilogram per hectare cumulative pollutant loading rate for cadmium. The 40 CFR 257.3–5(a) rule established a cumulative pollutant loading rate of between 5 and 20 kilograms per hectare, depending on the soil cation exchange capacity.

There are several reasons for the differences in the numbers. First, recent research shows that soil cation exchange capacity does not affect the plant's absorption of cadmium when cadmium is in a sludge-soil matrix (Reference number 26). Although previous experiments had shown a direct relationship between the milliequivalent of soil cation exchange capacity and plant absorption of cadmium, these experiments had used the more bioavailable soluble cadmium salts ($CdCl_2$) rather than the cadmium present in sewage sludge. Metals in sewage sludge tend to remain bound to the organic matrix so that not all of the metal is absorbed by the plant.

Another reason for the differences in the cadmium cumulative pollutant loading rates is that today's proposal assumes a soil pH of 6, rather than a soil pH of 6.5. At the time 40 CFR 257.3–5(a) was issued, data indicated that a soil pH of 6.5 or greater was necessary to minimize plant absorption of cadmium for food-chain crops. A more recent review of available data indicates that metal absorption by plants at a pH of 5.7–6.0 is the same as at a pH of 6.4 or greater (Reference numbers 71 and 72).

The Agency believes that basing cadmium's cumulative loading rate on a soil pH of 6 and a toxicity value using lettuce leaf absorption of cadmium (lettuce has a strong tendency to accumulate cadmium) will adequately protect public health and preclude phytotoxic effects. However, the Agency continues to evaluate data and welcomes additional data on the effect of different soil pH on plant absorption of metals from a sludge-soil matrix.

The limits in 40 CFR 257.3–5(b) for PCBs are based on a concentration of PCBs in sewage sludge or on a level of PCBs in animal feed or milk. Today's proposal uses the exposure assessment models to establish a numerical limit for PCBs that take into account PCB bioaccumulation in plants and animals. Therefore, the Agency believes that today's approach is more appropriate for establishing a numerical limit for PCBs.

The proposed numerical limit for PCBs in Table 1 is more restrictive than the Agency's PCB Cleanup Policy for residential areas where soil cleanup must not exceed 10 ppm with a 10-inch cap of soil of less than 1 ppm (40 CFR 761.125(c)(4)(v)). The Cleanup Policy limit for acceptable soil containment levels is based on soil ingestion, inhalation, and ground water contamination. The Cleanup Policy is not based on food-chain pathways, a particularly important pathway for the land application of sewage sludge to agricultural lands. The critical application of sewage sludge to agricultural land is a grazing animal that is used for meat and animal products because of the bioaccumulation of PCBs through the food-chain.

Alternatives to National Numerical Limits

The Agency is proposing national numerical limits for the pollutants in Tables 1 and 2. There is no provision for case-by-case use of site-specific data to calculate alternative pollutant limits as there is for the disposal of sewage sludge in a monofill or for the incineration of sewage sludge. EPA adopted the approach of proposing only national numerical limits for the application of sewage sludge to agricultural lands because the Agency did not find that changes in site parameters made a significant difference in the numerical limits when it performed sensitivity analyses on the site parameters. As discussed earlier, EPA is limiting the use of site-specific data to parameters related to the physical conditions of the site (i.e., depth to ground water) when calculating case-by-case numerical limits. However, the parameters in the exposure assessment models could be varied.

The Agency recognizes that there could be significant differences in the numerical limits, depending on the type of crop grown. Since crops are generally rotated, the Agency did not believe that it was administratively feasible to establish alternative numerical limits for every possible combination of crops that might be grown on a particular field.

The approach that the Agency is proposing may impose numerical limits that are more stringent than necessary in some cases and less stringent, although fully protective, in others. Therefore, the Agency is particularly interested in public comment on the values used in the exposure assessment models for land application. EPA also solicits comment on whether or not the combination of assumptions used in the models and the requirements in today's proposal adequately protect public health and the environment without over-regulating and discouraging the beneficial use of sewage sludge to agricultural lands.

As discussed in Part XI of the preamble, the Agency estimates that 266 POTWs that apply sewage sludge to agricultural lands are likely to exceed the numerical limits in Tables 1 and 2.

Agricultural Land—Management Practices (§ 503.14) 50-Metric Ton Limitation

The proposed rule limits the application of sewage sludge to agricultural lands to 50 metric tons per hectare (20.24 metric tons per acre) or less, on a dry weight basis. This is equivalent to 250 metric tons of wet sludge per hectare (approximately 100 metric tons of sludge per acre), assuming a 20 percent solids content. There are two reasons for the 50-metric ton limitation. First the exposure assessment model cannot calculate pollutant limits above 50 metric tons per hectare. At 50 metric tons per hectare, the sludge starts to dominate the sludge-soil mass, and the model loses its predictive capability. Second, and equally important, the Agency believes that land application becomes a disposal, rather than a reuse practice, at rates over 50 dry metric tons per hectare.

Crop and Access Limitations

Section 503.14(b) requires that owners or operators of agricultural land to which sewage sludge has been applied meet the crop and access restrictions in § 503.52. These restrictions are to protect crops, animals, and people from pathogenic organisms.

EPA is proposing that sewage sludge applied to the land meet one of the three classes of pathogen reduction which are discussed in connection with Subpart F of the preamble. The class of pathogen reduction selected determines the rigor of the access and use restrictions.

For the Class A pathogen reduction requirements, treatment works must reduce all pathogenic organisms below levels of detection. These requirements must also be met if the treatment processes raise the temperature of the sewage sludge to 53 degrees Celsius and reduce the density of fecal coliforms and fecal streptococci to 100 per gram of volatile suspended solids. Because the risk of infection and disease from pathogenic organisms has thereby been eliminated, no access or use restrictions are placed on sewage sludge that meets the Class A pathogen requirements.

If, however, a treatment work elects to meet the Class B pathogen reduction requirements, public access to the land and the growth and harvesting of crops are restricted to eliminate any remaining potential for pathogenic infections. Class B pathogen reduction requirements specify the reductions in the densities of pathogenic bacteria and animal viruses per unit mass of volatile suspended solids. Time and natural processes are used to kill the protozoa and helminth ova.

Section 503.52(b)(4) prohibits public access to the agricultural land where the sewage sludge has been applied for a period of 12 consecutive months after the application of sewage sludge meeting the Class B pathogen reduction requirements. This does not preclude owners, operators, or employees from working in the fields, but it assumes that they will take the necessary precautions of washing before handling food and preventing the spread of any organisms from their clothing. Access restrictions are being imposed because the Agency could not assume that the general public would be aware of the need for such precautions. EPA is not specifying the way in which land owners or operators are to restrict public access, although local authorities may wish to do so. It is the Agency's belief that fencing or periodic signs should be sufficient in populated areas.

The use restrictions on sewage sludge meeting the Class B pathogen reduction requirements in § 503.52(b)(2) specify that no food crops with harvested parts above the ground and touching the sludge or the sludge-soil mixture may be grown for a period of 18 consecutive months after the application of sewage sludge. The restriction does not apply to crops, such as tomatoes, with harvested parts that do not come into contact with the sludge. Research indicates that 18 months should be sufficient for the attenuation of the pathogenic organisms.

Food crops with harvested parts below the ground, however, may not be grown for a period of 5 years, unless a demonstration can be made that there are no viable helminth ova in the soil. If such a demonstration is made, food crops with harvested portions below the ground may be grown 18 months after the application of the sewage sludge. EPA is proposing this restriction because some helminth ova have been shown to survive for as long as 5 years. Even though a demonstration can be made that there are no surviving helminth ova, 18 months is needed to allow time for natural processes to inactivate or destroy helminth ova and other pathogenic organisms.

Today's rule also proposes that animal feed crops not be harvested for a 30-day period after the application of the sewage sludge. During this time, wind and rain are likely to reduce the amount of sewage sludge that adheres to the feed crops.

In addition to the restrictions on food and animal feed crops, EPA is proposing that no animals be allowed to graze on agricultural lands for 30 days after the applications of sewage sludge. The 30-day period allows time for the climatic conditions to integrate the sludge into the soil layer to prevent animals from physically removing the sludge from the fields or ingesting bacteria such as salmonella.

If the treatment work chooses to meet the Class C pathogen reduction requirements, more rigorous access, harvesting, and grazing restrictions are imposed. This is necessary because the reductions in the density of pathogenic bacteria and animal viruses are less stringent than those in the Class A or Class B requirements. Class C requirements specify that, except for those actually applying the sludge, access is prohibited for 12 months where sewage sludge meeting the Class C requirements has been applied.

The restrictions on growing food crops where sludge meeting Class C requirements is applied are the same as those for sludge meeting Class B requirements. However, the Agency is proposing to prohibit the harvesting of animal feed crops and the grazing of animals for 60 days after the application of sewage sludge.

Agronomic Rates

Section 503.14(c) includes a provision that sewage sludge may not be applied at rates in excess of the nitrogen requirement of the crop and at rates that would cause the excess nitrogen in the sewage sludge to leach to the ground water. The objective of this requirement is to optimize the removal of the nitrogen from the sewage sludge for optimal plant growth and to minimize nitrate contamination of ground water.

Sewage sludge contains three to five percent nitrogen. Nitrogen may be in the form of nitrogen, organic nitrogen, nitrogen as ammonia, and nitrogen nitrate. Organic nitrogen is the predominate form of nitrogen in sewage sludge and decomposes into ammonia and nitrate. Ammonia is the form of nitrogen absorbed by the plant. Ammonia not absorbed by the plant may volatilize or has the potential to oxidize and form nitrate, a water-soluble anion that moves readily downward into the soil profile. High levels of nitrate in drinking water supplies may result in health problems for both infants and livestock. The drinking water standard is 10 micrograms of nitrogen as nitrate per liter of water.

The nitrogen requirements of different plants can range from 50 to over 350 kilograms per hectare (45–312 pounds per acre). The nitrogen content of the sewage sludge, cropping patterns, plant-available nitrogen in the soil, supplemental fertilizers used, climatic conditions, and method of sewage sludge application also affect the amount of nitrogen that plants can effectively absorb from the sewage sludge.

Rather than establish a national numerical limit for nitrogen, the Agency is establishing a requirement that the appropriate limit be established based on site-specific land management practices. Guidance is available to assist in establishing the appropriate application rate from the "Process Design Manual—Land Application of Municipal Sludge" (Reference number 73) and from County Extension Service agents, State Extension soil fertility specialists, and State and local Soil Conservation Service agents.

10-Meter Set-Back

Section 503.14(e) prohibits the application of sewage sludge to land that is closer than 10 meters (30 feet) from a surface water source. EPA is proposing 10-meter set-back to reduce the potential for sewage sludge to reach the surface water in case of precipitation. In addition, the numerical limits established with the exposure assessment models are based on a 10-meter set-back from surface waters. Generally, however, States require a 100 to 200 foot set-back from surface water.

Wellhead Protection Areas

Other than the 10-meter set-back from a surface water source, EPA has not proposed locational criteria for the land application of sewage sludge. However, the Agency recommends that, in applying sewage sludge to the land, consideration be given to any Wellhead Protection Areas established pursuant to section 1428 of the Safe Drinking Water Act and any management strategies established by a State under such programs. The Wellhead Protection Program is designed to protect ground water that supplies wells and wellfields contributing water to public water supply systems. States may have established or may wish to establish other locational criteria consistent with their own Wellhead Protection Programs.

Other Management Practices

The Agency has not included provisions that require sewage sludge incorporation into the soil, soil testing for organic pollutants or metals, or achievement of a particular soil pH. Nor has the Agency included provision to limit the slope of the fields to which sewage sludge is applied. While these are sound management practices, EPA believes that its role is to establish standards which will ensure adequate protection of public health and the environment without specifying how individuals are to meet the standards. Frequently, States have specific requirements. Nine States require the incorporation of the sludge into the soil for new crops, 27 States have a soil pH requirement, 18 States require or conditionally require soil analysis, and 26 States have slope limits. Under the provision of today's proposal, States may continue to impose such requirements.

Non-Agricultural Land—Pollutant Limits (§ 503.15)

Figure IX–B.2 shows how the pollutant limits, pathogen and vector attraction reduction requirements, and management practices which determine whether sewage sludge may be applied to non-agricultural land.

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Figure IX–B.2

LAND APPLICATION (NON–AGRICULTURE)

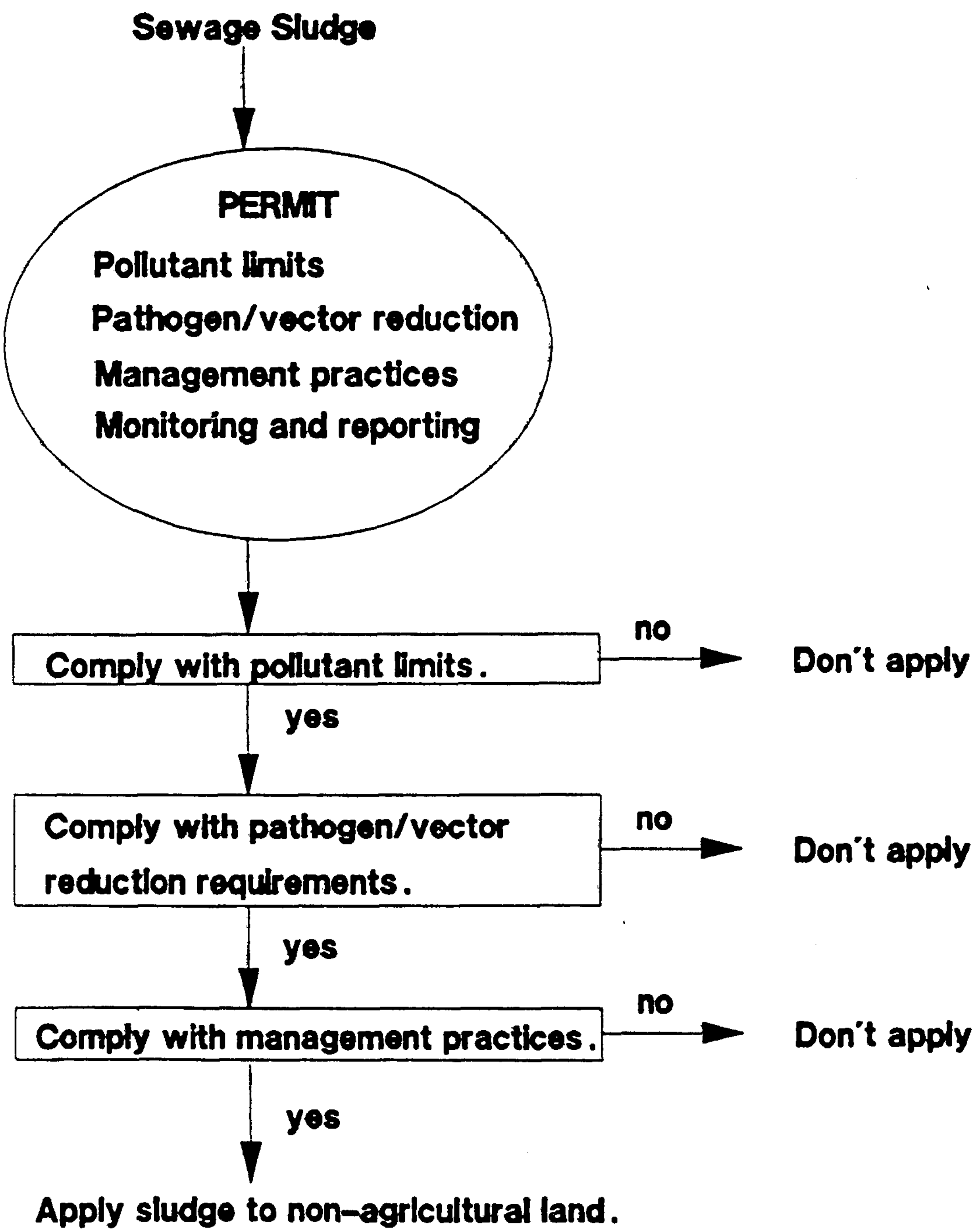

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Table 3 of the proposed rule lists the maximum concentration of a pollutant permitted in sewage sludge applied to non-agricultural lands. As discussed earlier, these concentrations are derived from current sludge quantity (i.e. the 98th-percentile concentrations shown in the "40 City Study" data base) unless the exposure assessment model calculated a higher concentration. To determine which method would give a higher concentration, the Agency assumed that sewage sludge would be applied at the rate of 50 metric tons for 10 years. Since the model calculated higher pollutant limits for aldrin, chlordane, dieldrin, DDD, DDE, DDT, heptachlor, hexachlorobutadiene, lindane, PCBs, and toxaphene, the values for these pollutants are based on the model.

As discussed in Part XI of the preamble, the Agency estimates that 12 POTWs are likely to exceed the numerical limits in Table 3.

Non-Agricultural Land—Management Practices (§ 503.16) Prohibition on Food or Feed Crops

EPA established the numerical limits for non-agricultural lands on the premise that pollutants would not reach individuals through the food-chain. Therefore, § 503.16 prohibits growing food or grazing animals on land where sewage sludge meeting the numerical limits in Table 3 is applied. Five years after the final application of the sewage sludge, food and feed crops may be grown and animals may be grazed on the sludge-amended soils.

The Agency recognizes that neither EPA nor owners or lessees can prevent inadvertent grazing by wild animals on lands where sewage sludge is applied. However, precautions must be taken to preclude hunting or foraging for food. Such precautions may include the periodic posting of signs and or fencing. Many non-agricultural lands receive a one-time sewage sludge application to assist in the reclamation of the land for more productive purposes. These purposes may eventually include covering the land to agricultural or residential uses where food-chain crops are grown or farm animals are raised. Therefore, EPA is limiting the prohibition to a period when the sludge is being applied and for 5 years after the final application of sewage sludge. Five years should provide sufficient time for the soluble portion of the metals to leach from the root zones of any crops grown or to become sorbed to the soil matrix.

EPA is interested in comments on difficulties that the Agency may incur in implementing these provisions and the experiences of State and local agencies with similar restrictions.

Other Management Practices

Vegetative covers are required on non-agricultural lands receiving sewage sludge to retard the migration of the sludge off the land into surface water bodies.

The access restrictions for Class B and Class C pathogen reduction requirements are the same for non-agricultural lands as they are for agricultural lands. For Class A sludge applied to non-agricultural lands, the Agency is proposing to restrict access to the land until a vegetative cover has been established. The establishment of a vegetative cover should reduce the risk of tracking the sewage sludge off the site until natural processes have worked the sludge into the soil profile.

In addition to these management practices, § 503.16 contains requirements precluding the application of sewage sludge to the land at rates in excess of the nitrogen requirements of the vegetation. Furthermore, sewage sludge shall not be applied to land that is 10 meters (30 feet) or less from a surface water. The reasons for these requirements are the same as those discussed in relationship to agricultural land.

The Agency believes that the proposed approach for non-agricultural lands will adequately protect public health and the environment. The exposure assessment model suggests there is some potential for exceeding the environmental toxicity values in the case of copper, zinc, and lead. This could occur if sewage sludge containing the concentrations shown in Table 3 was applied to a hectare of land at the rate of 50 metric tons per hectare on a dry weight basis. In these circumstances, the model indicates that pollutant loadings of copper and zinc would exceed the phytotoxicity values for lettuce, while pollutant loadings of lead would exceed the toxicity value for predators eating soil biota. However, in conducting the analysis, the Agency used the most sensitive species and an extremely high application rate—50 metric tons of sewage sludge per hectare, on a dry weight basis (over 100 metric tons of sewage sludge per acre, assuming 20 percent solids). Therefore, the Agency believes that the actual potential for significant or widespread adverse environmental effects is very low. EPA has requested data on the appropriate environmental criteria that should be used in evaluating the effect of applying sewage sludge to non-agricultural lands and is collecting data on concentrations of pollutants currently in sewage sludge through the National Sewage Sludge Survey.

Pathogen and Vector Attraction Reduction (§ 503.17)

Sewage sludge may be applied to agricultural or non-agricultural land if the sewage sludge meets any of the pathogen reduction requirements and the applicable access and crop restrictions are imposed. The three classes of pathogen reduction are discussed in Subpart F of this part of the preamble. EPA is seeking public comment on whether the proposed approach adequately protects the public from direct contact with pathogenic organisms and from ingestion of the organisms when sewage sludge is used in the production of agricultural commodities. Thirty-five States have adopted the pathogen reduction requirements in 40 CFR Part 257 for application of sewage sludge to agricultural lands. The Agency is particularly interested in the views of these States on the additional flexibility included in today's proposal.

In addition to the pathogen reduction requirements, Subpart F of the rule requires that treatment works process their sludge to rid sewage sludge of components that attract flies, rodents, mosquitos, and birds—disease vectors. This is generally done through the reduction of vegetative bacteria. Subpart F describes the five ways in which treatment works may reduce the vector attraction characteristic of sewage sludge.

Monitoring, Record Keeping, and Reports §§ 503.81 and 503.82)

Treatment works that apply sewage sludge to agricultural land are to measure the concentration of the pollutants on Tables 1 and 2 in § 503.13 in accordance with the frequencies established for the design capacity of the treatment work and with the sampling and analysis procedures in § 503.81. In addition, treatment works are to monitor the sewage sludge for compliance with Class A, Class B, or Class C pathogen reduction requirements. Section 503.82(a)(1) states that unless vector attraction reduction is achieved by injection below the soil surface, the sewage sludge must be monitored for volatile solids, specific oxygen uptake rate (SOUR), pH, and moisture content.

The agreements between the treatment works and the distributor or land applier contain all the records specified in § 503.82(b)(1) that treatment works must keep and all of the information necessary for treatment works to comply with the reporting requirements in § 503.82(c)(1).

EPA is proposing that treatment works applying sewage sludge to agricultural lands keep the records for the life of the treatment work to ensure that the cumulative pollutant loading rate is not exceeded for a particular parcel of land receiving sewage sludge. The Agency solicits comment on this proposal and on other appropriate time periods or ways the objective could be met without requiring records to be kept for the life of the treatment work.

The monitoring, record keeping, and reports required in §§ 503.81 and 503.82 applicable to non-agricultural lands are similar to those required for agricultural lands. One difference is that treatment works do not have to keep track of annual and cumulative pollutant loading rates. Therefore, the reports need only be kept for 5 years. Five years is not only the record retention requirements in the State sludge management program regulation, but it is also the period of time after the final application of sewage sludge that crops intended for human consumption may not be grown or animals intended for human consumption may not be raised on the land. As is true for agricultural lands, the agreement between the treatment work and the distributor or applier contains all the information necessary to comply with §§ 503.81 and 503.82.

Distribution And Marketing (Subpart C)

Applicability (§ 503.20)

Approximately 106 facilities distribute and market 705,500 dry metric tons of sewage sludge (nine percent of the sewage sludge generated). Although 22 States have regulations or guidelines applicable to the distribution and marketing of sewage sludge, today's proposal is the first Federal regulation that establishes specific requirements for sewage sludge that is distributed and marketed.

Distribution and marketing of sewage sludge as a means of managing the disposal of sewage sludge is a highly beneficial practice and one the Agency encourages. Like land application, distribution and marketing employs the soil conditioning and fertilizer value of sewage sludge. In a typical distribution and marketing (D&M) program, sludge products are sold or distributed without charge to commercial growers, landscaping firms, parks, highway departments, cemeteries, and golf courses, as well as to the public for use on lawns, ornamentals, and gardens and as a potting medium. The distribution may be carried out by the treatment work or by an independent distributor. The distributor may collect the sewage sludge from several treatment works and process the sewage before bagging or distributing the final product in bulk form. Although the municipality may receive some return from the sale of sludge products, these revenues do not usually cover the costs of treating, distributing, and marketing the sludge product. Decisions on the market area take into account such factors as the cost of shipping, the demand for the product, and the elasticity of the demand. Most facilities distributing and marketing sewage sludge products find that the demand far exceeds the supply.

Sludge quality is the most important factor to consider in the distribution and marketing of sewage sludge. The sludge must have a low concentration of metals and must meet the Class A pathogen reduction requirements in Subpart F to be distributed and marketed. This may affect some small communities that air-dry their sludge and informally give it away.

Communities that do not have adequate procedures to control the quality of their product may have to improve their quality control procedures or use an alternative practice. Sludge quality control is crucial in protecting human health and the environment and in maintaining public acceptance of the D&M method of managing sewage sludge. The numerical limits, management practices, and other requirements in today's proposal are designed to ensure that only the best quality sludges are distributed and marketed, that adequate quality control procedures are implemented, and that instructions for the appropriate uses and associated quantities of the product are given clearly. These requirements are designed to protect human health and the environment when sewage sludge is distributed and marketed and to fully inform the public on the proper use of the product. The Agency is interested in suggestions, particularly from facilities that are already involved in the distribution and marketing of sewage sludge or are considering the practice, on ways to encourage the distribution and marketing of sewage sludge.

Subpart C applies to sewage sludge that is distributed and marketed, to treatment works that distribute and market their sewage sluge, to distributors of sewage sludge or sewage sludge products, and to those applying the sewage sludge or sewage sludge products. Treatment works will need to decide whether the requirements for the land application of sewage sludge to either agricultural lands or non-agricultural lands in Subpart B are applicable or whether the requirements in this subpart apply.

In part, this decision will depend on whether or not a treatment work can enter into an agreement with a sludge user (e.g., municipal agency) that can restrict access to areas where the sludge has been applied (as required in Subpart B). If this is the case, Subpart B may provide the treatment work with more flexibility. If neither an agreement nor access restrictions are possible, however, the Subpart C requirements must be met.

The Agency developed the requirements for the distribution and marketing of sewage sludge on the premise that the sludge would be used in home gardens. Based on that premise, the Agency made the following assumptions: (1) The treatment work could not control product use; (2) the Agency could not impose access or use restrictions; (3) the Agency could require that instructions on the proper use of the product accompany the product; and (4) users would comply with the use instructions.

Specialized Definitions (§503.21)

A key concept in this subpart is the distinction between sewage sludge and a sewage sludge product. The sewage sludge product, which is the material that is distributed and marketed, may be sewage sludge or a mixture of sewage sludge and other materials (e.g., woodchips or other bulking agents).

The numerical limits in Table 4 of the proposed rule are in the form of pollutant concentrations that correspond to a specific annual whole sludge application rate. An annual whole sludge application rate is the maximum amount of sewage sludge or sewage sludge product that can be applied to a unit of land in a year without exceeding the pollutant concentrations in Table 4. The addition of bulking agents to sewage sludge by distributors may lower pollutant concentrations in the sewage sludge product, thus allowing a higher application rate for the product than for the unaltered sludge.

Pollutant concentrations in sewage sludge may vary from one treatment work to another. Thus, before distributing the product, distributors must determine the mixture's final pollutant concentrations to calculate the annual product application rate for the product's label or accompanying informational sheet.

Distribution and Marketing—General Requirements (§503.22) Agreements

Only sewage sludge or sewage sludge products that meet the requirements in

Subpart C may be distributed and marketed. To ensure product quality control, the Agency is requiring treatment works that do not distribute the sewage sludge product to enter into agreements (e.g., a performance agreement, contract, or other legally binding compliance mechanism) with their distributors. As with sludge that is applied to agricultural or non-agricultural land, sludge that is distributed and marketed must be used in compliance with the standards established in Part C of the proposed rule, which are independently enforceable and do not depend on the existence of the contract relationship between the POTW and any distributor. Rather, the performance agreement spells out the distributor's obligation under these regulations. The performance agreement is to contain the following:

- Name and address of the distributor;
- Concentrations of the pollutants listed in Table 4 of 40 CFR 503.23 that are in the sewage sludge disbursed to the distributor;
- Appropriate annual whole sludge application rate of the sewage sludge disbursed by the treatment work;
- Appropriate annual product application rate of the product to be distributed and marketed;
- Documentation that the sewage sludge disbursed to the distributor is in compliance with the Class A pathogen reduction requirements in 40 CFR 503.52(a) and that it has been monitored for volatile solids, specific oxygen uptake rate (SOUR), pH, or moisture content in compliance with the vector reduction requirements in 40 CFR 503.53; and
- Facsimile of the label or information sheet containing the information required, in 40 CFR 503.24(c), that is to accompany the product.

The Agency is reviewing examples of agreements that treatment works have with their distributors. Suggestions are particularly welcome on ways to simplify the performance agreement while still assuring compliance with the requirements in Subpart C.

The requirements for the distribution and marketing of sewage sludge include a provision that recommended application rates not exceed the nitrogen requirements for the use of the product for the reasons explained in Subpart B. This will require those developing the labels and information sheets to carefully consider the uses of their product and the areas of the country where the product is to be distributed. Nitrogen requirements differ depending on the crop and climatic conditions.

Distribution And Marketing—National Pollutant Limits (§503.23)

Pollutants

The Agency is proposing numeric limits for a total of 22 pollutants in sewage sludge that is distributed and marketed. Table III-1 lists the pollutants that were originally evaluated and Table III-2 lists the pollutants that do not interfere with the distribution and marketing of sewage sludge at the concentrations shown in the "40 City Study." The Agency determined that even under worst combination of conditions, cyanide, dimethyl nitrosamine, molybdenum, trichlorethylene, and pentachlorophenol do not interfere with sewage sludge products that are distributed and marketed. As shown in Table 12 of § 503.72, the Agency would authorize removal credits for these pollutants.

Table III-3 lists the pollutants that were originally evaluated, but for which numerical limits are not included in today's proposal due to insufficient data or because human health criteria have not been established. If sufficient information becomes available, these pollutants may be considered in a future rulemaking proceeding.

Figure IX-C.1 illustrates how the pollutant limits, pathogen and vector attraction reduction requirements, and management practices determine whether or not sewage sludge may be distributed and marketed. The requirements are discussed below.

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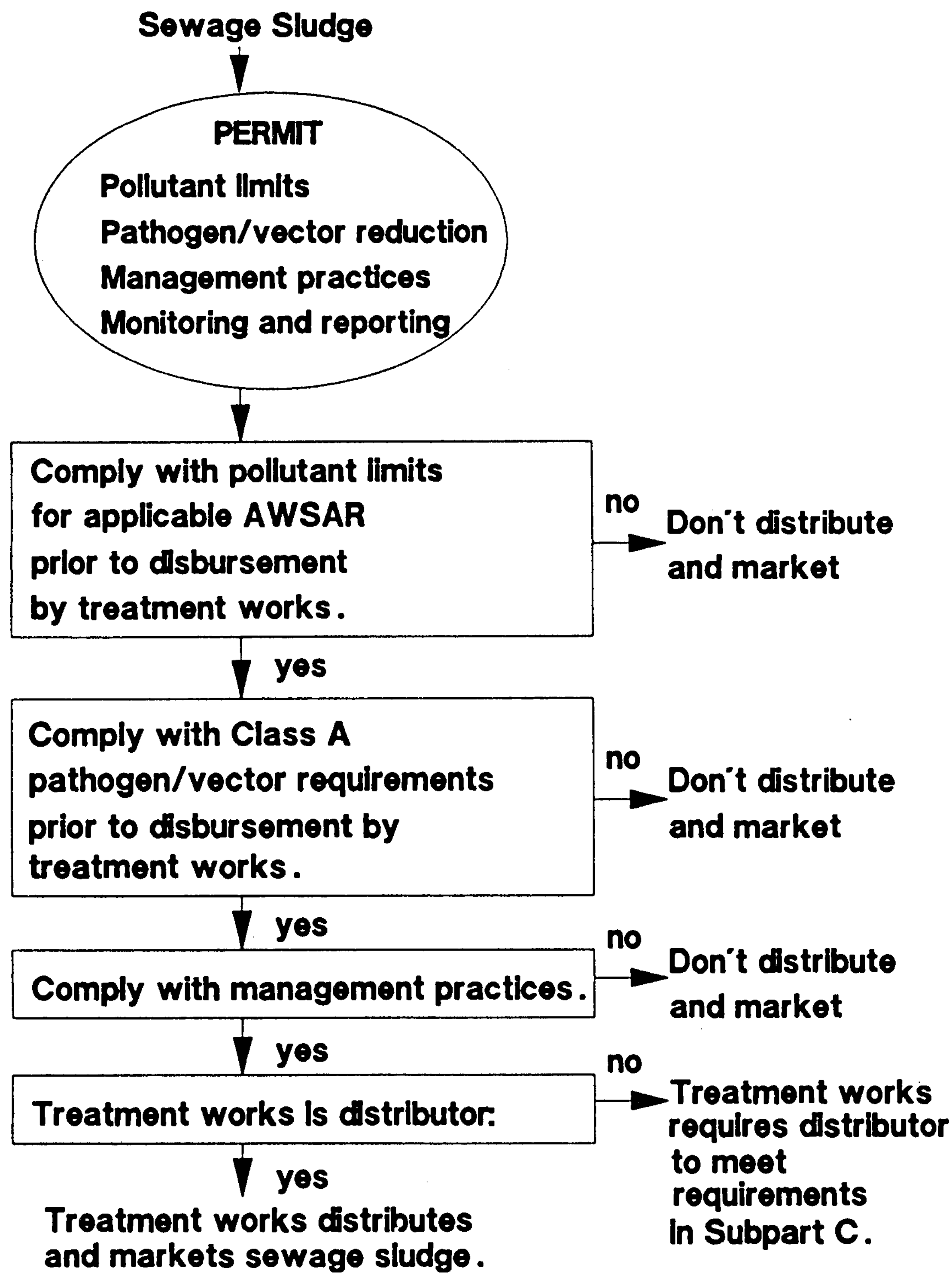
Figure IX-C.1

DISTRIBUTION AND MARKETING



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National Limits

Table 4 of the rule lists the pollutants and the concentrations of the pollutants that may be in sewage sludge that is distributed and marketed. EPA is proposing only national numerical limits because it is not feasible to take into consideration site-specific parameters when sewage sludge is distributed and marketed.

The pollutant concentrations in Table 4 correspond to an annual whole sludge application rate. Before sludge leaves a treatment work, either for distribution to the public or for transfer to a distributor, the concentrations of the pollutants in Table 4 may not exceed the concentration for the applicable annual whole sludge application rate. Similarly, the distributor must ensure that the pollutant concentrations in the product distributed and marketed do not exceed the applicable concentrations for the annual product application rate in Table 4.

EPA established the pollutant concentrations using the exposure assessment model, which calculated an annual organic pollutant loading rate or a cumulative metal pollutant loading rate. The Agency developed equations and procedures to correlate the annual pollutant loading rate to a corresponding annual whole sludge application rate and a pollutant concentration in sludge. The correlation ensures that the concentration of the pollutants reaching the plant would not exceed phytotoxicity values when sewage sludge or the sewage sludge product is applied to the land. The correlation also ensures that the concentration of the pollutants reaching an individual who ingests a plant that absorbed the pollutants or who ingests the sludge-soil mixture would not exceed the human health criteria for the pollutants. The relationship between annual pollutant loading rate, the annual whole sludge application rate, and the pollutant concentration are shown below with the same equations that were discussed in the application of sewage sludge to agricultural lands:

$$APLR = C \times 0.001 \times AWSAR \quad (1)$$

$$C = \frac{APLR}{0.001 \times AWSAR} \quad (2)$$

Where:

APLR = Annual pollutant loading rate, in kilograms per hectare.
C = Pollutant concentration in sewage sludge, in milligrams per kilogram (dry weight basis).
AWSAR = Annual whole sludge application rate, in metric tons per hectare, per year (dry weight basis).
0.001 = Converts milligrams per kilogram times metric tons per hectare to kilograms per hectare.

A treatment work or a distributor would determine the pollutant concentration in the sewage sludge or sewage sludge product for the pollutants listed in Table 4 of the rule. When the actual pollutant concentration is between the values of the Table, the lower annual whole sludge application rate applies. The appropriate whole sludge application rate is determined by the lowest annual whole sludge application rate after calculating application rates for all of the pollutants. The pollutant limits that the treatment work must meet prior to distribution are those for the appropriate annual whole sludge application rate. The annual product application rate is determined in the same way. If the distributor does not add bulking agents to reduce pollutant concentrations in the sludge, the annual product application rate is the same as the annual whole sludge application rate. If bulking agents are added or the distributor mixes sludges of different qualities, the annual product application rate would be based on the actual pollutant concentrations in the mixture. Appendix B describes the procedure in detail and provides an example.

The annual whole sludge application rates for PCBs are limited to concentrations of 49 ppm. For reasons described elsewhere in this preamble, sewage sludge with PCB concentrations of 50 ppm or greater are regulated under TSCA and the implementing regulations in 40 CFR Part 761.

Sludge-Soil Mixture

In establishing the pollutant limits in Table 4, the Agency made certain critical assumptions. The first assumption is that the sewage sludge is mixed with the soil to a depth of 6 inches. The ratio of sewage sludge to soil becomes 1 to 200, if applied at a rate of 10 metric tons per hectare.

The Agency recognizes that homeowners fertilizing their lawns are unlikely to incorporate the sludge product into the soil unless establishing new lawns. Nevertheless, homeowners may water the lawn after applying the sludge product causing the pollutants to migrate into the soil profile in a short period of time. The Agency has no data on the sludge-to-soil ratio when sludge migrates into the soil profile through watering or natural processes and is requesting data and views on the premise that either the homeowner or natural processes will ensure that sludge and soil are mixed to a depth of 6 inches.

The assumption that the sludge mixes with soil to a depth of 6 inches is critical in evaluating the effect of sewage sludge on children who inadvertently ingest soil. Because the Agency assumes that children ingest a sludge-soil mixture (i.e., a diluted form of sludge), direct ingestion of sludge is no longer the pathway that determines the pollutant concentration for lead in distributed and marketed sludge. If the Agency had assumed that children ingested pure sludge, the model would have calculated a more stringent pollutant concentration for lead. However, since the label and informational sheets accompanying the product are to warn that children should not be allowed to ingest the product, the Agency believes that children will be adequately protected.

Pathways Of Exposure Eliminated For D&M Scenario

Another key assumption in the D&M scenario is that animals would not be raised for human consumption. In addition, the Agency assumed that homeowners would not apply a sewage sludge product in quantities sufficient to affect the ground water adversely. By eliminating the animal and ground-water exposure pathways, some pollutant concentrations in Table 4 become less stringent than those in the agricultural land application tables. Chlordane and toxaphene concentrations are less stringent in D&M than in agricultural land application because the ground-water pathway was eliminated. The limits for DDD/DDE/DDT, heptachlor, hexachlorobutadiene, lindane, PCBs, toxaphene, mercury, and selenium also are less stringent in D&M because the animal pathways of exposure were eliminated. Selenium is toxic to animals when they eat plants that have absorbed large quantities of the pollutant. The remaining pollutants bioaccumulate through the food-chain and, therefore, limit the pollutant concentration when sewage sludge is applied to agricultural lands.

The Agency is proposing to prohibit grazing or feeding animals intended for human consumption on pastures or crops to which sewage sludge that meets the D&M pollutant limits has been applied. As an alternative, the Agency could include the animal pathways of exposure, if there is sufficient indication that the D&M scenario should include raising animals for human consumption.

The Agency is interested in the views of commenters on the assumptions it used in defining the D&M scenario. Also the Agency would like to know if the apparent anomaly of less restrictive pollutant limits for the D&M practice, which is otherwise more tightly controlled than agricultural land application, will create problems for those involved in the distribution and marketing of sewage sludge.

Number of Applications

In establishing the numerical limits for the nine metals in Table 4, the Agency had to make assumptions on the number of years that sewage sludge would be applied to the land. The Agency selected 20 applications as a reasonable basis for its calculations. Because the total amount of metals applied to the soil is the critical parameter, it is not important whether the applications are consecutive or whether the applications occur biannually, etc. It is the total amount of metal that is applied to the land that is critical. If the Agency had limited the number of applications to less than 20, the concentration of the metal in the sludge could increase. Conversely, if the Agency had assumed that the number of applications would be greater than 20, the pollutant concentrations would have to decrease.

The Agency examined an alternative of requiring the distributor to specify the number of years on the product label and to use the specified number of years in calculating the limits for metals. This approach was rejected because a homeowner is unlikely to know whether a previous owner had used a sewage sluge product and, if so, how many applications were made. In addition, the proposed approach is simpler to implement. The Agency is soliciting comment on whether 20 years is an appropriate time period to use in establishing the numerical limits for metals.

The pollutants in Table 4 are among the pollutants that are eligible for removal credits when sewage sludge is distributed and marketed. POTWs whose sludge meets the pollutant limits in Table 4 may issue removal credits to their industrial users if the POTW is eligible to do so under the provisions in 40 CFR Part 403.

As discussed in Part XI, the Agency estimates that 35 of 106 facilities will fail to meet the pollutant limits in Table 4.

Distribution and Marketing—Management Practices (§ 503.24)

Labels and Information Sheets

EPA is proposing that sewage sludge products be labeled or accompanied by information on the proper use of the product. When there is a reasonable expectation that individuals will comply with label instructions, the Agency prefers to rely on the use of labels, rather than on licensing or prohibiting the application of a product. EPA has every reason to believe that the instructions included in § 503.24 will be followed.

If the sewage sludge is distributed in bulk form, an information sheet is to be given to the individual who receives the product. If the sewage sludge is distributed in bags or other containers, a label is to be affixed to the bag or container. In general, the label or information sheet is to contain information on the product's distributor, product contents, appropriate product uses, amount to be used, prohibited uses, and warnings. This type of information is on the labels of many sewage sludge products. Fourteen of the 22 States regulating the distribution and marketing of sewage sludge require product labels. Specifically, the labels and informational sheets are to include the following information:

- Name and address of the distributor of the product;
- Statement that the product is derived from sewage sludge;
- List of the pollutant concentrations in the product (at a minimum, the list of pollutants is to include the pollutants in Table 4 of 40 CFR 503.23, if they are present, and the nitrogen concentration of the product);
- Statement prohibiting the use of the product on frozen, snow-covered, or flooded land;
- Statement prohibiting use, except in accordance with the instructions;
- Instructions on the appropriate uses of the product;
- Rate at which the product may be applied for the stipulated uses;
- Warning to keep product out of reach of children;
- Statement prohibiting the grazing of animals raised for human consumption on land where the product is applied;
- Statement prohibiting the use of crops as feed for animals raised for human consumption; and
- Statement that compliance with the instructions on the label or information sheet will constitute compliance with section 405(e) of the CWA.

Provided the label instructions are followed, EPA believes that the pollutant concentrations in Table 4 adequately protect human health and the environment. Except for the pathways involving the raising of animals for human consumption, the drinking of ground water from wells that might become contaminated, and the inhalation of volatile organic compounds, EPA has examined all possible pathways through which a pollutant might reach an individual, a plant, or an animal. The numerical limits in Table 4 reflect the pathway that establishes the most stringent pollutant concentration.

A statement prohibiting the application of the product on frozen, snow-covered, or flooded land is specified to preclude product run-off into a nearby river, stream, or lake. Unlike the requirement in Subpart B, this is an absolute prohibition. It would be impossible for all who use the product to demonstrate that if the sewage sludge is applied to frozen snow-covered, or flood land, that the sewage sludge would not reach a river, stream, or lake.

Statements prohibiting animals raised for human consumption from grazing on pastures or feeding on crops grown on soil to which sludge has been applied are included because of the tendency of some of the pollutants to bioaccumulate in the food-chain. As mentioned above, the Agency is requesting comment the need to assume that animals will be raised for human consumption in the D&M scenario and to revise the numeric limits accordingly.

EPA is proposing that the labels include warnings to keep the product out of the reach of children. Over a period of time, eating significant amounts of undiluted sewage sludge out of the bag could adversely affect young children. As described elsewhere in the preamble, the Agency modeled inadvertent sludge-soil mixture ingestion in young children (ages 1 through 5). The Agency did not model the ingestion of pure sludge of young children because either the applier or natural processes are expected to mix the sludge product with the soil. Therefore, the Agency believes that the warning on the label should provide adequate protection for young children.

The Agency is requiring that the labels or information sheets state the proper amount of the sewage sludge to use because of (1) the requirement that sewage sludge not be applied in excess of the nitrogen requirements of the vegetation and (2) the correlation between the pollutant concentrations and the annual whole sludge or product application rate described above. The instructions should be in terms that an average individual would understand. For example, if the product is authorized to be applied at an annual product application rate of 15 metric tons per hectare, the phrase, "307 pounds per thousand square feet per year", stated on the label on the information sheet, would be more understandable and more likely to be followed.

Products with higher pollutant concentrations must be applied at lower annual application rates. Questions have been raised whether a homeowner would follow a label if the rate is limited to one metric ton per hectare (i.e., 20.5 pounds per 1000 square feet) or even 5 metric tons per hectare (i.e., 102.4 pounds per 1000 square feet). Some believe that a homeowner might not apply the product at very low rates on the assumption that the sewage sludge would not provide sufficient nutrient and soil conditioning properties at such low rates. If the product were applied at higher rates, the application rate would exceed the authorized pollutant concentrations in Table 4. The Agency is seeking comment on whether instructions for lower application rates are likely to be followed and whether the pollutant concentrations should start at a higher annual whole sludge or product application rate, such as 10 metric tons per hectare (i.e., 205 pounds per 1000 square feet).

Pathogen and Vector Attraction Reduction (§ 503.25)

Sewage sludge that is distributed and marketed is likely to be handled by the general public without protective clothing or applied where public access cannot be restricted. In addition, fruits and vegetables are likely to be planted immediately after the product is applied to the soil. Therefore, all sewage sludge that is distributed and marketed must meet the Class A pathogen reduction requirement in § 503.52(a). As previously explained, Class A pathogen reduction requires that pathogenic bacteria, animal viruses, protozoa, and helminth ova be reduced below levels of detection. Class A requirements may also be met if the treatment processes raise the temperature of the sewage sludge to 53 degrees Celsius and reduce the fecal coliform and fecal streptococci in the treated sewage sludge to less than 100 per gram of volatile suspended solids. The vector attraction reduction requirements are outlined in § 503.53.

EPA is proposing that the treatment works treat the sludge to meet the requirements for Class A pathogen reduction and vector attraction reduction before distributing the sewage sludge to the public or to a distributor. The processes needed to comply with these requirements are part of the treatment works' processes and are the responsibility of the treatment works.

Monitoring, Record Keeping, and Reports 503.81 and 503.83)

Section 503.83 requires that prior to distributing or marketing their sewage sludge, treatment works determine from a representative sample of the sewage sludge the pollutant concentrations and nitrogen content in order to calculate the annual whole sludge application rate. Depending on the frequency with which treatment works distribute a stock pile of sewage sludge to the public or to distributors, the monitoring may take place at more frequent intervals than those in § 503.81(c). Therefore, treatment works may have to hold the sludge until the representative sample can be analyzed. If the distribution of sewage sludge takes place at less frequent intervals than specified in § 503.81(c), treatment works must monitor their sewage sludge at the intervals specified in § 503.81(c). Treatment works also must monitor the sewage sludge to determine compliance with Class A pathogen reduction and vector attraction reduction requirements prior to distribution.

If the treatment work is not the distributor, the distributor must monitor the product for the pollutants in Table 4. The distributor must then calculate the annual product application rate on the basis of the pollutant concentrations in the product and place the annual product application rate on the label or information sheet.

The performance agreement with the distributor contains the information identical to that which treatment works must keep to meet the record keeping requirements in § 503.83(b) and the reports required under § 503.83(c). If the treatment work distributes and markets the sewage sludge, the treatment work is likely to keep these records and will be required to do so under the provisions in §§ 503.83(b) and 503.83(c).

The Agency is proposing retention of records for 5 years, the record retention requirement included in the State program management regulation (40 CFR Part 501). The Agency also considered 3 years. Comment is solicited on the period of time that the Agency should require that treatment works retain records if their sewage sludge is distributed and marketed.

Monofills (Subpart D)

Applicability (§ 503.40)

The requirements contained in this proposal apply to landfills receiving only sewage sludge (monofills) and to any person who disposes of sewage sludge in a monofill. A monofill is an area of land (i.e., a landfill) that contains one or more units accepting only sewage sludge. These units are covered by suitable material at the end of each operating day or at more frequent intervals. EPA has identified 49 monofills (see Regulatory Impact Analysis) and estimates that just over 100,000 dry metric tons out of the approximately 8 million dry metric tons of the total sewage sludge generated, is disposed of in monofills.

A much larger percentage of the sewage sludge generated (i.e., 41 percent or 3.2 million dry metric tons) is disposed of with municipal solid waste in 6,700 MSWLFs. Sewage sludge typically represents five percent of the total waste in these landfills.

Under the joint authority of Sections 4004 and 4010 of RCRA and section 405(d) of the CWA, the Agency proposed requirements for MSWLFs that apply to sewage sludge that is placed in these landfills (see 53 FR 33314, August 30, 1988). The Agency adopted this approach for the reasons discussed in Subpart A of this part of the preamble. Treatment works using a MSWLF to dispose of their sewage sludge must ensure that their sewage is non-hazardous and passes the Paint Filter Liquid Test. They must also send their sewage sludge to State-permitted facilities. If these requirements are met, treatment works will be in compliance with section 405(e) of the CWA.

Specialized Definitions (§ 503.31)

Class I, Class II, And Class III Ground Water

In August 1984, EPA issued its Ground-Water Protection Strategy (Reference number 38) to set out a policy framework for enhancing ground-water protection efforts by EPA and the States. In December 1986, the Agency released draft "Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy" (Reference number 53). The classification guidelines provide the procedures for implementing the Strategy and can be used in differentiating classes of ground water based on use, value to society, and vulnerability of the ground water to contamination. In developing the definitions of Class I, Class II, and Class III ground water in today's proposal, the Agency used the guidelines as the basis of the definitions.

Class I ground water is defined as an existing source of drinking water or unusually high value that is vulnerable to contamination and is either irreplaceable as a source of drinking water for substantial numbers of people or is ecologically vital (i.e., habitat for rare or endangered species). Class II ground water includes all non-Class I ground water that is currently used for, or is potentially available for, drinking water. Class III ground water is not a source of drinking water because the ground water has one or more of the following characteristics: (1) The concentration of total dissolved solids (TDS) is greater than or equal to 10,000 milligrams per liter (mg/1); (2) the concentration of pollutant(s) exceeds the drinking water standard(s) and cannot be cleaned-up using treatment methods reasonably employed in public water systems; and (3) the yields are insufficient to meet the needs of an average household (150 gallons per day).

As explained later in this subpart of the preamble, the pollutant limits and the way in which the pollutant limits are calculated depend on the class of ground water under the monofill. Therefore, in accordance with the definitions in § 503.31 (b), (c), and (d), owners or operators must document the class of ground water underlying the monofill.

In the Spring of 1988, the Agency conducted a probability analysis of the classes of ground water under the 49 current active monofills. For each monofill site, the analysis estimated the probability that a monofill would be located over a Class I, Class II, and Class III ground water (Reference number 54).

All ground water underlying the monofills was estimated to have an 82 percent probability of being designated as Class II. Fourteen monofills had a 16 to 18 percent probability of lying over ground water designated as Class I. Only two monofills had any probability of lying over ground water designated as Class III. These monofills would be over ground water that is not currently being used as a source of drinking water. The probability analysis was conducted as part of the Agency's effort to assess the impact of the rule on existing facilities. It was not intended to replace State and local site-specific classifications of the ground water underlying each sludge monofill.

Lateral Expansion

The Agency has defined lateral expansion to mean a horizontal expansion of a sewage sludge unit boundary (see Figure IX-D.1). A sewage sludge unit is an area of land within a monofill in which only sewage sludge is placed and where the sewage sludge is covered with suitable material. Under today's proposal, lateral expansions are treated as new units and must meet the requirements applicable to new units. Any area of an existing unit that has not received waste by the effective date of this rule, but later receives waste is a lateral expansion.

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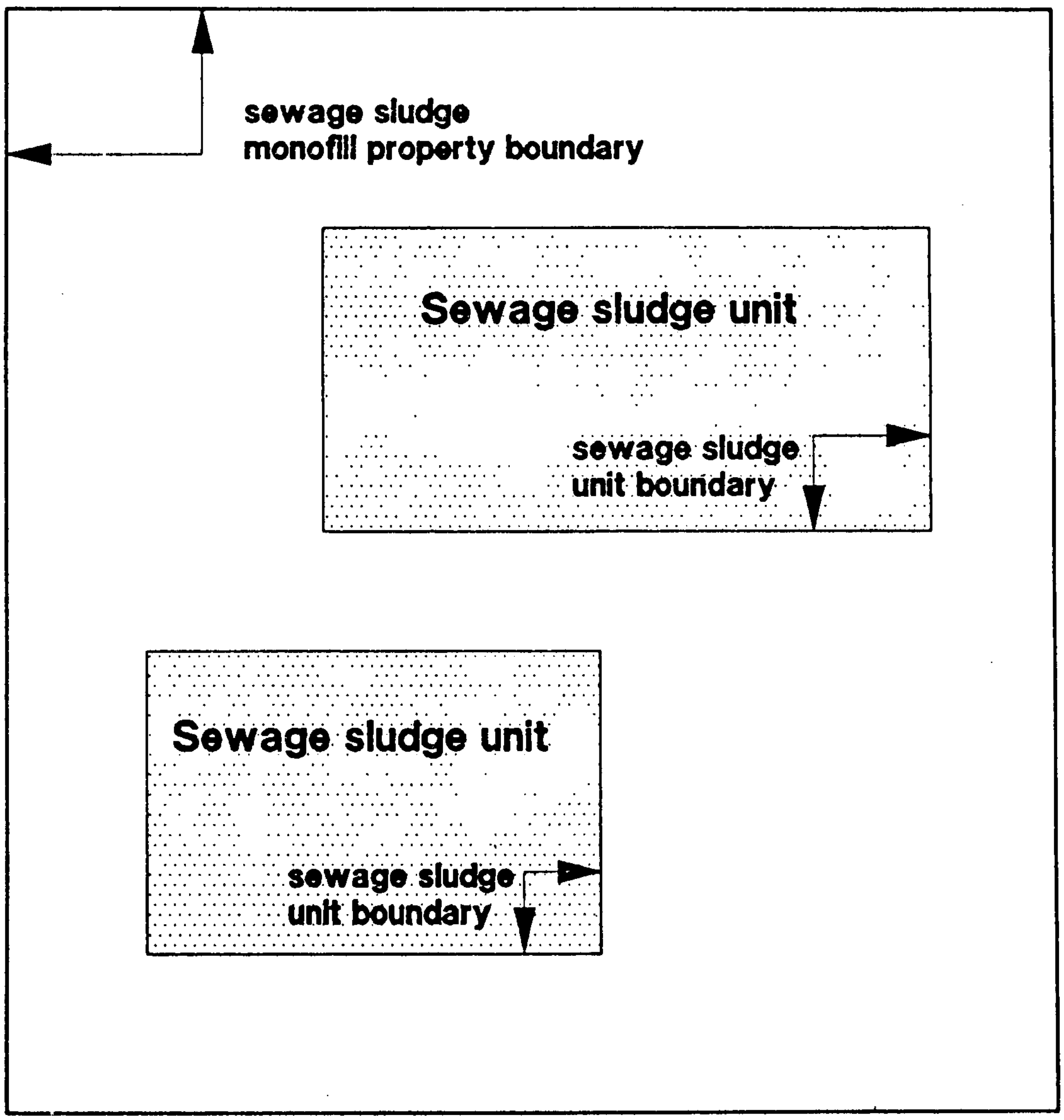
Figure IX-D.1

SEWAGE SLUDGE MONOFILL AND SEWAGE SLUDGE UNIT



Sewage sludge monofill

BILLING CODE 6560-50-C

General Requirements For Monofills (§ 503.32)

Section 503.32(a) prohibits the disposal of sewage sludge in a monofill unless the requirements of the subpart are met. In addition to the other requirements, owners or operators of monofills must obtain an NPDES permit for any discharge from the monofill (i.e., the collection and discharge of run-off from the monofill).

Requirements For Ground-Water Classification

EPA is proposing in § 503.32(c) that owners and operators document the class of ground water underlying the monofill, in accordance with the definitions of ground water discussed above. The documentation should be confirmed by the appropriate State authority as accurately representing one of the classes of ground water in § 503.31 (b), (c), or (d) and as consistent with the way that the State has classified or would classify the ground water.

"The Guidelines for Ground-Water Classification Under the EPA Ground-Water Protection Strategy" (Reference number 53), is an important resource to consult in determining the class of ground water under a monofill. Prior to initiating efforts to classify the ground water under a particular monofill, EPA recommends that owners and operators consult with the appropriate State agencies.

Threatened Or Endangered Species

Monofills should not be located where they would cause or contribute to the harm of a threatened or endangerd species of plant, fish, or wildlife. Care also should be taken to ensure that monofills do not result in the destruction or adverse modification of the critical habitat of such a species. This provision is carried forward from 40 CFR 257.3–2 to ensure that the disposal of sewage sludge is conducted in an environmentally responsible manner.

Requirements For Monofills In Floodplains

In § 503.32(e), EPA is proposing that new and existing monofills located in a 100-year floodplain shall not restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in a washout of solid waste that would pose a hazard to human health and the environment. Today's proposal would allow new and existing monofills to be located in a 100-year floodplain only if the monofills can be designed and operated to protect human health, wildlife, or land or water resources.

This requirement may be necessary to ensure adequate protection of human health and the environment from sewage sludge placed in monofills. Floods can damage or undermine the structural integrity of monofills causing release and dispersion of pollutants. Pollutant limitations were derived based upon an assumption of structural integrity of the monofill. Additionally, the model developed to derive limitations accounts for normal rainfall but does not account for the transport of pollutants resulting from the immersion of the monofill by a flood.

Disposal of sewage sludge in floodplains may have significant adverse impacts. If the monofill is not adequately protected from washout, wastes may be carried by flood waters from the site, causing water quality criteria to be exceeded downstream. Filling in the floodplain may restrict the flow of flood waters, causing greater flooding upstream, or may cause more rapid movement of flood waters downstream, resulting in higher flood levels, greater flood damage, and greater risk to human health and the environment.

Owners and operators should use flood insurance rate maps (FIRMS) developed by the Federal Emergency Management Agency (FEMA) to determine whether a unit is located in the 100-year floodplain. FEMA has developed maps for approximately 99 percent of the flood-prone communities in the United States. These maps can be obtained at no cost from the FEMA Flood Map Distribution Center, 6930 (A–F), San Tomas Road, Baltimore, Maryland, 21227–6227. In areas of the country where FIRMs are not available, other sources of information include the U.S. Army Corps of Engineers, the Soil Conservation Service, the National Oceanic and Atmospheric Administration, the U.S. Geologic Survey, the Bureau of Land Management, the Bureau of Reclamation, the Tennessee Valley Authority, and State and local flood control agencies.

If the monofill is expected to, or does, restrict the flow of the 100-year flood and the water storage capacity of the floodplain, the monofill may not be located in the floodplain and must close within one year of the date this rule is promulgated, in accordance with § 503.32(l).

These location and closure requirements should safeguard the 100-year flood flow and water storage capacity of the floodplain from problems related to the location of a monofill. Other Agency regulations allow activities and facilities in 100-year floodplains if precautions have been taken to prevent washout (see 40 CFR Part 257, 40 CFR Part 264, and proposed 40 CFR Part 258). The Agency is soliciting comment on its proposal to prohibit monofills in the 100-year floodplain if the monofill does, or is likely to, restrict the flow of a 100-year flood.

Requirements for Monofills Near Airports

In today's proposal, § 503.32(f) specifies appropriate distances between monofills and airports. Monofills located within 10,000 feet of airports handling turbine-powered aircraft and within 5,000 feet for airports handling aircraft powered by piston engines must not attract birds that could pose a hazard to aircraft. The proposed requirement is included because monofills may receive putrescible wastes which attract birds despite requirements for daily cover. The birds may present a significant risk of collisions with aircraft. The distances specified are designed to meet the requirements of the Federal Aviation Administration (FAA) Order 5200.5, "FAA Guidance Concerning Sanitary Landfills on or near Airports" (October 6, 1974). This states that solid waste disposal facilities "may be incompatible with safe flight operations" when located near an airport. The distances derived from FAA Order 5200.5 are based on the fact that more than 62 percent of all bird strikes occur below altitudes of 500 feet (150 meters) and that aircraft generally are below this altitude within the distances specified.

EPA recommends that owners and operators of monofills consult with the U.S. Fish and Wildlife Service or the appropriate State agency to determine whether specific facilities pose a hazard to aircraft from birds. Where appropriate, this determination should be made in consultation with the FAA, as well as with the owners and operators of near-by airports. Waste disposal within the specified distances may continue if the owner or operator can demonstrate that the operation does not increase the risk of bird and plane collisions.

Requirements for Monofills in Seismic Zones

Section 503.32(g) of today's proposal would require that sewage sludge units in a monofill located within a seismic zone be designed and built to resist the maximum ground motion. Seismic zones are defined as areas having a ground motion greater than or equal to 0.10 gravities.

Maps depicting the potential seismic activity across the United States at a constant probability have been prepared (U.S. Geological Survey Open-File Reports 82-1033). The maps show that certain portions of the country have higher levels of seismic hazard than other areas. For example, portions of the eastern United States have higher levels of seismic hazard than portions of the western United States.

EPA is proposing that sewage sludge units of monofills located in seismic zones be built to withstand the maximum ground motion because ground motion could cause cracks in foundations or the collapse of structures. Studies indicate that ground motion resulting from earthquakes without associated surface faulting has been found in some cases to be two or three times that associated with quakes with faulting (Reference number 74). The appropriate peak ground acceleration on which to base the design of the sewage sludge unit may be determined from regional studies and site-specific analyses. Designs appropriate for the peak ground acceleration should be approved by EPA.

Requiring sewage sludge units of monofills to be built to withstand the maximum ground motion is consistent with other Agency rules. However, the Agency is soliciting comment on whether to prohibit the location of monofills in seismic zones.

Requirements for Landfills Near Holocene Faults

In § 503.32(h), EPA is proposing to prohibit the siting of sewage sludge units of monofills in locations within 60 meters (200 feet) of faults that have had displacement in Holocene time. The Holocene is a geologic time unit, known as an epoch, that extends from the end of the Pleistocene to the present (approximately the last 11,000 years.)

Earthquakes present a threat to public safety and welfare in many areas of the United States. Damage and loss of life in earthquakes occur from surface displacement along faults (surface faulting) and ground motion (shaking), as well as secondary effects of the shaking, such as ground or soil failure. Today's proposal is designed to protect facilities from deformation (i.e., bending and warping) and displacement (i.e., the relative movement of any two sides of a fault measured in any direction) of the earth's surface that occurs when the fault moves. If a facility is located near a fault, containment structures (i.e., liners, leachate collection systems, and final covers) may be inadequate to prevent release of sewage sludge during an earthquake. The Agency is proposing that monofills now located within 60 meters (200 feet) of a Holocene fault close, in accordance with § 503.32(l), within 1 year of promulgation of this rule.

Holocene faults are designated in this proposal because geologic evidence indicates that faults that have moved in recent times (i.e., during the last 11,000 years) are the ones most likely to move in the future. Faults that have moved in Holocene time are easier to identify and date in the field than older faults because this epoch produced recognizable geological deposits. The U.S. Geological Survey mapped the location of Holocene faults in the United States in 1978 (Reference number 74). Maps of identified Holocene faults in the United States also are available from the States of California and Nevada.

EPA is prohibiting sewage sludge units of monofills within 60 meters of a Holocene fault because studies suggest that most deformation takes place within this distance. The effects of deformation drop off rapidly as distance from the fault increases. The farther away the monofill is from the main fault, the less likely it will be to be affected by deformation. EPA's definition of "fault" (see § 503.31(i)) includes main, branch, or secondary faults. This definition includes faults that appear at the surface and those that do not have surface expression (including the small fault planes associated with surface faults). The 60-meter setback would be measured from any surface or subsurface fault, thus giving ample protection against the effects of deformation.

Today's proposal differs from the proposed requirements of 40 CFR 258.13 in that closure of existing MSWLFs is not required for those landfills located in fault areas, although new units are prohibited from being sited in these areas. EPA does not have sufficient information to justify allowing existing sewage sludge units to remain open while prohibiting the siting of new monofills or sewage sludge units in these areas.

Requirement For The Location Of Monofills In Stable Areas

EPA is proposing that monofills be located in areas having adequate support for the structural components of the sewage sludge units (§ 503.32(i)). Locating monofills in unstable areas is inappropriate because, if the soil subsides, damage to the monofill may cause extensive environmental damage and, potentially, adverse human health effects.

To determine if an area is unstable, the following factors should be considered: (1) Soil conditions that cause significant differential settling; (2) geologic or geomorphologic features such as areas prone to mass movement, Karst terrains, or fissures; (3) surface areas weakened by withdrawal of oil, gas, or water; and (4) other features that historically have indicated that protective measures cannot be designed to withstand a natural event such as a volcanic eruption. A detailed description of unstable areas is contained in the "Technical Support Document: Landfilling of Sewage Sludge" (Reference number 58).

EPA has not tried to delineate all potential unstable areas. Rather, EPA believes that owners or operators, in conjunction with the permitting authority and on a case-by-case basis, will make determinations on the stability of an area and on the appropriateness of an area for a monofill. The Agency has proposed a similar requirement for MSWLFs and is considering such a requirement in its revisions to the hazardous waste landfill regulation.

Section 503.32(l) requires closure of sewage sludge units of monofills that are located in unstable areas within 1 year. This differs from the proposed requirements for MSWLFs (40 CFR 258.15) in that closure of existing MSWLFs in unstable areas is required within 5 years of the effective date of rule. This period, however, may be extended by the State after considering the availability of alternative disposal capacity and the potential risk to human health and the environment. Such a consideration is allowed under the "practicable capability" language of RCRA, while the CWA has no such provision. In addition, the CWA requires compliance within 1 year of the effective date of the regulations. For these reasons, the requirements in today's rule differ from those in 40 CFR 258.15.

Prohibition of Monofills In Wetlands

Section 503.32(j) includes a provision to prohibit the location of sewage sludge units of monofills within the perimeter of wetland areas. Wetland areas are defined as those "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include, but are not limited to, swamps, marshes, bogs, and similar areas" (see 40 CFR Part 230). Wetland maps are available from the U.S. Fish and Wildlife Service.

Constructing sewage sludge units, essentially a fill operation, has the potential for causing significant environmental damage in a wetland. Such damage cannot be restored because of the complexities and fragility of the wetland ecosystem. In 40 CFR Part 258, new facilities are allowed in wetlands provided very strict demonstrations are made. The Congressional directive in Section 4010 of RCRA, as amended, allows EPA to consider the "practicable capability" of owners and operators of facilities that may receive household hazardous waste or small quantity generator waste in determining the standards to be set. The CWA has no such statutory authority for the sewage sludge reuse and disposal standards.

The Agency has identified wetlands protection as a top priority and, since the proposal of the Part 258 requirements, has under consideration the prohibition of all landfill operations in wetlands. The Agency believes more appropriate locations may be found for the siting of monofills. Section 503.32(l) requires sewage sludge units of monofills located in wetlands to close within 1 year. We invite comment on the appropriateness of this prohibition.

Requirement For Water Collection And Discharge

Section 503.32(k) requires the collection and discharge of the volume of water from the 24-hour, 25-year storm event, in accordance with an applicable NPDES permit. The Agency is proposing this requirement to ensure that the pollutants in the runoff from sewage sludge units in a monofill are collected and, if appropriate, treated in accordance with an NPDES permit. Control of surface runoff may be accomplished by (1) minimizing water that enters the active sewage sludge units of the facility (run-on controls), (2) minimizing the size and number of active sewage sludge units in a monofill, (3) preventing the disposal of sludge with low solids content, and (4) collecting and managing the runoff. Today's proposal only requires the collection and management of the runoff.

The Agency chose the 25-year storm as the design parameter to be consistent with the requirements for hazardous waste landfills in 40 CFR 264.301(g) and the proposed requirement in 40 CFR 258.26(a)(2). Both of these provisions require the active portions of the landfill to be protected from the peak discharge of a 25-year storm. Twenty-seven States require runoff controls for their landfills.

EPA is requesting information on problems that communities may have encountered with locating monofills in areas subject to more frequent flooding (e.g., in 5- or 10-year floodplains) and whether the Agency should consider prohibitng or restricting the location of monofills in areas of frequent flooding.

The Agency also considered requiring run-on controls to prevent flow onto the active portion of the landfill during the peak discharge from a base flood, as is required in 40 CFR 258.26(a)(1). Such controls minimize both the generation of leachate and the volume of runoff which must be collected.

Rainfall and the generation of leachate is considered in the exposure assessment model for calculating the pollutant concentrations for disposing of sludge in monofills. Since leachate generation is already taken into the pollutant limits, a requirement for run-on controls is unnecessary. While run-on controls do minimize runoff, the decision on how to meet the standard is left to the owner or operator of each treatment work. EPA, therefore, rejected this requirement as redundant. Comments are requested on the advisability of requiring run-on controls in addition to controls of surface water runoff.

Closure Requirements

Section 503.32(l) requires that existing sewage sludge units located within 60 meters of a fault or stress fractures that have had displacement in Holocene time, located in unstable areas, or located in wetland areas close within 1 year of the effective date of this rule. This requirement is necessary because section 405(d)(2)(D) of the CWA requires compliance with these rules within 1 year of their promulgation.

Closure Plan

Section 503.32(m) of today's proposal requires that owners or operator prepare a written closure plan for each sewage sludge unit that will need to be closed. The closure plan is necessary to ensure that owners or operators have considered and planned for the necessary activities (e.g., the type of final cover, the cover maintenance, gas venting, and public access controls) to close the sewage sludge unit in a manner that will continue to protect human health and environment. The final cover must be designed to minimize volatilization of pollutants, settling, subsidence, erosion, or other events and prevent runoff from, or other damage to, the final cover. Although the Agency believes the numerical limits and management practices required in today's proposal are adequate to protect human health and the environment, the requirement for a closure plan ensures continued human health and environmental protection, particularly for monofills receiving sewage sludge before the promulgation of today's requirements.

Today's proposal for a closure plan requires that the final cover, gas venting, and public access controls be maintained for 10 years. This requirement is based in part on a recent study entitled "Pilot Scale Evaluation of Sludge Landfilling—Four Years of Operation" (Reference number 76). In that study, sewage sludge, sewage sludge mixed with municipal solid waste (MSW) and MSW itself were placed in simulated landfill cells and methane production was monitored for 3 years and seven months. The results indicate that gas production levels off by the end of the third year. However, because this experiment was a laboratory simulation and was not performed on an operating landfill, there is uncertainty as to the time required for methane gas production to practically cease in an operating landfill. To account for this uncertainty and to allow a safety factor, a 10-year period of methane monitoring was selected for the proposal. States may extend the period of time for post-closure care if it is deemed appropriate. The Agency is soliciting public comment on the 10-year time period and would be particularly interested in hearing from those States and municipalities with monofills.

Financial Assurance Requirements

Financial assurance requirements were considered, but rejected, for this rule. Financial assurance is primarily aimed at fulfilling the closure responsibilities under the closure plan and for corrective action in the event of contamination of ground water.

Today's rule is based on sewage sludge meeting the concentration limits for pollutants in the sludge and on monitoring the sewage sludge to comply with this requirement. Complying with the concentration limits will protect ground water from contamination during the period of active use and the period covered by the closure plan. Further, the costs of closure under the closure plan required at § 503.32(m) are expected to be minimal. For these reasons, the Agency did not believe the limited possibility that the pollutants would leach to the ground water in concentrations in excess of the drinking water standards warranted the imposition of an extensive burden of financial responsibility on owner or operators. EPA invites comment on the advisability of adding financial assurance requirements to the monofilling portion of today's rule.

Wellhead Protection Areas

In addition to the location requirements discussed above, EPA recommends that owners and operators consider the location of any Wellhead Protection Areas established pursuant to section 1428 of the Safe Drinking Water Act and any management strategies established by a State under such programs. The Wellhead Protection Program is designed to protect ground water that supplies wells and wellfields that contribute drinking water to public water supply systems.

The Agency solicits comments whether State or local restrictions are adequately protective and comprehensive or market forces are adequate to obviate the need for any of these proposed Federal regulatory requirements. (For example, are there State regulations that would prevent inappropriate location of monofills in floodplains? Do existing insurance requirements accomplish the same objective as today's floodplains proposal?) If there are such existing requirements, to what extent is it appropriate for the Agency to rely on them in lieu of regulatory provisions in Part 503?

Monofills—National Pollutant Limits (§ 503.33)

Ground-Water Protection Standard

The objective in establishing the pollutant limits for the disposal of sewage sludge in monofills is to ensure that the pollutant concentrations reaching the ground water do not exceed the drinking water standard or, if no drinking water standard exists, other appropriate human health criteria. This ground-water protection standard is the basis for the Agency's determination that the pollutant limits are adequate to protect public health and the environment from any reasonably anticipated adverse effect of a pollutant.

The Agency used exposure assessment models to simulate the movement of the pollutant into and through the soil profile to the ground water. The models calculate a pollutant concentration that will not exceed an MCL at the point of compliance. For Class I ground water, the point of compliance is the point where the leachate enters the aquifer. For Class II and Class III ground water, the point of compliance is immediately below the property boundary or 150 meters from the point of entry to the aquifer, whichever is less.

The critical parameters in the model are those listed in Table 6 of the proposed rule. In selecting the parameters for development of the rule, the Agency made conservative, but reasonable, worst-case choices to assure an adequate level of protection. Therefore, these parameters tend to over-estimate the mobility of the pollutant out of the sludge matrix, thus reducing the time for the pollutant to reach the ground water.

For example, the model assumes that all pollutants eventually solubilize. However, there is evidence that the pollutants in a sludge matrix are strongly attached to the matrix and do not go into solution or readily leach to the ground water. This is particularly the case with sewage sludge, a by-product of wastewater treatment processes. Any readily soluble pollutant would be removed during treatment processes and contained in the effluent leaving the treatment works, rather than present in sewage sludge. The other critical parameters are discussed in Part IV of the preamble. This combination of reasonable worst-case assumptions used in the models has the effect of increasing the toxicity and potency of a pollutant, increasing its mobility to ground water, and intensifying its effect. Thus, this compounding of conservative factors introduces an added margin of safety in the calculation of the pollutant concentrations. On the basis of these analyses, it is the Agency's belief that the pollutant concentrations meet the ground water protection standard and adequately protect public health and the environment.

Today's proposal modifies and expands the approach used in the "Criteria For Classification Of Solid Waste Disposal Facilities and Practices" (see 40 CFR Part 257). § 257.3-4 establishes a general prohibition on the contamination of an underground drinking water source beyond the solid waste boundary or beyond an alternative boundary specified in accordance with the requirements in the rule. This generic standard was not accompanied by monitoring to ensure compliance.

Today's proposal replaces 40 CFR Part 257, as it applies to sewage sludge, with an approach that takes advantage of the information gathered in the past 10 years. It builds on the ground-water protection standard concept by establishing limits for the sludge on a pollutant-by-pollutant basis to ensure that the concentration of the pollutant reaching the ground water will not exceed the drinking water standard or another appropriate standard. In addition, by requiring the analysis of pollutant concentrations in the sewage sludge placed in a monofill, the Agency is providing a mechanism to ensure that the ground-water protection standard will not be exceeded. Therefore, in preparing today's proposal, the Agency has not carried over the generic ground-water protection standard in 40 CFR 257.3-4, but is requesting public comment on whether it should do so as an additional check on the efficacy of the pollutant-specific sewage sludge limitations.

A fundamental regulatory principle used in developing today's rule is pollution prevention. The Agency believes that it is more protective and equitable to prevent sewage sludge contamination by controlling pollutants at the source than it is to require clean-up of the contaminated ground water. Therefore, controlling the quality of the sludge placed in the monofill is an over-riding objective of today's standards.

This up-front sludge pollution prevention approach is different from the alternative approach taken in the proposed "Solid Waste Disposal Facility Criteria" (see 53 FR 33314, August 30, 1988). The proposed criteria revisions for MSWLFs use location, design, and operating criteria to achieve a ground-water protection performance standard. In addition to those criteria, the Agency also proposed that owners or operators of MSWLFs monitor the ground water and take corrective action when pollutants in the ground water exceed State-established trigger levels. This ground-water monitoring serves as a method of verifying the adequacy of the design and operation of a particular MSWLF. Ground-water monitoring and corrective action were mandated for the proposed criteria revisions by Section 4010 of RCRA "as necessary to detect contamination".

Consistent with the principle of pollution prevention, today's proposal requires that treatment works monitor the quality of the sludge before the sludge is placed in the monofill. The available scientific and technical information indicates that, if the pollutant concentrations do not exceed the limits in today's proposal, the pollutants are unlikely to migrate to the ground water, especially at levels that exceed the drinking water standards. In such circumstances, the Agency believes that requiring ground-water monitoring and corrective action, in addition to sludge testing, is not justified by the regulatory record.

Because of the characteristics of the sewage sludge that bind the pollutants into a sludge matrix, it is highly unlikely that any leaching of the pollutant to the ground would occur within the design life of 30 to 40 years for a monofill. The Agency is requesting public comment on the correctness of its approach. The Agency is also soliciting comment on whether ground-water monitoring would be an appropriate protective measure to back-stop the proposed pollutant specific sludge limitations, and on whether corrective action should be required if the monitoring indicates that ground-water protection standards have been exceeded.

The Agency further requests comment on the need for ground-water monitoring and corrective action for those who apply sewage sludge to agricultural and non-agricultural land and to those who dispose of sewage sludge at sewage sludge surface disposal sites. The Agency is also interested in opinions on the effects of such measures on the beneficial reuse of sewage sludge.

Pollutants

EPA is proposing numerical limits in the form of pollutant concentrations for 18 pollutants when sewage sludge is placed in monofills. Table III-1 lists the pollutants that were originally evaluated and Table III-2 lists the pollutants that do not interfere with the disposal of sewage sludge in monofills. Chlordane, chromium, and nickel were found not to interfere with the disposal of sewage in monofills over Class II or Class III ground water, but may adversely effect human health or the environment if the monofill is over Class I ground water. Since Class I ground water is irreplaceable as a source of drinking water, the Agency is proposing more stringent numerical limits for monofills over Class I ground water. This will be discussed in depth later in this subpart of the preamble.

When the Agency originally evaluated cyanide with the exposure assessment model, significant violations of the cyanide drinking water standard were predicted because of the following assumptions:

- All of the cyanide in sludge partitions to the leachate;
- No decay of cyanide occurs as the leachate percolates through the soil to the ground water; and
- No cyanide precipitates out of solution with metals once the leachate mixes with the ground water.

These assumptions were included in the model because no data were available to quantify the leaching, decay, or precipitation of cyanide compounds. However, under the anaerobic environment below landfills, cyanide would be expected to decompose into ammonia and methane.

EPA's Water Engineering Research Laboratory (WERL) investigated the potential for cyanide leaching from sewage sludge (Reference number 76). Sewage sludge samples were collected from POTWs in 12 cities in Ohio serving populations from 5,000 to 400,000. The 12 samples were split, with half the samples analyzed by WERL and half sent to an EPA contract laboratory. The contract laboratories extracted the samples using the zero head space extractor procedure outlined in the TCLP (40 CFR Part 261, Appendix II).

Standard methods were used to analyze the sludge samples and TCLP extracts for total cyanide, weak acid dissociable cyanide, and percent solids. The quality control checks for the analyses indicated good precision and excellent recovery of spiked cyanide.

The sludge samples contained concentrations of total cyanide ranging from 0.9 to 605 ppm but analyses showed no detectable levels of cyanide in any of the leachate samples. The study demonstrated that cyanide forms complexes with the metals in sewage sludge and thus does not readily leach from the sludge. From these results, EPA concluded that its assumption on the amount of cyanide leaching from the sludge matrix was in error. Therefore, the Agency is not proposing a numerical limit for cyanide in sewage sludge that is disposed of in a monofill.

Table III-3 lists pollutants for which the Agency has deferred proposing a numerical limit until sufficient data become available to use in its exposure assessment model. As noted earlier in the preamble, EPA has recently established human health criteria for methylethyl ketone and methylene chloride. Therefore, these two pollutants will be evaluated in future Part 503 rulemaking proceedings.

For EPA to establish a numerical limit for cobalt, an MCL or an acceptable daily intake value would be needed. For phenanthrene, the Agency needs data on the soil half-life of phenanthrene and an MCL or sufficient data to establish a risk specific dose or an RfD. The Agency is seeking data on these pollutants and is requesting that commenters send available data to facilitate the evaluation of these pollutants in future Part 503 rulemaking proceedings.

Bases of Polutant Limits

Table 5 in § 503.33 of the proposed rule lists the 18 pollutants for which the Agency is proposing numerical limits. These numerical limits are established so that the concentration of the pollutant will not exceed a human health criterion at the point of compliance for Class I ground water. The point of compliance is where the leachate enters the ground water. For Class II and Class III ground water, the point of compliance is immediately below the property boundary of the monofill or 150 meters from the point of entry, whichever is less. The human health criteria are: (1) MCLs established under the Safe Drinking Water Act, (2) a risk specific dose corresponding to an incremental carcinogenic risk level of 1×10^{-4} (one cancer incident in 10,000) for carcinogenic pollutants that have no MCL, or (3) an RfD for non-carcinogenic pollutants that have no MCL. For the reasons described earlier, EPA is using existing Agency standards as the human health criteria in the models. MCLs were used for arsenic, benzene, cadmium, copper, lead, lindane, mercury, trichloroethylene, and toxaphene. The Agency used a risk specific dose and an incremental carcinogenic risk level of 1×10^{-4} as the human health criteria for benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chlordane, DDT/DDE/DDD, dimethylnitrosamine, and PCBs.

A key factor in establishing numerical limits for sewage sludge placed in monofills is the class of ground water under the monofill. As discussed earlier, owners and operators, in conjunction with the appropriate State agency, need to classify their ground water in accordance with the definitions in § 503.31 (b), (c), or (d)(1), (d)(2), or (d)(3).

Figure IX-D.2 shows the circumstances under which the national pollutant limits in § 503.33(a) apply and those under which the case-by-case pollutant limits in § 503.33(b) apply.

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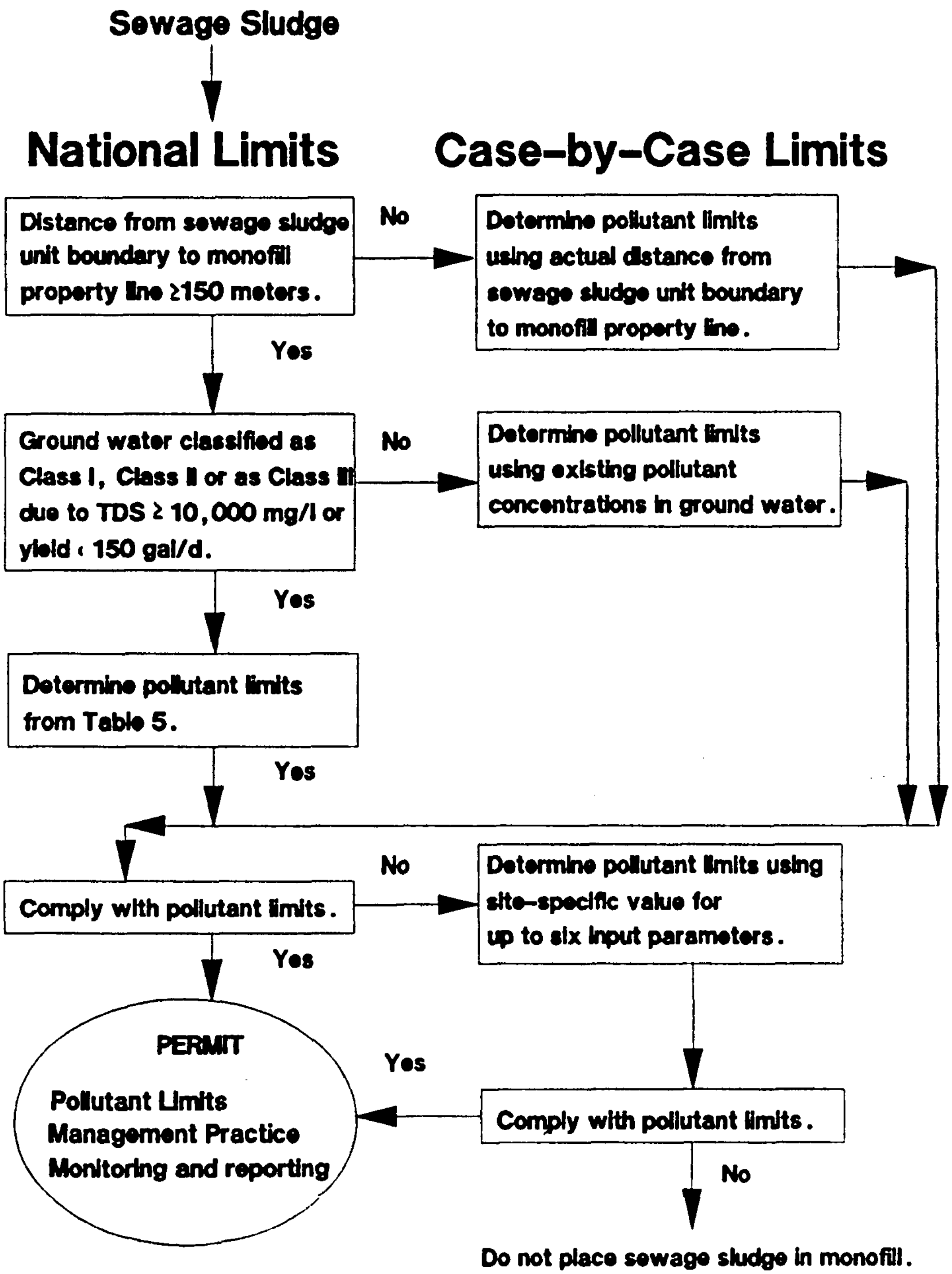
Figure IX-D.2

SEWAGE SLUDGE MONOFILL



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National Limits

EPA is proposing national numerical limits for the pollutants in Table 5 of § 503.33 of the proposal. These values apply to monofills where the boundaries of the sewage sludge units are 150 meters or more from the property boundary of the monofill. If the distances are less than 150 meters, EPA calculates case-by-case numerical limits.

The national numerical limits apply to monofills over Class I, Class II, and Class III ground water unless the ground water is not a source of drinking water because the background ground-water pollutant concentrations exceed the MCL or other human health criteria listed in Appendix A of the proposed rule. For monofills located over ground water in which the background pollutant concentrations exceed the values in Appendix A, the procedure in § 503.33(b) (2) is used to establish case-by-case numerical limits.

As shown in Table 5 of the rule, one set of values applies to monofills over Class I ground water. A different set of values applies to monofills over Class II ground water, as well as to those over Class III ground water that is not a source of drinking water because either TDS levels exceed 10,000 milligrams per liter or the yields are insufficient to supply the needs of an average household (i.e., 150 gallons per day).

Although Class III ground water is not used as a source of drinking water because of TDS or yield limitations, the Agency does not believe that Class III ground water should be allowed to deteriorate. At some future time, technology may become available to reduce TDS levels. Moreover, the need for ground water may be so acute in water scarce areas that concepts of the yields necessary to supply an average household (150 gallons per day) may not be valid.

If the pollutant concentrations of the sewage sludge to be disposed of in a monofill exceed the values in Table 5, the owner or operator of the monofill or treatment work (if different from that of the monofill), may submit data, in accordance with the procedures in § 503.33(b)(3), documenting that values other than those listed in Table 6 of the rule should be used in calculating a numerical limit using the EPA or other approved model. The discussion below describes how EPA will use site-specific data to calculate alternative pollutant concentrations.

Case-By-Case Limits

As discussed in Part VIII of the preamble, when EPA uses the exposure assessment models to establish numerical limits, alternative numerical limits may be established on a case-by-case basis when the physical parameters at a site differ from those used in the model. In developing the standards for monofills, EPA is proposing three circumstances under which the Agency would establish case-by-case numerical limits. Sections 503.33(b) (1) and (2) mandate the calculation of case-by-case numerical limits. Section 503.33(b)(3) allows case-by-case numerical limits when the values in Table 5 are exceeded. Each subparagraph of § 503.33(b) is discussed in turn below.

When a monofill has a sewage sludge unit that is less than 150 meters from the property boundary of the monofill, § 503.33(b)(1) requires EPA to calculate numerical limits for the pollutants in Table 5. The Agency would use the actual distance to the property boundary as the amount of dilution that would be factored into the EPA-approved exposure assessment model so that numerical limits will not exceed the human health criteria at the point of compliance (i.e., the property boundary). For the other parameters in the model, EPA will use the values in Table 6 unless the owner or operator can demonstrate that other site-specific values should be used. In the latter case, EPA will use the site-specific values in accordance with § 503.33(b)(3) discussed below.

Section 503.33(b)(2) requires EPA to calculate case-by-case numerical limits for those monofills over ground water categorized as Class III because the background ground water concentration of one or more pollutants exceeds the values in Appendix A of the rule. The values in Appendix A are the MCLs, the risk specific doses corresponding to an incremental carcinogenic risk level of 1×10^{-4}, or the RfDs, as appropriate. Owners or operators of monofills are to supply EPA with the background ground water concentration for those pollutants exceeding the values in Appendix A. EPA will then calculate a concentration for the pollutant in sewage sludge so that further degradation of the ground water will not occur because of the disposal of sewage sludge in a monofill. For other parameters in the model, EPA will use the values in Table 6 of the rule. For those pollutants that do not exceed the values in Appendix A, the values in Table 5 apply.

If the concentrations of one or more pollutants exceed the limits listed in Table 5, § 503.33(b)(3) allows the owner or operator to submit documentation that site-specific data, rather than the values shown in Table 6, should be used in calculating the pollutant concentrations for sewage sludge placed in the particular monofill. EPA will recalculate the numerical limits for all pollutants listed in Table 5 using the site-specific data that the owner or operator submits for the parameters in Table 6. If owners or operators choose not to submit data for one or more of the parameters in Table 6, EPA will use the values in Table 6.

The parameters included in Table 6 are depth to ground water, partition coefficient for the unsaturated zone, soil type, net ground-water recharge rate, ground-water electromotive potential (Eh), and ground-water pH. As discussed previously, these are the parameters that, if changed, make a significant difference in the allowable pollutant concentrations (i.e., the pollutant concentration in sewage sludge that does not exceed an MCL or other human health criterion at the point of compliance). The "Technical Support Document: Landfilling of Sewage Sludge" (Reference number 58) documents the values for the parameters in Table 6 and lists the sources for, and the ways in which owners and operators may determine, the site-specific values for these six parameters.

If one or more of the parameters in Table 6 is changed, EPA would calculate new numerical limits for all pollutants in Table 5. The reason for this approach is that a parameter may affect different pollutants in different ways. For example, if changes were made in ground-water pH or net ground-water Eh, the allowable pollutant concentration of some metals would increase while the allowable pollutant concentration of other metals would decrease. Since the model EPA used can calculate the numerical limits simultaneously, it is a simple and straight-forward procedure to recalculate all the numerical limits.

The rule allows site-specific modeling to derive the numerical concentration limits for sludge disposed of in monofills. The rule does not preclude the applicant from incorporating into the model the sites's artifical characteristics (e.g., a synthetic liner) in addition to its natural characteristics (e.g., a natural clay liner). The applicant is thus not prevented from incorporating the effect that containment measures would have on infiltration or recharge flow rates through the fill material and on the porosity and pollutant sorption beneath the fill. The numerical limits are thus capable of being modified to account for the effect of containment measures such as liners.

Nevertheless, the Agency's model was not developed with the specific intent of describing the behavior of liners or other containment measures. Furthermore, in its current form it cannot account for any deterioration in containment effectiveness that may occur over time. The Agency is soliciting comment on whether the model should be modified to account for the effect of liners and the assumptions that the Agency should use in doing so.

If the sewage sludge that a treatment work wishes to place in a monofill continues to exceed the numerical limits in Table 5 or the numerical limits that EPA calculated on a case-by-case basis, the treatment work must either reduce the concentration of the pollutants through more stringent local pretreatment limits or find an alternative way of managing the sewage sludge.

As discussed in Part XI of the preamble, the Agency estimates that all of the facilities are likely to exceed the numerical limits in Table 5. However, this estimate does not take into account the possibility that some sewage sludge may come into compliance when site-specific data is used to re-calculate numerical limits.

Lead

The concentration for lead in Table 5 of the proposal is based on the existing MCL of 50 (μg/l). The Agency has proposed a new MCL for lead (see 53 FR 31516, August 18, 1988) of 5 μg/l in water leaving the drinking water plant. Because lead frequently leaches from pipes, the Agency proposed that, if a specified number of "morning first draw" tap water samples exceed 10 μg/l, public water supply systems would be required to implement a State-approved treatment plan. Although EPA proposed a number of alternatives and received public comment on them, the Agency is seeking public comment today on whether 5 or 10 μg/l should be the basis of the numerical concentrations for monofills. The effect of using 5 or 10 μg/l lead limitations is shown below:

MCL	Class I ground water	Class II and III(1) and (3) ground water
5 μg/l	0.068	37.9 μg/l
10 μg/l	0.079	82.1 μg/l

The Agency requests public comment on the lead level it should use as the human health criterion.

Non-Degradation of Class III Ground Water

The Agency also seeks guidance on the approach it is proposing for Class III ground water that is not a drinking water source because the background ground-water concentration of one or more pollutants exceeds the values in Appendix A. Under the proposed approach, numerical limits would be set so that the background ground-water concentration of a pollutant would not be exceeded.

The Agency is proposing this approach because it does not want any further degradation of ground water in case future technological advances allow public treatment systems to treat polluted ground water economically. However, EPA recognizes that this approach is relatively more stringent for ground water that is not a source of drinking water than the approach for Class II ground water that is a current or potential source of drinking water or the approach for Class III ground water that is not a source of drinking because of TDS levels or yield limitations. For Class II ground water and for the other two categories of Class III ground water, EPA is establishing numerical limits to prevent pollutants from exceeding the MCL or other appropriate human health criteria. Potentially, pollutant levels in monofills located over high quality ground water (i.e., ground water with pollutant concentrations below the MCL or other human health criteria) could increase as long as the pollutant levels did not exceed the MCL or other appropriate human health criteria. The Agency is seeking public comment on whether the basis of the numerical limits for this type of Class III ground water should be some value other than background concentrations.

In addition, the Agency is soliciting public comment on the need to propose, and the basis of numerical limits for, a "non-degradation policy" for all ground water underlying a monofill. Such a policy would require owners or operators to analyze their ground water for background ground water concentrations, regardless of the class of ground water under the monofill. It would also require the Agency or the permitting authority to set case-by-case numerical limits for all monofills; no national limits would be established in the rule. Under a "non-degradation" policy for Class I and Class II ground water, numerical limits for monofills could be based on background concentration or a percentage over background concentration.

Monofills—Management Practices (§ 503.34)

Daily Cover Requirement

Today's proposal requires that suitable cover material be applied at the end of each operating day or at more frequent intervals, if necessary, to control disease vectors, gas venting, odors, and scavenging. Covering the wastes helps control disease vectors, rodents, and odors if putrescible wastes are placed in the monofill. Cover material also reduces air emissions from the monofill, lessens the risk and spread of fires, and reduces infiltration of rainwater, which, in turn, decreases leachate generation and potential surface and ground water contamination. As an additional benefit, daily cover enhances the appearance of an otherwise aesthetically displeasing site and may increase the number of beneficial uses for the site after completion of the filling activities. Cover is normally applied over sludge the same day that the sludge is placed in trenches. The soil excavated during trench construction provides the material that is used for daily cover.

EPA is not specifying the type or amount of cover material to be used, leaving the determination of "suitable material" and minimum cover depth up to the permitting authority. However, good engineering practice suggests that a 6-inch depth of compacted earthen material be used as cover material. Tests have shown that 6 inches of compacted sandy loam soil prevents fly emergence, and daily (or more frequent) cover has been shown to reduce the attraction of birds and to discourage rodents from burrowing into the waste (Reference number 77).

Nineteen States and territories have requirements for daily, intermediate, or final cover. Seven States require 6 inches of daily cover and one State requires 12 inches. One State requires 6 inches of daily cover over stabilized sludges and 2 feet over unstabilized sludges. Four other States require only that solid waste and sludge be covered at the end of each day.

Intermediate cover is specified by two States. One requires 24 inches of intermediate cover, while the other does not specify a depth for the required intermediate cover. Eight States specify a depth of final cover. Six States require 2 feet and two States require 3 feet (Reference number 52). In the closure plan, EPA requires owners or operators to provide a final cover and to maintain that final cover for 10 years. EPA requests comments on the daily cover requirement and whether there are circumstances when EPA should exempt the requirement.

Methane Gas Monitoring

The decomposition of sewage sludge produces methane gas that, if allowed to accumulate, can migrate to monofill structures or nearby off site structures resulting in fire and explosions and potentially injuring or killing employees and occupants of nearby structures. EPA established an explosive gas criterion in 40 CFR 257.3-8(a) to regulate the concentration of methane in facility structures and at the property boundary. This requirement is expanded in today's proposal consistent with the proposal for MSWLFs.

Section 503.34(b) requires that the concentration of methane gas generated in a sewage sludge monofill shall not exceed 1.25 percent methane in any structure within the sewage sludge monofill and shall not exceed 5.0 percent methane at the property line of the sewage sludge monofill. Five percent methane is the lower explosive limit (LEL). This is the lowest percentage, by volume, of a mixture of explosive gases that will flame at 25 degrees Celsius (77 degrees Fahrenheit) at atmospheric sea level pressure. Today's proposal would require that the concentration of methane generated by the monofills not exceed 25 percent of the LEL (i.e., 1.25 percent methane) in facility structures (excluding gas control or recovery system components) and the LEL itself at the property boundary. EPA based its selection of the 25-percent criterion on a safety factor recognized by other Federal agencies as being appropriate for similar situations (Reference number 77). The Agency is not requiring the same 25-percent criterion at the property boundary, since gases at or below the LEL at the property boundary will become diffused before passing into any structure beyond the property boundary. Requiring that the LEL for methane not be exceeded at the property boundary protects against offsite explosions. The Agency believes that the limits in § 503.34(b) adequately protect public safety without being unduly restrictive.

For owners and operators to comply with the methane gas requirement, they will have to install (if they have not already done so) equipment to monitor methane continuously in the buildings and at the property boundary. This equipment must be maintained for 10 years after closure, as required by § 503.32(m)(3). Twenty-eight States have gas monitoring requirements for landfills.

Other Volatile Organic Compounds (VOCs)

By limiting the concentration of methane gas to 1.25 percent in buildings located in monofills, the Agency believes that other volatile organic compounds (VOCs), such as trichloroethylene, that may still be present in sewage sludge should not pose any human health problems. The sewage sludge placed in monofills will be digested to meet a minimum of Class B pathogen reduction requirements. Digestion raises the temperature of the sewage sludge and evaporates most, if not all, of the volatile portion of the organic compounds. Any remaining VOCs are unlikely to represent more than a tiny fraction of the gases (largely methane) produced by the degradation of the organic compounds in the monofill. Therefore, the Agency did not examine the potential for human health effects associated with volatile organic compounds from the uncovered surface of the monofill which might seep into facility structures during the working portion of the day. EPA believes that the evaporation of VOCs from the open portion of the monofill, rather than seepage, would likely pose a greater health risk. However, the Agency will carefully examine and consider evidence indicating that its assumptions are incorrect.

In its proposal for MSWLFs, EPA proposed to regulate other gases because these landfills appear to be a source of air pollutants (see 53 FR 33338, August 30, 1988). Gases of decomposition originate within a municipal landfill and vent to the atmosphere by vertical migration or lateral migration. Landfill gas is generated by chemical reactions and by microbial degradation of refuse materials into a variety of simpler compounds. Typically, landfill gas consists of nearly 50 percent methane, 50 percent carbon dioxide, and trace constituents of VOCs and other toxic constituents. Pollutants commonly found in gas at municipal landfills include vinyl chloride, benzene, trichloroethylene, and methylene chloride. Some of these compounds can create an unpleasant odor nuisance, while the VOCs and other toxic emissions can constitute a health hazard. This is in addition to the dangers from the explosive potential of methane. EPA decided to regulate air emissions from MSWLFs under section 111(b) of the Clean Air Act, for new landfills, and section 111(d) for existing landfills. Under section 111(d), EPA is preparing air emission guidelines that are to be adopted by the States. They will prepare plans for controlling existing sources of air emissions from municipal landfills, according to the EPA guidelines. The regulations will be based on both collecting and controlling landfill gas. EPA plans to propose air emission standards for these landfills in the near future.

EPA is uncertain that similar air pollution problems are prevalent at monofills. The Agency is soliciting data on any monofill air monitoring by States to assist in determining if regulation of air emissions from landfills should be expanded to include the 49 existing monofills and any new monofills.

Access Controls

Section 503.34(c) requires that access to monofills be controlled, as appropriate, to protect human health and the environment from methane gas hazards and other hazards that could result from disturbing the monofill cover. Access controls are also necessary to prevent illegal dumping and to keep unauthorized vehicular traffic from disturbing the monofill cover. Keeping trespassers off sludge landfills is important because the sludge may not be sufficiently stable to support their weight. Unauthorized access to monofills may be prevented by placing gates with locks at all entrances (access roads) to the site. Other provisions may need to be investigated on a site-by-site basis. EPA is allowing owners and operators the flexibility to implement systems appropriate for their facilities based on the characteristics of their sites, but signs and gates should be posted across access roads even in remote areas. Twenty States require access controls to landfills.

Pathogen Reduction Requirements (§ 503.35)

Section 503.35 requires that sludge placed in monofills meet, at a minimum, the Class B pathogen reduction requirements in § 503.52(b) of the rule. As explained elsewhere in the preamble, Class B pathogen reduction requirements include requirements for access and use restrictions. The access restrictions in Subpart D of today's proposal are more restrictive than those for the Class B pathogen reduction standards and therefore govern.

EPA is including pathogen reduction requirements for sewage sludge disposed of monofills even though the Agency is not aware of any incident in which illnesses have been attributed to pathogens from monofills. A review of the literature (see Reference number 78) indicates that, potentially, pathogens could pose a problem if monofills were located in sandy soils. This conclusion was based on field studies of the transport and fate of viruses from septic tanks. The results of these studies suggest that enteroviruses can travel substantial distances. In one study, researchers added a single dose of vaccine poliovirus type 1 (derived from cell culture or from stools of recently vaccinated infants) to several septic tank systems. In all cases, the researchers found the viruses persisted for several months and reached the ground water or traveled to nearby bodies of water. Little virus removal occurred during transport through the unsaturated zone. Although no studies have been conducted on sewage sludge placed in monofills to determine if the viruses exhibit similar survival and mobility in a sludge matrix, the high organic content in sludge is unlikely to retard the movement of viruses.

Bacterial movement through the soil surface appears to be more restricted than that of viruses, although rainfall can increase bacterial migration by increasing infiltration rates. However, if bacteria are able to penetrate to the saturated zone, they appear capable of being transmitted significant distances in sandy and gravel soils, although significant reductions may occur from the travel distance. EPA believes that the requirement for daily cover and for the collection of runoff should reduce potential bacteria problems at monofills.

EPA's Office of Research and Development has undertaken an assessment of the potential pathogenic risks from monofills (see Reference number 79) and intends to prepare a quantitative pathogen risk assessment methodology. When the results of the assessment are complete, EPA will re-evaluate the need for additional requirements beyond those in the Class B requirements. However, without additional data on the concentration of pathogens in the leachate or the decay rate of pathogens in the leachate, the Agency will assume that no further decay of pathogens occurs subsequent to the Class B reduction. Such an assumption may not be entirely valid. Therefore, the Agency is requesting laboratory or field data that may assist it in predicting the fate of pathogens from monofills.

As an alternative to the pathogen reduction requirements, particularly for monofills located in sandy soils, the Agency could require owners or operators to add liners. The Agency is soliciting comment on the alternative of requiring liners instead of imposing pathogen reduction standards.

Monitoring, Record Keeping, and Reports (§ 503.81 and § 503.84)

Owners and operators of monofills are to measure the concentration of the pollutants listed in Table 5 at the frequencies established for the design capacity of the treatment work and with the sampling and analysis procedures in § 503.81. Owners and operators must also monitor the sewage sludge to demonstrate compliance with the Class B pathogen reduction requirements, continuously monitor the methane gas at the property boundary, and monitor the volume and concentration of the pollutants in runoff. Section 503.81(b) lists the analytical methods for sampling and analyzing the sewage sludge for the constituents in Table 5 and for pathogenic bacteria, animal viruses, fecal coliform, fecal streptococci, protozoa and helminth ova.

EPA is proposing that owners and operators keep the records required in § 503.84 for a period of 10 years. Ten years is the proposed period of time that the final cover is to be maintained, methane gas monitored, and access to the monofill restricted. The records to be kept and the reports to be submitted ensure that owners and operators of monofills will comply with the monitoring and verification requirements of the rule. Owners and operators must certify that the monofill:

- Does not cause or contribute to the harm of threatened or endangered species or their habitat, does not restrict the flow of a base flood, does not reduce the temporary water storage capacity of a floodplain, and does not present a hazard to human health, wildlife, or land or water resources;
- Does not attract birds that present a hazard to aircraft if the monofill is located either within 3,048 meters (10,000 feet) of aircraft runways used by turbine-powered aircraft or 1,524 meters (5,000 feet) of an airport runway used only by piston engine-powered aircraft;
- Is designed to withstand stress created by the maximum ground motion if the monofill is located in a siesmic zone;
- Is located 60 meters or more from a fault that has had displacement in Holocene time;
- Is located in areas that adequately support the structural components of the unit; and
- Is located outside the perimeter of wetland areas.

In addition, the monofill owner or operator must report the concentration of the pollutants in sewage sludge, level of pathogen reductions achieved, the record of the methane gas concentration in any structure within the monofill boundary and at the property boundary, the volume of runoff treated and discharged, and the concentration of the pollutants in the discharge.

These monitoring, record keeping, and reports relate to key elements within Subpart D and were described throughout the discussion of the requirements for monofills.

Surface Disposal Sites (Subpart E)

Applicability (§ 503.40)

The requirements contained in this proposal apply to surface disposal sites receiving only sewage sludge. The requirements also apply to any person who disposes of sewage sludge on a sewage sludge disposal site.

Specialized Definitions (§ 503.41)

Surface Disposal Sites

There are a number of different ways to apply sewage sludge to the land for reuse or disposal. Sewage sludge applied to agricultural and non-agricultural land, and the distribution and marketing of sewage sludge, generally is done to use the nutrient and soil conditioning properties of the sewage sludge. Applying sewage sludge to dedicated, non-agricultural land, however, is an exception. This practice does not use the nutrient and soil conditioning properties for a beneficial use. Rather, it is a disposal method that uses the soil to bind the metals and uses soil microorganisms, sunlight, and oxidation to destroy the organic matter in the sludge. Disposing of sewage sludge in monofills is also a method of disposal that does not use the beneficial characteristics of the sewage sludge.

The Agency has identified another disposal method that, while similar to some disposal methods and treatment practices, such as surface impoundments, is not strictly covered by those terms. In this method of disposal, sewage sludge is placed on the surface of the land in "piles". The Agency is calling this method of disposal, sewage sludge surface disposal.

The Agency defines a surface disposal site as an area of land on which only sewage sludge is placed for a period of one year or longer. Surface disposal sites do not have a vegetative or other cover. The one year time period is used to differentiate surface disposal from treatment or storage. As explained elsewhere in the preamble, today's proposal only covers final use or disposal methods, not treatment processes or storage.

In 1984, when the Agency initiated the Part 503 rulemaking process, surface disposal sites were considered surface impoundments that were used for treatment or interim storage, not use or disposal facilities. Subsequently, the Agency learned that some communities use surface impoundments for extended periods of time, suggesting that the practice is the community's method of disposal. When surface impoundments are used for the final disposal of sewage sludge, they are surface disposal sites and are subject to the CWA's requirements as a disposal method. The CWA requires the Agency to develop standards for all use or disposal methods that are adequate to protect human health and the environment from any adverse effect of each pollutant.

The Agency identified approximately 5,600 facilities that dispose of 476,500 dry metric tons of sewage sludge by "other" practices, some of which may include surface disposal sites to dispose of 200,000 dry metric tons of sewage sludge. The Agency believes that approximately 2,400 POTWs use surface disposal sites for the disposal of their sewage sludge.

Based on available information, the Agency believes that surface disposal sites generally are small, are located in rural areas on lands owned or controlled by local governments, and do not expose individuals to significant concentrations of pollutants. EPA is collecting additional information on the location, size, and the physical characteristics of surface disposal sites, as well as on the characteristics and quality of sewage sludge placed on, and the typical management practices associated with, surface disposal sites. This information will be used to evaluate the human health and environmental impacts of treatment works using surface disposal sites.

The Agency has initiated work to develop an exposure assessment model for surface disposal sites in much the same way it developed exposure assessment models for other methods of use and disposal. Where possible, the Agency will use existing equations to simulate the movement of pollutants from a surface disposal site into the air, ground water, and surface water. The Agency is soliciting suggestions on modifications that it should make to either the monofill or land application models to develop a surface disposal model.

After completing the exposure assessment model, the Agency will evaluate MEI and aggregate exposure from surface disposal sites. Information on the likely exposure of individuals and the aggregate effects of surface disposal sites, as well as comments on today's proposal, will be used in evaluating the appropriateness of the standards for sewage sludge disposed of on such sites.

For the purpose of regulation, the Agency has tried to distinguish surface disposal from land application to dedicated non-agricultural land and from disposal in monofills. Despite the similarities, there are differences between surface disposal and dedicated non-agricultural land application. On a surface disposal site, no vegetative cover is established on the sewage sludge. However, on dedicated non-agricultural land, a vegetative cover is established.

By the same token, if a surface disposal site is surrounded by a containment wall or if the sewage sludge is placed in a natural topographic depression or a man-made excavation, it resembles a monofill. Again, however, there are differences. One of the main differences is that no daily or final cover is established over the sewage sludge on a surface disposal site. Under the same conditions, surface disposal sites may also resemble sewage sludge treatment facilities such as pits, ponds, and lagoons. The distinguishing feature, though, is that a surface disposal site is the ultimate method of disposal, rather than part of the wastewater or sewage sludge treatment processes.

The Agency is soliciting comment on whether it should distinguish surface disposal from dedicated non-agricultural land application and from disposal in monofills. Comment is also solicited on the use of a 1-year time period to distinguish surface disposal from treatment or storage. Some treatment practices, such as composting, may take as long as 50 weeks. The Agency considered and is soliciting comment on regulating surface disposal sites, dedicated non-agricultural land, and monofills in a similar manner without regard to current practice. This approach would force all current practices to conform to the same standards (i.e., cover, etc.) based on the characteristics of the disposal method, rather than on the anticipated human health and environmental effects of the practice.

The remaining definitions in § 503.41 of the rule are identical to the definitions in § 503.31 for monofills.

General Requirements (§ 503.42)

The requirements for surface disposal sites are similar to those for non-agricultural land, except for the vegetative cover, and similar to those for monofills, except for the daily cover, the determination of the class of ground water under the site, and a closure plan. The Agency is not requiring that owners or operators of surface disposal sites have a vegetative or other cover on the sewage sludge because covers may not be necessary to protect human health and the environment.

The Agency is not requiring owners and operators to determine the class of ground water under their site because the pollutant limits for surface disposal sites are based on "current sludge quality" (i.e., the 98th-percentile pollutant concentration shown in the "40 City Study") and are not contingent on the class of ground water under the site, as they are for monofills.

The Agency is requesting public comment on requiring a closure plan for surface disposal sites and the requirements for the closure plan. For monofills, the Agency is requiring a final cover and, for 10 years, maintenance of the final cover, methane gas monitoring, and restrictions on public access. EPA requests opinions and information on the efficacy of these provisions, particularly since the Agency is not proposing a daily cover, and on the need for a closure plan when one is not required for dedicated non-agricultural land application.

EPA believes that the other general requirements for dedicated non-agricultural land and for monofills are applicable to surface disposal sites. Surface disposal sites should not threaten endangered species or their critical habitat, restrict the flow of a base flood, reduce the temporary water storage capacity of a floodplain, or present a hazard to human health, wildlife, or land or water resources due to a washout of the sewage sludge. In addition, if a surface disposal site is located near an airport, the sewage sludge disposed on the site should not pose a hazard to aircraft by attracting birds to the site.

EPA is proposing that sewage sludge surface disposal sites located in a seismic zone be designed to withstand the maximum ground level acceleration. The Agency further proposes that surface disposal sites be located 60 meters or more from a fault that has had displacement in Holocene time; located in areas where there is adequate support for the site; and located outside the perimeter of wetland areas. If surface disposal sites are located closer than 60 meters from a fault that has had displacement in Holocene time, located in unstable areas, or located in wetland areas, they would have to be closed within 1 year. These facilities must close within a year because Section 405(d)(2)(D) of the CWA requires compliance with the requirements of these rules within 1 year.

The Agency is also requiring that owners or operators collect the volume of water from the 24-hour, 25-year storm event that runs off a surface disposal site and that they discharge the water in accordance with an applicable NPDES permit. This requirement precludes sewage sludge from washing out of the surface disposal site and endangering human health and environment.

As proposed, the requirements for surface disposal sites apply to active sites still receiving sewage sludge. The Agency is seeking public comment on whether any or all of the requirements in § 503.42 should apply to sites that have not received sewage sludge for more than one year.

Surface Disposal Sites—Pollutant Limits (§ 503.43)

Figure IX–E.1 shows the key elements in determining whether or not sewage sludge may be disposed of on surface disposal sites.

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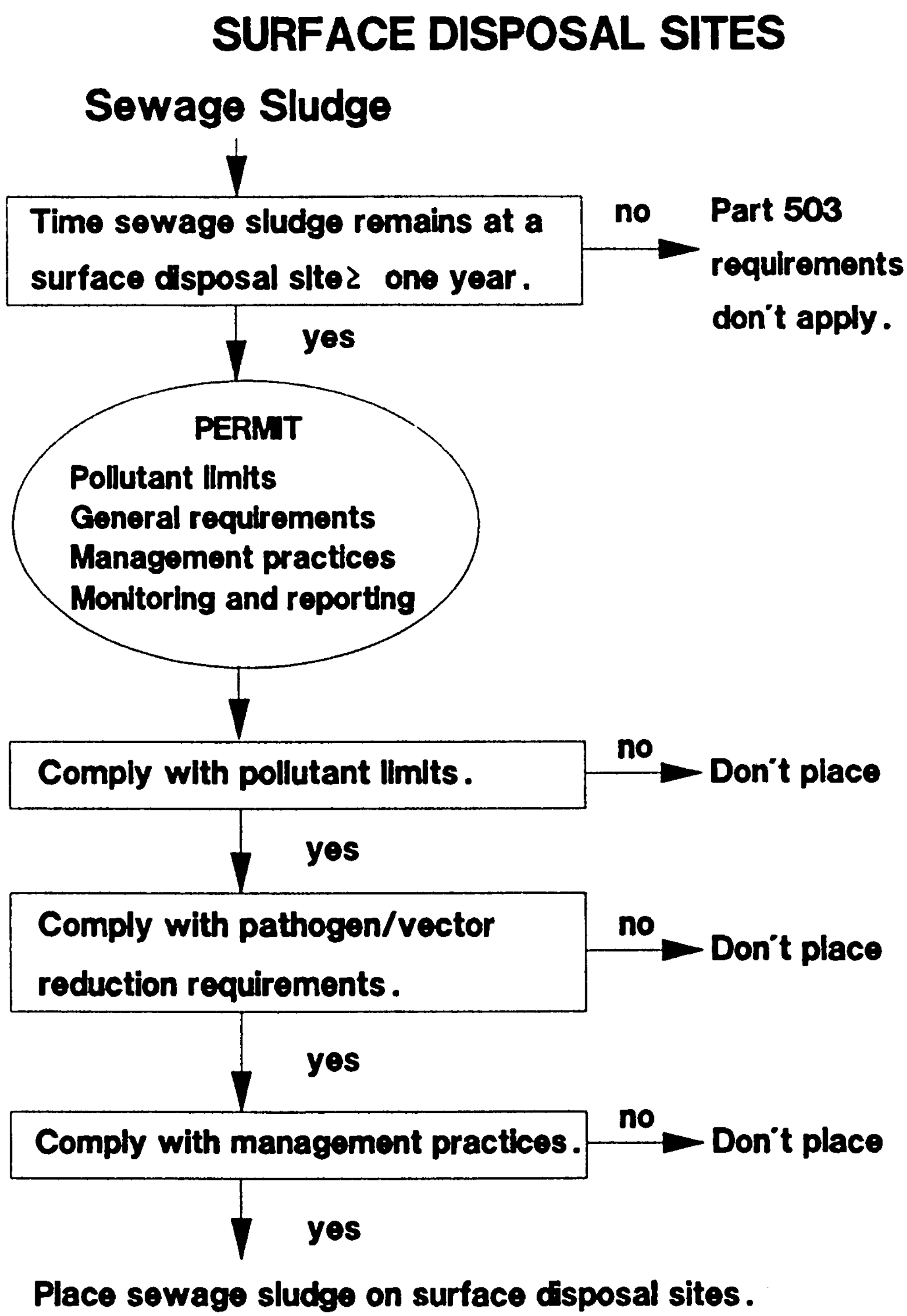
Figure IX-E.1



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The pollutant limits for sewage sludge placed on surface disposal sites are shown in Table 7 of the proposed rule. The Agency is proposing to use "current sludge quality" (i.e., the 98th-percentile pollutant concentrations) as the basis of the pollutant concentrations for surface disposal sites because the aggregate effects analysis is expected to show a low incidence of adverse human health effects from this disposal method. Since surface disposal sites are generally small and are located on municipal property away from population centers, few individuals are likely to ingest the pollutants from the sludge by drinking water from wells located near surface disposal sites or inhale the vapors from surface disposal sites. If these assumptions are incorrect, the Agency will propose an alternative approach based on the exposure assessment model that is currently under development.

The numerical limits for surface disposal sites correspond to the 98th-percentile pollutant concentrations unless the exposure assessment model calculates a higher pollutant concentration for monofills located over Class I ground water. In the latter case, the Agency is proposing the higher pollutant concentration calculated by the model. The higher pollutant concentrations are based on the stringent assumptions in the model for Class I ground water. In other words, the pollutant levels in the leachate cannot exceed the MCLs because the facility is located in a sandy soil immediately over the ground water. The pollutant concentrations for DDT/DDE/DDD (total), lindane, toxaphene, and benzo(a)pyrene are based on the monofill model rather than the 98th-percentile pollutant concentration.

There are two main reasons why the model calculates a higher pollutant concentration than the 98th-percentile concentration for these organic pollutants. The concentration values reported for organic pollutants in the "40 City Study" may not accurately reflect the actual concentrations in the sewage sludge. At the time the "40 City Study' data were collected, the analytical techniques used in the Study were not as sophisticated or precise as current techniques and they had higher limits of detection for ogranic pollutants. In effect, concentrations or organic pollutants were not detected. It is likely that the National Sewage Sludge Survey will find these compounds in sewage sludge. Even if these compounds are found, the models may still calculate a less stringent limit for DDT/DDE/DDD (total), lindane, and toxaphene because these are high molecular-weight, chlorinated organic pollutants that have a low solubility in water and, therefore, do not leach to the ground water. The models also may calculate a less stringent concentration for benzo(a)pyrene than the 98th-percentile concentration because the partition coefficient for benzo(a)pyrene is very high. This means that only a small portion of the pollutant goes into solution and leaches to the ground water.

Surface Disposal Sites—Management Practices (§ 503.44)

The requirement that owners or operators monitor methane gas is the same for surface disposal sites as for monofills. Methane gas forms during the decomposition of organic pollutants under the anaerobic conditions in the layer of sludge at the bottom of the surface disposal site and could accumulate. The Agency is proposing that owners or operators monitor for methane gas, either in buildings located within the boundary of the surface disposal site or at the property boundary, to protect against any potential accumulation to levels that could endanger public safety.

EPA is proposing that crops not be grown for human consumption on a surface disposal site, that vegetation growing on a surface disposal site not be fed to animals, and that animals raised for human consumption not be grazed on the vegetation. The reason for these requirements is that vegetation may spontaneously grow at surface disposal sites. If this occurs, care should be taken to ensure that animals do not graze on the vegetation and that individuals do not harvest the vegetation for subsequent feeding to animals or humans.

Access controls are to be erected to prevent unauthorized entry to the surface disposal site. This requirement is designed to protect the public from methane gas and from walking on an unstable surface. The access controls should also assist in guarding against any illegal dumping.

Pathogen And Vector Attraction Reduction Requirements (§ 503.45)

The Agency is proposing that sewage sludge placed in surface disposal sites meet at least the Class B pathogen reduction requirements to reduce the spead of pathogenic organisms from the surface disposal site. The basis of this requirement is the study, described in the discussion of monofills, that shows the migration of pathogenic organisms from septic tanks located in sandy soils. As in the case of monofills, the Agency is requesting comment on whether the pathogen reduction requirement for sewage sludge on surface disposal sites should be waived if a liner is installed. In addition, the Agency is requesting comment on whether it should allow Class C pathogen reduction for sewage sludge disposed of on surface disposal sites, as it does for dedicated non-agricultural lands.

EPA is requiring that sewage sludge disposed of on surface disposal sites meets one of the vector attraction reduction requirements in § 503.53. The Agency did not propose that sewage sludge placed in monofills meet the vector attraction reduction requirements because the sewage sludge is covered daily. A daily cover should provide sufficient protection against the attraction of vectors to the sewage sludge and the subsequent spread of pathogenic organisms from the monofill. However, the Agency is not proposing a similar daily cover provision for surface disposal sites and, therefore, believes that the vector attraction reduction requirements in § 503.53 are needed to reduce the attraction of vectors to the sewage sludge and the potential spread of pathogenic organisms from the surface disposal site. The vector attraction reduction requirement for surface disposal sites is the same as the requirement for dedicated non-agricultural land.

Monitoring, Record Keeping, And Report Requirements (§§ 503.81 and 503.85)

Owners and operators of surface disposal sites are to measure the concentration of the pollutants listed in Table 7 of the rule at the frequencies established for the design capacity of the treatment work and with the sampling and analysis procedures in § 503.81. Owners or operators must monitor the sewage sludge to ensure compliance with the Class A or Class B pathogen reduction requirements, monitor the methane gas at the property boundary, and monitor the volume and concentration of the pollutants in the runoff. Section 503.81(b) lists the analytical methods for these analyses.

EPA is proposing that the specified records be kept for 5 years, a requirement of the State program management regulation (40 CFR Part 501). Also under consideration is a record retention requirement of 3 years. The Agency is seeking public comment on the appropriate period of time treatment works should be required to retain the records for surface disposal sites.

The reports ensure that owners or operators of surface disposal sites will comply with the monitoring and verification requirements of the rule. In addition, owners or operators must certify that each surface disposal site:

• Does not cause or contribute to the harm of threatened or endangered species or their habitat, does not restrict the flow of a base flood, does not reduce the temporary water storage capacity of a flood plain, and does not present a hazard to human health, wildlife, or land or water resources;

• Does not attract birds that present a hazard to aircraft if the surface disposal site is located either within 3,048 meters (10,000 feet) of aircraft runways used by turbine-powered aircraft of 1,524 meters (5,000 feet) of an aircraft runway used only by piston engine-powered aircraft;

• Is designed to withstand stress created by the maximum recorded ground level acceleration if the surface disposal site is located in a seismic zone;

• Is located 60 meters or more from a fault that has had displacement in Holocene time;

• Is located in areas that adequately support the structural components of the surface disposal site; and

• Is located outside the perimeter of a wetland area.

In addition, the owner or operator of each surface disposal site must report, at the same frequency specified for sewage sludge monitoring, the concentration of the pollutants in sewage sludge, the level of pathogen reduction achieved, the vector attraction reduction approach used, the record of the methane gas concentration in any structure within the surface disposal site boundary or at the property boundary, the volume of runoff treated and discharged, and the concentration of the pollutants in the runoff.

Pathogen And Vector Attraction Reduction Requirements (Subpart F)

Applicability And Scope (§ 503.50)

The pathogen reduction and vector attraction reduction requirements included in Subpart F pertain to sewage sludge that is applied to agricultural and non-agricultural land, distributed and marketed, or disposed of in monofills or on surface disposal sites. Pathogenic organisms in wastewater and sludge include bacteria, viruses, protozoa, and helminth ova and constitute one class of contaminants. These organisms can cause diseases, usually enteric diseases, through direct human contact with the organisms or through ingestion of an infected animal.

Pathogen bacteria and viruses occur in sewage. Based on a literature review, Table IX-F.1 lists those pathogenic organisms that (1) are associated with a high incidence of disease, (2) are found in high concentrations in sewage sludge, (3) exhibit resistance to environmental stresses, (4) can be detected with available methods, and (5) exhibit low infectious doses.

TABLE IX-F.1—PRIMARY PATHOGENS IN SEWAGE SLUDGE

Type	Organism	Disease
Bacteria	*Campylobacter jejuni*	Gastroenteritis.
	Escherichia coli (pathogenic strains)	Gastroenteritis.
	Salmonella sp.	Gastroenteritis, Enteric fever.
	Shigella sp.	Gastroenteritis.
	Vibrio cholerae	Cholera.
Viruses	Enteroviruses	
	Poliovirus	Gastroenteritis, meningitis, carditis central nervous system involvement, pneumonia infectious hepatitis.
	Coxsackievirus	
	Echovirus	
	Hepatitis A virus	
	Norwalk viruses	Gastroenteritis.
	Norwalk-like viruses	Gastroenteritis.
	Reovirus	Respiratory infections, gastroenteritis.
	Rotavirus	Gastroenteritis, infant diarrhea.
Helminths	*Necator americanus*	Hookworm.
	Taenia sp.	Taeniasis (tapeworm).
	Toxocara sp.	Visceral larva migrans.
	Trichuris sp.	Ascariasis.
	Hymenolepis nana	Taeniasis.
Protozoans	*Toxoplasma gondii.*	Toxoplasmosis.
	Balantidium coli	Balantidiasis.
	Entamoeba histolyca	Amebic dysentery.
	Gardia lambia	Giardiasis.
	Cryptosporidium	Gastorenteritis.
Fungi	*Aspergillus fumigatus*	Aspergillosis or respiratory infections.

Source: Technical Support Document: Pathogens and Vectors. EPA, 1988.

Wastewater treatment processes remove pathogenic organisms from wastewater, not so much by destroying them as by concentrating them in the residual sludge streams. Because sludge volume is much smaller than wastewater volume, concentrations of pathogens on a volume basis are much higher in the sludge than in the original wastewater. The increased pathogen content of sludge makes it essential that the Agency require processing and other procedures that minimize exposure of humans and animals to infectious organisms in sludge.

Ideally, regulations designed to protect individuals from pathogenic organisms in sewage sludge take into consideration:

• The densities of specific pathogens of major public health significance contained in sewage sludge;

• The ability of specific wastewater and sludge treatment processes to reduce the concentrations of these pathogens;

• The survival or transport of pathogenic organisms in the environment; and

• The risk to humans ingesting a specific number of these pathogens.

However, research on the fate and pathogenicity of microorganisms in sewage sludge is still under development. Therefore, the Agency has traditionally specified technology-based standards (i.e., processes that significantly reduce pathogens—PSRP—and processes that further reduce pathogens—PFRP). These treatment technologies are included in 40 CFR 257.3-6.

The Agency is gathering additional information on the survival and transport of pathogenic organisms in the environment and on the specific number of pathogenic organisms likely to cause an infection. This information will be used to develop a series of equations to simulate the movement of pathogenic organisms through the environment. These equations will be integrated into a model similar to the other exposure assessment models discussed in Part IV of the preamble. The model will (1) start with levels of pathogenic organisms usually seen in wastewater prior to treatment, (2) project the level of reduction attained by wastewater and sewage sludge treatment, and (3) calculate the movement, survival, and attenuation of the pathogenic organisms in the environment, as well as the risk of human disease.

In conjunction with the development of the model, the Agency is gathering information on the infectious dose of pathogenic organisms (i.e., the minimum number of bacteria, viruses, protozoa, or helminths necessary to cause an infectious dose in the host). In defining an infectious dose, the Agency will use a process similar to the way in which it establishes RfDs for non-carcinogenic pollutants. The numbers will likely be similar to an RfD (i.e., establishing a level such that the likelihood of developing an infectious case is very low). Once microbiological "human health criteria" are established for pathogenic organisms, the Agency will incorporate this information with data on survivability, transport, and climatic effects into a model to calculate the densities of pathogenic organisms in sewage sludge that can be applied to the land or disposed of in monofills or on surface disposal sites without infecting individuals.

Because more data are available on bacteria, the Agency anticipates modeling bacteria first, followed by viruses, protozoa, and helminth ova. Once the model and criteria are fully developed and have undergrone review by the Agency's Science Advisory Board, the Agency will publish the model and, if necessary, propose revisions in the Part 503 requirements.

Until the Agency develops microbiological human health criteria that link specific numbers of pathogenic organisms to an infectious dose, the Agency is basing today's proposal on the premise that pathogenic organisms must be below levels of detection or below specified levels of fecal coliforms and fecal streptococci/enterococci (indicator bacteria) to protect human health and the environment. To attain this standard, treatment works may use treatment processes alone (Class A, such as composting), or a combination of treatment processes and periods of time when access to and use of the land where sludge is applied are restricted to allow environmental exposure (sunlight and soil temperature) to kill the remaining pathogens (Class B and Class C). Less stringent treatment standards (Class B and Class C) are combined with more rigorous restrictions on access to the land and on growing and harvesting food and feed crops on sludge-amended soils. The combination of treatment standards and access and use restrictions should ensure that the densities of the remaining pathogenic organisms are sufficiently attenuated that the risk of human disease is negligible.

EPA is specifying reductions in pathogenic organisms and densities of indicator organisms that must be attained, rather than continuing to specify technologies that must be used, because of the difficulties in equating new processes to the documented processes (i.e., PSRP or PFRP). Without performance standards corresponding to a desired level of pathogen reduction or density of indicator organisms, manufacturers had difficulty in demonstrating that their technology was equivalent to the treatment process specified in 40 CFR 257.3-6. In 1985, the Agency established a Pathogen Equivalency Committee to review and assist the Agency in assigning new technologies to either PSRP or PFRP. However without performance standards, the Agency believes manufacturers still will encounter difficulties and be reluctant to invest in new technologies.

Today's performance standards are based on well-operated wastewater and sewage sludge treatment processes (see Reference number 78). Any process may be used for a particular class of pathogen reduction as long as the appropriate pathogenic organism reduction or density of indicator organisms is attained.

Another reason that the Agency is revising the requirements in 40 CFR 257.3-6 is to provide additional flexibility for small treatment works to meet the requirements in the rule. The two technologies specified in 40 CFR 257.3-6 (PSRP and PFRP) did not give sufficient flexibility to small treatment plants with processes that are not equivalent to PSRP to meet the requirements by increasing the access and use restrictions, rather than investing in significantly more costly processes. Therefore, the Agency is adding a third class of pathogen reduction/indicator organism densities that is combined with more rigorous access and use restrictions to provide additional opportunities for small treatment works to attain the performance standard.

The Agency is also revising the 40 CFR 256.3-6 requirements because of the growing concern about applying septage to the land. In 1979, when the 40 CFR Part 257 requirements were published, septage was considered to have been treated to a level equivalent to PSRP. Therefore, septage could be placed on the land as though it had been treated by PSRP. In today's proposal, septage is defined as sewage sludge. Therefore, septage collected and applied to the land or disposed of in monofills or on surface disposal sites would have to be monitored and meet the requirements for the appropriate class of pathogen reduction in the same manner as would any other sewage sludge that is generated or treated. The Agency recognizes that this way may require that septage haulers have their septage processed prior to applying the septage to the land. However, the Agency is unsure about the extent and magnitude of any disruptions that today's approach may cause. Public comments are requested on the impact of the proposed rule on the use and disposal of septage.

The Agency also is revising the approach used in 40 CFR 257.3-6 to separate the pathogen reduction/indicator organism density requirements from the vector attraction reduction requirements. The Agency is proposing (1) five ways to demonstrate that vectors would no longer be attracted to sewage sludge or (2) that sewage sludge be injected below the surface of the land. Except for ensuring that the vector attraction reduction is concurrent with or follows the Class A pathogen reduction processes (to preclude explosive regrowth of the pathogens), the Agency sees no merit in linking a particular vector attraction reduction option to a particular pathogen reduction performance standard.

Specialized Definitions (§ 503.51)

Aerobic Digestion

Digestion by aerobic processes is commonly used to stablize sewage sludge. Typically there is no attempt to control temperature, so temperatures ordinarily range from 10 to 30 degrees Celsius, depending on the daily weather conditions. If energy is conserved (e.g., by minimizing air flow and covering the digester), temperatures can increase to the thermophilic range (50 to 60 degrees Celsius). Nominal residence times range from 10 to 40 days. Volatile solids reductions, which indicate a reduction in the ability of the sludge to create odors and attract vectors, is increased by operating at higher temperatures and for longer residence times.

The three types of aerobic digestion processes are conventional semi-batch digestion, conventional (mesophilic) continuous digestion, and autoheated (thermophilic) continuous digestion. In the semi-batch operation, solids are pumped directly from the clarifier into the continually aerated digester. When the digester is full, aeration continues for an additional 2 to 3 weeks. The conventional continuous operation closely resembles the activated sludge process with a flow-through aerobic digester followed by a clarifier-thickener. Many conventional aerobic digesters are operated in the ambient temperature ranges. In the autoheated processes, sludge from the clarifiers is usually thickened to provide a digester feed with greater than four percent solids. In these digesters, thermophilic conditions (50 to 60 degrees Celsius) result from the exothermal heat of substrate oxidation.

Anaerobic Digestion

Anaerobic digestion is the degradation of microbiological organic substance in the absence of oxygen. Primary or secondary sludge is digested in an air-tight reactor for varying periods of time depending on the temperature.

The three basic types of anaerobic digestion are low-rate digestion, high-rate digestion, and two-stage digestion. In low-rate digestion, the sludge is unmixed in the reactor and the processes of sludge thickening and liquid solid separation are carried out simultaneously. In high-rate digestion, the sludge in the reactor is mixed and heated to speed up microbial processing of the sludge. High-rate reactors are operated at either mesophilic (30 to 38 degrees Celsius) or thermophilic (50 to 60 degrees Celsius) temperatures. High-rate reactors have shorter detention times than do low-rate reactors (i.e., 30 to 60 days for low-rate digesters versus 10 to 20 days for high-rate digesters). In the two-stage process, a high-rate digester is linked to a second digester, generally unmixed. The second digester primarily serves as a thickener.

Density of Microorganisms

The density of microorganisms per unit mass of volatile suspended solids is the number of microorganisms divided by the mass of volatile suspended solids in the sewage sludge. The number of microorganisms may be colony-forming units or most probable number of bacteria, plaque-forming units of viruses, or the actual number, by count, of either protozoan cysts or helminth ova.

The Agency is defining the density of microorganisms in terms of volatile suspended solids because these organisms are associated with volatile suspended solids (i.e., organic material) in the sewage sludge. The Agency invites comment on this approach.

Specific Oxygen Uptake Rate

Specific oxygen uptake rate (SOUR) is the rate at which bacteria consume oxygen in a liquid sewage sludge that has been treated in an aerobic process (i.e., mass of oxygen consumed per unit time, per unit mass of sewage sludge solids). A high SOUR indicates there is a large and active bacteria mass in the sewage sludge and the sewage sludge is likely to putrefy rapidly. A low SOUR indicates that the bacteria in the sewage sludge have consumed available food sources and the sewage sludge will not putrefy rapidly. The SOUR standard of 1 milligram of oxygen per hour, per gram of sewage sludge solids or less is used as one of the indicators that the treatment has met the vector attraction reduction requirements.

The SOUR standard is only appropriate for sewage sludge or compost that has undergone aerobic digestion and has a high proportion of aerobic bacteria. Therefore, untreated, limed, and anaerobically digested sewage sludge are not eligible to use this standard.

Volatile Suspended Solids

Volatile suspended solids is that portion of the total solids in sewage sludge that is removed when the sewage sludge is burned at 550 degrees Celsius in the presence of excess air. Microbiological densities are measured in terms of volatile suspended solids in the sewage sludge because these microbes are associated with the volatile suspended fecal material.

Pathogen Reduction Requirements (§ 503.52)

Section 503.52 proposes three classes of pathogen reduction to achieve the objective of reducing pathogenic organisms below levels of detection. EPA developed the three classes or levels of pathogen reduction (i.e., Class A, Class B, and Class C) to provide treatment works greater flexibility in reducing the risk of infection and disease from pathogens than was allowed in 40 CFR 257.3-6. Treatment works may meet the pathogen reduction requirement by treating the sewage sludge to the Class A performance standard. The requirement may also be met by treating the sewage sludge to a Class B or a Class C performance standard and by placing time restrictions on public access to the land where the sewage sludge is applied and placing time restrictions on growing and harvesting crops and grazing animals on that land. These access and use restrictions are not applicable to sewage sludge disposed of in monofills or on surface disposal sites because crops are not grown on monofills or surface disposal sites and because the access restrictions for these disposal practices are more stringent than the access restrictions for land application of sewage sludge.

Class A

Class A pathogen reduction is achieved by processing the sewage sludge. Generally, this will involve composting the sewage sludge or using other processes that increase the temperature of the sewage sludge to 50 to 60 degrees Celsius.

To achieve Class A reduction, the pathogenic bacteria, viruses, protozoa, and helminth ova in the sewage sludge must be reduced to below detectable limits. By requiring that bacteria, viruses (*Salmonella* sp.), protozoa, and helminth ova are all below levels of detection, the Agency believes that these organisms will not infect individuals or animals.

The proposed methods to be used in measuring each of these organisms are presented in § 503.81(b) and discussed later in the preamble. As part of that discussion the Agency is inviting comments on the methods.

An alternative requirement is presented in today's proposed rule for Class A pathogen reduction because of the difficulty in demonstrating that all four types of pathogens are below detectable limits. EPA is proposing that when the temperature of sewage sludge is raised (53 degrees Celsius for 5 days or 55 degrees Celsius for 3 days or 70 degrees Celsius for one-half hour) and the density of fecal coliforms and fecal streptococci (enterococci) per gram of volatile suspended solids are each equal to or less than 100, the Class A pathogenic reduction requirements are achieved.

Fecal coliforms and fecal streptococci are benign organisms present in fecal material. They are used as indicators of the presence of fecal material. If their densities are high, the risk of infectious levels of pathogenic organisms is also high. Agency data indicate that when coliform densities in processed sludge are low (100 per gram of volatile suspended solids or less), *Salmonella* are absent and when coliform densities are high, *Salmonella* are present (Reference number 78). Thermal processes are about as efficient in destroying pathogenic organisms as they are in destroying fecal indicators, but the fecal indicators are present in much higher densities. When the fecal indicators are reduced to very low values, the likelihood of pathogen survival is negligible. Research also shows that thermal processes must raise the temperature of the sludge to 53 degrees Celsius or above to ensure the destruction of helminth ova (*Ascaris* sp.) (Reference number 78). Other processes may reduce fecal indicator densities to low levels but may not reduce all of the pathogens in sewage sludge to acceptable levels. For example, ionizing radiation is more effective against bacteria than against viruses. For this reason, viruses may be present in the sewage sludge even though the fecal indicators are below the 100 gram level. Another example is chemical treatment of sewage sludge. Chemical treatment may reduce pathogenic bacteria and viruses, but may not reduce helminth ova because the ova are protected by a shell that may be impervious to chemicals. Therefore, measurement of fecal indicators may be used only when thermal processes raise the temperature of the sludge for the specified periods of time.

The Agency invites comments on applying the fecal indicator alternative only to processes that raise the temperature of the sewage sludge to at least 53 degrees Celsius and solicits data on the correlation of pathogens to fecal indicator organisms for other technologies. The Agency also requests comments on both the use of indicator organisms to measure pathogen reduction and on the use of the density of 100 per gram of volatile suspended solids value for fecal coliforms and fecal streptococci/enterococci. The Class A pathogen reduction must be completed prior to or must be concurrent with the processes that are used to meet the vector attraction reduction requirements (see § 503.52(a)(3)). The objective of this requirement is never to leave a sewage sludge that is required to meet Class A requirements nearly devoid of vegetative bacteria unless there is something present that inhibits bacterial growth. The inhibiting factor may be dryness, presence of certain chemicals, or presence of vegetative bacteria. If the Class A process that reduces pathogens follows the process for reducing vector attraction (for example, pasteurization after anaerobic digestion), vegetative bacteria are destroyed. Subsequent contamination by pathogenic bacteria could result in explosive regrowth. If the situation were reversed, the presence of nonpathogenic bacteria that caused the digestion and reduced the value of the sludge as an energy source would severely limit potential for explosive regrowth. This does not apply to Class B and Class C pathogen reduction because competitive bacterial organisms that hinder regrowth are present in the sewage sludge.

Since the Class A pathogen requirements reduce pathogenic organisms to levels unlikely to cause an infectious dose, the Agency is not imposing restrictions on access to or use of the land for any period of time. Access is restricted for non-agricultural lands until a vegetative cover is established, but only to keep individuals from sitting in or tracking sewage sludge off the field. Sewage sludge that is distributed and marketed must meet Class A pathogen reduction requirements. It is optional for other methods of use or disposal.

Class B

To reduce pathogenic organisms to safe levels, Class B pathogen reduction requirements use a combination of treatment and time restrictions on access to and use of land to which the sewage sludge is applied. The level of pathogenic organism reduction or the density of indicator organisms is based on well-operated treatment works that use primary settling, followed by activated sludge treatment and anaerobic digestion. For treatment works to achieve the Class B pathogen reductions, they must either demonstrate that the treatment processes reduce the average density of pathogenic bacteria and of viruses per unit mass of volatile suspended solids in the sludge two orders of magnitude lower than those densities in the incoming wastewater or demonstrate that the densities of each of the fecal indicator organisms is 6 $\log_{10}$ or less.

For example, if the influent to the treatment work shows that the average density of pathogenic bacteria per unit mass of volatile suspended solids is 1 million (10^6) and that the average density of viruses per unit mass of volatile suspended solids is 10,000 (10^4), after treatment, the processed sludge must show pathogenic bacteria densities of 10,000 (10^4) and virus densities of 100 (10^2) per unit mass of volatile suspended solids.

No requirements for reduction in protozoan cysts or helminth eggs are specified. Protozoan cysts are believed to be greatly reduced in numbers by sludge processing and even if they were not greatly reduced, their numbers are reduced through environmental exposure on land. Helminth eggs are not significantly reduced by processing and their densities decline slowly in the environment. The long period when growing food crops with the harvested portion below the ground is not allowed (5 years or 18 months if no viable helminth ova are found) and the 12-month period during which public access to the fields is restricted protect the public against possible ingestion of viable infective helminth eggs.

The test data that the Agency has on the reductions in pathogenic organisms are based on relative $\log_{10}$ reductions. The Agency found that absolute numbers varied significantly between facilities depending on the influent to the treatment work, the method used to measure the pathogenic organisms, and the investigator conducting the measurements. However, for fecal coliforms and fecal streptococci, the Agency does have data indicating that when treatment of the influent includes a well-operated physical or biological process and these processes are combined with alkali additions, chlorine additions, or storage of the sewage sludge, the log density of fecal coliforms and fecal streptococci each are 6.0 or less. Reductions in fecal indicators correlate well with reductions in pathogenic bacteria and viruses when a combination of processes is used to treat the influent and the sewage sludge. Current data also indicate that the logarithms of the densities of fecal coliforms and fecal streptococci in the influent to the treatment works do not vary significantly for different wastewater. For these reasons, the Agency believes an absolute value for fecal indicators can be used to indicate that the Class B pathogen reduction has been achieved. The Agency invites comments on this alternative requirement and on limiting the applicability of the requirement to the use of certain technologies. The Agency also solicits data on the correlation of fecal coliforms and fecal streptococci to pathogenic bacteria and viruses. The access and use restrictions discussed later in this section of the preamble also apply when this alternative requirement is achieved.

EPA is proposing to state the standard in terms of the difference in log densities between the influent wastewater and the processed sludge. The Agency is using this approach to credit the wastewater treatment processes as part of the processes to reduce pathogenic organisms. The requirements in 40 CFR 257.3–6 only recognized processing of the sludge. However, some wastewater treatment processes are more effective than others in reducing pathogenic densities. Therefore, since the overall objective is to reduce the level of pathogenic organisms in the final sludge, the Agency now believes that treatment works using those wastewater treatment processes that are more effective in reducing pathogenic organisms should be credited for doing so.

Access And Use Restrictions—Class B

When the Class B treatment standards are met, some pathogenic bacteria and viruses remain. In addition, if protozoa and helminth ova are in the influent, they are likely to be in the sewage sludge. Therefore, as part of the Class B pathogen reduction requirements, EPA is imposing access and use restrictions to limit exposure to the sewage sludge and provide time for attenuation of the pathogenic organisms. The period of time EPA is proposing to limit access to and use of the land should be sufficient to minimize the risk of disease when individuals, plants, and animals come in contact with the sewage sludge.

The use restrictions for Class B reduction apply to agricultural land where sewage sludge is applied. The public access restrictions apply to both agricultural and non-agricultural land. The access restrictions do not apply to monofills and surface disposal sites because the access restrictions for these disposal methods are more rigorous. The access restrictions for monofills and surface disposal sites are designed to preclude public exposure to potentially toxic pollutants in the sewage sludge.

The first two Class B use restrictions are for food crops. Food crops that have harvested parts above the ground touching the sludge-soil mixture cannot be grown for 18 months after application of the sewage sludge. If the harvested parts are above the ground and do not touch the sewage sludge, there is no restriction on growing the crop. The 18-month period provides time for the sun's radiant energy and desiccation to inactivate helminth eggs that are the most resistant to environmental stress.

Food crops with harvested parts below the ground cannot be grown for a period of 5 years unless a demonstration is made that there are no viable helminth ova in the soil. Research results indicate that helminth ova survive in soils for as long as 4 years after application of the sewage sludge to the land, even though their survival rate is expected to be low (Reference number 79). At least 18 months is sufficient, however, to allow time for the inactivation of most of the helminth ova on the soil surface.

The third requirement is that feed crops may not be harvested for a period of 30 days after application of the sewage sludge. The restriction protects humans and animals from contact with the harvested product. The 30-day period allows wind action and rainfall to reduce the amount of sewage sludge that adheres to the crops. Thirty States have a similar restriction.

The fourth requirement restricts the grazing of animals on agricultural land for 30 days after application of the sewage sludge. This prevents animals from physically removing the sewage sludge from the fields where the sewage sludge was applied. The restriction also reduces the potential for infection of animals from bacterial diseases, such as salmonellosis, that can be transmitted to humans. Thirty days should provide sufficient time for rain and wind to remove most of the sludge from the plants and for the adverse environmental factors to cause pathogen die-off.

The Class B access restriction further prevents access by the uninformed public to the land where the sewage sludge is applied for 12 consecutive months. Agricultural workers and personnel who apply the sewage sludge to agricultural and non-agricultural land are exempt from the restriction. Twelve months is fully protective against viruses and bacteria and will provide protection against helminths. The time restriction for public access is less than the time restriction for growing crops because the risk of infection is less from walking or sitting on the land than it is from ingesting food crops grown on the sludge-amended soil.

The time periods that are in today's proposal are based on research results and on experience discussed in the "Technical Support Document: Pathogens/Vectors" (Reference number 78). The Agency invites comments on these time periods and on the types of activities that are restricted.

Class C

Class C pathogen reduction requirements and the densities of indicator organisms are based on the performance of treatment works that have aerobic treatment processes with long detention times and no primary settling processes. The Class C reductions in pathogenic organisms or densities of fecal indicator organisms are slightly less stringent than the Class B requirements. Therefore, the Class C access and use restrictions are more stringent than the Class B restrictions.

Class C pathogen reduction is achieved when processes reduce the density of bacteria and animal viruses per unit of volatile suspended solids in the sludge 1.5 orders of magnitude lower than those densities in the incoming wastewater. The Agency invites comment on the 1.5 logarithmic reduction for Class C.

Treatment works may also demonstrate that the density of fecal coliforms in sewage sludge does not exceed 6.3 $\log_{10}$ or less per gram of volatile suspended solids and the density of fecal streptococci (enterococci) in the sewage sludge does not exceed 6.7 $\log_{10}$ or less per gram of volatile suspended solids prior to disposal. The Agency also invites comments on these values.

Access and Use Restrictions—Class C

The further reduction in pathogenic bacteria and animal viruses and the reduction in protozoa cyst and helminth ova for Class C pathogen reduction are achieved through the access and use restrictions. These restrictions allow the protozoa and helminth ova to be reduced by natural processes. Crops, animals, and humans are protected by the access and use restrictions on the land where the sewage sludge is applied.

The first two Class C use restrictions are the same as the first two Class B use restrictions. They restrict growing food crops with harvested parts that are above the ground and that touch the sludge-soil mixture for a period of 18 months. Restrictions are also placed on growing crops with harvested parts below the ground for a period of 5 years, unless a demonstration is made to show that helminth ova are not present in the soil. If that demonstration is made, food crops with harvested parts below ground may be grown after 18 months.

The third and fourth requirements restrict the harvesting of feed crops for 60 days and the grazing of animals for 60 days. Both of these requirements are 30 days longer than the Class B restriction. This additional time is being imposed because of the less stringent logarithmic reduction in pathogenic organisms and the less stringent pathogenic densities for indicator organisms.

The access restriction for Class C pathogen reduction restricts access to all personnel, except for those applying the sewage sludge, for 12 months. The Class B access requirement only restricts access to the public for 12 months. The Class C access requirement is more stringent because of the less stringent logarithmic reduction in pathogenic organisms for Class C requirements. The Agency requests comment on this approach.

Vector Attraction Reduction (§ 503.53)

Vectors such as rodents, flies, and mosquitoes play an important role in the spread of pathogenic diseases. To break that link, treatment works are to eliminate the characteristics of sewage sludge that attract vectors. Untreated sewage sludge is a high energy food source that can nourish insect larvae and provide food for vectors. Putrescible organic compounds, including organic amines such as putrescine and cadaverine and short-chained fatty acids such as butyric acid, give off odors that attract vectors. The characteristics of sewage sludge that attract vectors can be reduced or eliminated by composting or digesting the sewage sludge, by raising the pH of the sewage sludge, by reducing the moisture content of the sewage sludge, or by injecting the sewage sludge below the surface of the ground. EPA is proposing five indicators which show that the sewage sludge has been processed sufficiently so as not to attract vectors. In lieu of meeting these indicators, owners or operators of treatment works may inject the sewage sludge below the surface of the ground to meet the vector attraction reduction requirements (unless the sewage sludge is distributed and marketed). When sewage sludge is distributed and marketed, injection below the soil surface cannot be used to comply with the vector attraction reduction requirement because there is no control over the end user of the distributed and marketed product. In addition, sewage sludge is generally liquid when it is injected below the soil surface, but distributed and marketed sewage sludge is generally dried when it is either given away or sold.

The vector attraction reduction requirements may be met by reducing the volatile solids in the processed sewage sludge. The volatile solids of the processed sludge must be 38 percent lower than the volatile solids in the influent. Experience over the last 9 years indicates that if the volatile solids content of sewage sludge has been reduced by 38 percent, sewage sludge does not attract vectors (see Reference number 78). Volatile solids reduction is calculated by a volatile solids balance of the digester.

An alternative to the 38 percent volatile solids reduction is proposed because the Agency is aware of other measures that can be used to show a reduction in volatile solids. In many treatment plants, sewage sludge is returned after treatment to the aerator for more treatment or to the inlet of the digester to improve the fluidity of the incoming sludge. The sludge entering the digester has already been partially digested so it is extremely difficult to achieve an additional 38 percent volatile solids reduction by digestion. Available data indicate that when digestion occurs at mesophilic temperatures (30 to 38 degrees Celsius), the reduction in vector attraction of the sewage sludge is achieved if less than a 15 percent volatile solids reduction occurs in 40 additional days of batch digestion. The "ability to digest further" appears to be the best indicator of an index of the potential for the sewage sludge to putrefy further. This approach would not be a viable approach if an immediate evaluation of a sludge is required. The Agency invites comment on this approach.

Another way vector attraction reduction can be achieved is to reduce SOUR of the sewage sludge to 1 milligram of oxygen per hour, per gram of sewage sludge solids or less. This requirement only applies to sewage sludge treated in aerobic processes. If a sludge has been treated aerobically to the point where the biological organisms present are consuming very little oxygen, the value of the sludge as a food source for microorganisms is very low and thus the sewage sludge does not putrefy or attract vectors. The Agency also invites comments on the use of SOUR to demonstrate vector attraction reduction of a sludge or a composted product and on the 1 milligram value in today's proposal.

Vector attraction reduction may also be met by adding alkali to raise the pH of the sewage sludge to 12 or above and, without the further addition of alkali, to remain at 12 or above for two hours and then to remain at 11.5 or above for an additional 22 hours. When the pH of the sewage sludge is raised to 12 or above, the bacterial activity is greatly diminished. When the pH of the sewage sludge drops below 10.5, bacterial regrowth from spore-forming bacteria commences and the sewage sludge begins to putrefy. The requirement that no additional alkali be added after the initial increment assures the presence of sufficient excess alkali to prevent pH from falling below 10.5 for the several days needed to apply the sludge to the land. The pH values and time periods in the proposed rule are based on research results and experiences (Reference number 78). The Agency invites comments on the pH values and time periods and solicits data on alkali addition to sewage sludge and the time the pH of a sewage sludge has to be maintained at a certain pH value.

Another way to achieve vector attraction reduction is to dry the sewage sludge to achieve a 75 percent solids content of the sludge. Dry sewage sludge greatly diminishes the bacterial activity and, therefore, will not produce odors and will not putrefy. The 75 percent solids value must be complied with prior to mixing the sewage sludge with other materials. The Agency invites comments on the 75 percent solids requirement and solicits data on the reduction of vegetative bacteria in sewage sludge that has a lower percent solids content. While the Agency believes that the 75-percent value is adequate, data on a wide variety of sludge are solicited, particularly on the potential spontaneous combustion of sewage sludge with a solids content between 60 and 80 percent.

The final way vector attraction reduction can be achieved is to inject the sewage sludge below the soil surface. The ground absorbs the moisture in the sewage sludge and that, combined with the cover over the sewage sludge, reduces the vector attraction of the sewage sludge.

When the vector attraction reduction for a Class A sewage sludge is achieved by injection below the soil surface, there is a concern that bacterial regrowth may occur in the sewage sludge-soil mixture. Good management practices could reduce, but hardly eliminated, all sources of contamination. Research results and experience indicate that if the fecal coliforms and fecal streptococci of the sewage sludge do not exceed 1000 (3 $\log_{10}$) per gram of volatile suspended solids at the time the sewage sludge is injected, it is likely that any bacteria introduced by contamination of the sewage sludge would have grown to densities that could threaten human health (Reference number 78). For this reason, § 503.52(a)(4) requires that if the sewage meets Class A pathogen reduction requirements and is to be injected below the soil surface for vector attraction reduction, owners and operations would have to monitor the densities of fecal coliforms and fecal streptococci to ensure that the densities do not exceed 1000 (3 $\log_{10}$) per gram of volatile suspended solids at the time of injection.

As an alternative, the Agency considered specifying that the sewage sludge would have to be injected into the ground within a specified period of time after processing. However, without knowing the specific circumstances under which the sewage sludge would be handled or distributed, EPA could not discern an appropriate length of time between processing and injection. Therefore, the Agency felt that it was more reasonable to look for evidence of regrowth. Public comment is requested on the proposal to monitor the sludge prior to injection and the alternative of specifying a period of time within which injection would have to occur.

Sampling Protocols And Analytical Methods (§ 503.81)

Sections 503.81(b) (3) through (11) lists the proposed protocols for sampling and analyzing sewage sludge for pathogenic organisms, fecal indicator organisms, volatile solids, volatile suspended solids, percent volatile solids reduction, and SOUR. The Agency is interested in other methods that should be considered, particularly for pathogenic organisms because standard methods are available only for a few microorganisms.

Although many of the microbiological methods were originally developed for water, with proper sample processing, they are also applicable to sewage sludge. Part 908 of "Standard Methods for the Examination of Water and Wastewater" (16th edition, 1985) discusses the handling of mud, sediments, and sludge.

In addition to Part 917 "Standard Methods for the Examination of Water and Wastewater" for measuring the density of protozoa and helminth ova, EPA is proposing the use of Fox, J., P. R. Fitzgerald, and C. Lue-Hing, "Sewage Organisms: A Color Atlas". This book presents and discusses several types of media, as well as techniques for measuring protozoa and helminth ova. Neither technique is a standard method. However, the methods presented in the book, although not subjected to rigorous statistical analytical comparisons, were developed for, and were extensively tested on, sludge and soils. Some of the methods are appropriate for particular types of helminth ova and some are not. Before selecting a method, the Agency notes that the introductory materials must be carefully reviewed to assure the appropriate method is used.

Incineration (Subpart G)

Applicability (§ 503.60)

The requirements in Subpart G will apply to those facilities that fire waste streams consisting only of sewage sludge. As previously discussed, this excludes four facilities that currently fire waste streams consisting of between three and nine percent sewage sludge, on a dry weight basis.

The standards proposed in Subpart G do not apply to sewage sludge incinerators that fire sewage sludge containing 50 ppm or more of PCBs, on a dry weight basis. Owners or operators whose incinerators fire sewage sludge containing 50 ppm or more of PCBs, on a dry weight basis, must comply with the requirements in 40 CFR 761.70. In addition, owners or operators of facilities firing sewage sludge that has been determined to be hazardous must comply with the requirements in 40 CFR 264.34.

Specialized Definitions (§ 503.61)

Air Pollution Control System

Air pollution control systems include one or more processes used to treat the air emissions from a sewage sludge incinerator. These systems use a variety of wet and dry devices. For example, sewage sludge incinerators either are or could be fitted with wet and dry cyclones, low and high pressure drop venturi scrubbers, scrubbing towers, impingement scrubbers, wet and dry electrostatic precipitators (ESPs), and fabric filters. Incinerators may also be fitted with after-burners, dry lime scrubbers, and lime spray dryers.

Control Efficiency

Control efficiency refers to the effectiveness of an incinerator and its air pollution control system in preventing the release of metal to the atmosphere. Control efficiency is determined as follows:

$$CE_i = \frac{Mass_i \text{ in} - Mass_i \text{ out}}{Mass_i \text{ in}}$$

Where:
CE_i=Control efficiency for metal i (decimal fraction).
$Mass_i$ in=Mass of metal i in the sewage sludge fed to the incinerator, in grams per hour.
$Mass_i$ out=Mass of metal i in the emissions of the incinerator measured after the air pollution control system, in grams per hour.

The combined metal control efficiencies of the incinerator and the air pollution control system are a key variable in calculating numerical limits for metals. In Table 10 of the proposed rule, EPA lists the control efficiencies to be used in calculating numeric limits for arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel. Except for beryllium and mercury, the metal control efficiencies listed in Table 10 represent the lowest tenth percentile metal control efficiencies of sewage sludge incinerators in EPA's data base. The metal control efficiencies for beryllium and mercury are based on the assumptions used in developing the National Emission Standards for Hazardous Pollutants (NESHAPs) for these pollutants. For other metals, EPA's data base includes information reported in the literature from 1972 to 1985 and data from four incinerator tests conducted by the Agency in 1987. Table IX-G.1 summarizes EPA's sewage sludge metal emission data base and lists the 10th-percentile control efficiency on which the Agency set the values in Table 10.

TABLE IX-G.1—SUMMARY OF CONTROL EFFICIENCY DATA FOR METALS

Contaminant	Number of incinerators tested	Minimum	Mean	Maximum	10th percentile	Regulatory value
Arsenic	7	93.90	98.62	100.00	95.52	96
Cadmium	24	40.25	88.54	99.98	65.15	65
Chromium	23	88.92	99.16	100.00	96.12	96
Lead	24	34.22	92.24	99.67	66.73	67
Nickel	19	89.15	98.68	100.00	95.00	95

The owner or operator of a facility may use either the control efficiencies listed in Table 10 or may conduct a performance test of the facility to calculate the efficiency with which the incinerators and air pollution control systems control the emissions of one or more of the metals listed in this proposal. The emission control tests are to be conducted in accordance with EPA guidance. EPA is developing guidance for emission control tests specific to sewage sludge incinerators. This guidance will be available for public review and comment prior to the promulgation of the rule.

Dispersion Factor

A dispersion factor is a derived numerical value that relates the maximum allowable emission rate of a pollutant from a sewage sludge incinerator stack to a maximum allowable increase in the ground level ambient air concentration for that pollutant at a specified distance from the incinerator. EPA developed the dispersion factors in Table 9 of the proposed rule using the ISCLT air model. The dispersion factors were developed using a number of conservative factors including the meteorology of Atlanta, Georgia, and low gas exit temperatures (38 degrees Celsius, 100 degrees Fahrenheit). The ISCLT model accounts for significant atmospheric downwash from short incinerator stacks. A full discussion of the derivation of the dispersion factors is included in the "Technical Support Document for Incineration" (Reference number 56).

The owner or operator would use the appropriate dispersion factor based on the height of the facility's stacks. The rule also provides that owners and operators may calculate a dispersion factor on a case-by-case basis for their facilities using the "Guidelines on Air Quality Models" (Reference number 44).

Maximum Combustion Temperature

The maximum combustion temperature occurs in the combustion zone of the sewage sludge incinerator. In multiple hearth and electric incinerators, the combustion zone is in the middle hearths. In a fluidized bed incinerator, the maximum combustion temperature usually occurs in the free board space above the fluidized bed. The proposal specifies that for incinerators not tested for case-by-case metal control efficiencies, the maximum combustion temperature must not exceed 898 degrees Celsius, 1650 degrees Fahrenheit to avoid excessive metal emissions. For incinerators which are tested for case-by-case metal control efficiencies, the maximum combustion temperature will be based on the results of the test.

Risk Specific Concentration

The risk specific concentration is the maximum allowable annual incremental increase that may occur in the ground level ambient air for a pollutant when sewage sludge is incinerated. This concentration is the human health criterion upon which the numerical limit is based. The risk specific concentrations are derived from the cancer inhalation potency values. Risk specific concentrations are listed in Table 8 of the proposed rule.

No risk specific concentrations were developed for mercury or beryllium because the numerical limits for these pollutants are based on their NESHAPs. Therefore, the NESHAP values, expressed as an emission rate (grams per 24 hours) are used to develop numerical limits for mercury and beryllium. Equations are provided in the rule to convert the NESHAP emission rate to a pollutant concentration that would be incorporated into a facility's permit. Similarly, the numerical limit for lead is based on the National Ambient Air Quality Standard (NAAQS) value and equations are used to convert the NAAQS value to a pollutant concentration.

The Agency derived the risk specific concentrations (RSC) using the cancer potency values (Q_1^*) with the following equation:

$$RSC = \frac{RL \times BW \times 1{,}000}{Q_1^* \times I_a}$$

Where:
RSC = Risk specific concentration, in micrograms per cublic meter.
RL = Risk level expressed as a negative exponent of 10.
BW = Body weight, in kilograms.
1,000 = Factor to convert milligrams to micrograms.
Q_1^* = Cancer potency expressed as milligrams per kilogram of body weight per day^{-1}.
I_a = Inhalation rate expressed in cubic meters per day.

In establishing a risk specific concentration, EPA used the following values in the equation:

RL = 1×10^{-5}, or one chance in 100,000 of developing cancer.
BW = 70 kilograms, which is the standard body weight of an adult male.
I_a = 20 cubic meters, which is the standard inhalation rate of an adult male.
Q_1^* = Potency value for each pollutant.

For example, the derivation of the risk specific concentration for arsenic is as follows:

$$RSC\ (Arsenic) = \frac{(1 \times 10^{-5}) \times (70\ kg) \times (1{,}000)}{(15.0\ [mg/kg/day]^{-1}) \times (20\ m^3/day)}$$

RSC (Arsenic) = 0.0023 $\mu g/m^3$

In deriving the risk specific concentrations for chromium, and nickel, and in using the NAAQS for lead, EPA made critical assumptions that are discussed below.

1. *Chromium.* In deriving a risk specific concentration for chromium (0.085 $\mu g/m^3$), the Agency assumed that one percent of the total chromium emission is in the form of hexavalent chromium (Cr^{+6}). Chromium can be emitted in either the highly-carcinogenic, hexavalent state or in the relatively non-toxic trivalent state (Cr^{+3}). Trivalent chromium compounds have not been shown to be carcinogenic. Toxic levels of trivalent chromium are prevalent only at concentrations higher than those normally found in sewage sludge.

Hexavalent chromium, representing the more oxidized state of chromium, would be expected to be in the emissions when sewage sludge containing chromium compounds is incinerated. However, some investigators speculate that most of the chromium is likely to be emitted in the trivalent state because the hexavalent state of chromium is highly reactive and is likely to re-form into trivalent chromium.

Japanese laboratory and EPA-sponsored research, reported in the literature, have shown a correlation between the amount of hexavalent chromium formed in the ash from the incineration of sewage sludge and the degree of lime treatment of sludge before incineration. As the quantity of lime added to the sludge was increased, the quantity of hexavalent chromium formation in the ash increased. The increased level of hexavalent chromium formation in the ash would likely be reflected in increased hexavalent chromium concentration in air emissions (Reference numbers 23 and 12).

EPA attempted to determine the ratio of hexavalent chromium to total chromium in the emissions of sewage sludge incinerators. To date, only two sewage sludge incinerators have been tested successfully. The two results were quite variable, ranging from a level below the detection limits of hexavalent chromium (at 10 ppm Cr^{+6} to total chromium) to about 13 percent hexavalent chromium to total chromium (Reference numbers 47 and 39).

In several instances the Agency encountered problems with the hexavalent stack testing method. Recovery problems have been encountered in the extraction procedure used to remove the chromium from the collected particulate matter. It is suspected that certain organic and metal compounds emitted from combustion sources and present in the particulate catch could be reducing the hexavalent chromium to the trivalent form. This would result in a significant under-estimation of the actual hexavalent amount in the stack emissions.

EPA is currently investigating procedures to improve the recovery of hexavalent chromium in stack emission tests. At this time, the Agency is close to completion of a new ion chromographic method for hexavalent chromium. This new method is expected to be available for use in stack emission testing in 1989.

Based on the limited hexavalent chromium data from actual emissions tests, EPA is proposing to assume that one percent of the total chromium emitted is hexavalent chromium. The Agency derived one percent by calculating the geometric mean of the two results, 10 ppm and 13 percent. The geometric mean is 0.11 percent hexavalent chromium to total chromium. The mean value was then multiplied by a safety factor of 10 to derive the one percent assumption today's proposal.

EPA plans further tests of sewage sludge incinerator emissions using improved sampling and analysis methods for hexavalent chromium. These additional tests should provide more insight into the ratio of hexavalent chromium to total chromium in the emissions of sewage sludge incinerators.

2. *Nickel.* Nickel emissions present a problem similar to chromium. Nickel can potentially be emitted from combustion sources in several different forms. Nickel subsulfide has been identified as the most carcinogenic form of nickel. Because EPA currently has no data on the chemical form of nickel emissions from sewage sludge incinerators, the Agency assumed that all nickel emitted is in the most carcinogenic form, nickel subsulfide. EPA has initiated studies on the speciation of nickel emissions from combustion sources to evaluate their health effects. Until these studies demonstrate otherwise, the Agency believes the appropriate approach is to assume that all nickel emitted is in the form of nickel subsulfide.

EPA requests comments on the assumptions used in deriving the risk specific concentrations for chromium and nickel. The Agency also requests submission of data on the emissions of chromium and nickel from sewage sludge incinerators as part of comments on today's proposal to assist in evaluating its proposal.

3. *Lead.* EPA is proposing to limit lead emissions from sewage sludge incinerators so that the ground level concentration of lead does not exceed 25 percent of the NAAQS for lead. The NAAQS for lead is 1.5 micrograms per cubic meter maximum arithmetic mean averaged over a calendar quarter (see 40 CFR 50.12).

In deriving a ground level concentration for lead, the Agency evaluated the following two alternatives: 10 percent of the NAAQS, the percent used in the forthcoming proposed revisions to the Hazardous Waste Incinerator regulation; and 25 percent of the NAAQS. States allocate a percentage of the NAAQS to various sources of lead emissions in non-attainment areas through State Implementation Plans (SIPs). Up to now, States have not included limits for sewage sludge incinerators in their SIPs, leading the Agency to believe that States do not consider sewage sludge incinerators to be significant sources of lead emissions. EPA is soliciting comments on this assumption.

EPA is proposing to use 25 percent of the NAAQS as an initial step in regulating lead from sewage sludge incinerators. Based on available information, limiting lead emissions from sewage sludge incinerators to 25 percent of the NAAQS ensures that the increase in ground level ambient concentration of lead would not exceed the current lead NAAQS.

The Agency is soliciting comments on limiting emissions to 10 percent of the NAAQS. Ten percent would further limit lead exposure. The Agency's goal is to minimize lead exposure from all sources due to the significant biological changes across a broad range of exposures to lead (down to very low levels). Keeping the contribution of sewage sludge incinerators to ambient air lead levels to 10 percent of the NAAQS level (i.e., 0.15 $\mu g/m^3$) would be consistent with this goal. Allowing sewage sludge incinerators alone to contribute potentially up to 25 percent of the NAAQS may be excessive since allowing that increment could allow ambient lead levels in some areas to rise substantially from the present average background level of 2.0 $\mu g/m^3$. States may wish to further limit the emission of lead from sewage sludge incinerators if it is warranted in non-attainment areas.

The 1978 NAAQS for lead was designed to ensure that 99.5 percent of the population has blood lead levels below 30 micrograms per deciliter ($\mu g/dl$), the level then judged to provide an adequate margin of safety from adverse health effects. The Agency now has data indicating that much lower blood lead levels are associated with a variety of toxic effects in men, women, and, particularly, in the very young. EPA is currently reviewing the current NAAQS for lead and will incorporate this new information. Until a new NAAQS is promulgated for lead, the current NAAQS will be the basis of the numerical limit when sewage sludge is incinerated. When EPA revises the current NAAQS of 1.5 $\mu g/m^3$, the Agency also will revise the numerical limit for lead from sewage sludge incineration.

Sewage Sludge Feed Rate

The feed rate is either the average amount of all the sewage sludge incinerated per day at the facility or the design capacity of the facility, taking into account the total amount of sewage sludge that can be fired each day by all the incinerators within the property line of the facility. "The Technical Support Document for Incineration" (Reference number 56) describes how the sewage sludge feed rate is to be measured.

The feed rate of a facility, in metric tons per day is used in calculating the pollutant limits (i.e., concentration of a metal in sewage sludge). The numerical limit must be calculated based on all sludge fired at a facility. Otherwise, it will not account for all the emission from the facility and may not provide an adequate level of protection.

Stack Height

The stack height is the difference between the elevation of the top of a sewage sludge incinerator stack and the elevation of the ground surface at the base, when the difference is equal to or less than 65 meters. Owners or operators of incinerators with stacks higher than 65 meters must determine the creditable stack height above 65 meters in accordance with "good engineering practice" (GEP) (see 40 CFR 51.100(ii)(1)(ii)). Creditable GEP stack height means the greater of the following measurements: (1) 65 meters, measured from the ground level elevation at the base of the stack; or (2) a calculated measurement based on the height (and, possibly, width) of nearby structures and a constant. The latter measurement is derived from the formula that follows:

$$Hg = H + 1.5L$$

Where:

Hg=GEP stack height, measured from the ground level elevation at the base of the stack, in meters.

H=Height of nearby structure(s), measured from the ground level elevation at the base of the stack, in meters.

L=Lesser dimension, height or projected width, or nearby structure(s), in meters.

The creditable GEP stack height was developed by the Agency to assure that the degree of emission limitations required for the control of any air pollutants under an applicable SIP is not affected by that portion of a stack height exceeding GEP or by any other dispersion technique. Guidance is available on how to calculate good engineering stack height (Reference number 42).

Total Hydrocarbons

Total hydrocarbons is the sum of all emitted organic compounds that have one or more carbon-to-carbon bonds, one or more carbon-to-hydrogen bonds, and that may also have one or more carbon-to-chlorine, carbon-to-nitrogen, or carbon-to-oxygen bonds. For the purposes of today's proposal, total hydrocarbons is defined as a pollutant for which the Agency is proposing limits. The limits are expressed in terms of the concentration of total hydrocarbons in the emissions. EPA is controlling hydrocarbon emissions as a way of limiting the emission of organic pollutants present in the sludge fed into the incinerator and that are created during the incineration process. This proposed approach is discussed further later in this subpart of the preamble.

General Requirements (§ 503.62)

Other Governing Regulations

In addition to the requirements in Subpart G of the proposed rule, owners and operators of sewage sludge incinerators must comply with existing requirements promulgated under the authority of the Clean Air Act (CAA). Sewage sludge incinerators are subject to both the beryllium NESHAP (40 CFR 61.30 through 61.34) and the mercury NESHAP (40 CFR 61.50 through 61.55). Furthermore, the 47 facilities built or substantially modified after July 11, 1973, and any new sewage sludge incinerators that are built are subject to the NSPS for sewage sludge incinerators in 40 CFR 60.150 through 60.154.

State Implementation Plans require the review of new sewage sludge incinerators under procedures for "prevention of significant deterioration (PSD) of air quality" (see 40 CFR 51.21) and for "new source review" (see 40 CFR 51.165). These procedures are designed to (1) prevent further air quality degradation in non-attainment areas because of particulates, ozone, nitrogen oxides, sulfur dioxide, lead, and carbon monoxide; (2) ensure that no significant deterioration occurs in other areas; and (3) ensure compliance before a permit is issued to construct or modify an emission source. This review may require a new sewage sludge incinerator to install the best available control technology economically achievable to control the criteria pollutants to a level that will not cause any deterioration in air quality.

Incinerator Ash

Today's proposal does not include separate requirements for the disposal of ash from the incineration of sewage sludge. Rather, the Agency is referencing the applicable requirements for the disposal of incineration ash from 40 CFR Parts 257, 258, and 261 through 268.

Feed Rate

EPA is requiring the use of either the design capacity of the facility or the feed rates of all sewage sludge incinerators within the property boundary of a facility in calculating the pollutant limits for a facility. As discussed above, this requirement is necessary to ensure that emissions from the facility will not contain pollutant concentrations that pose an unreasonable risk to human health. For the purposes of this rule, an unreasonable risk would be one in which the pollutant limits exceeded an incremental carcinogenic risk level of 1×10^{-5}. If the feed rate of all sewage sludge incinerated at a facility is not considered, the emissions from the facility could pose an incremental risk greater than 1×10^{-5}.

Monitoring Instruments

Owners and operators of sewage sludge incinerators must install, calibrate, operate, and maintain an instrument that measures the sludge feed rates of an incinerator. The instrument must have an accuracy of plus or minus five percent over its operating range, a standard generally used by the Agency. EPA is also proposing that owners and operators install, calibrate, operate, and maintain instruments that continuously monitor and record the oxygen content of the exit gas (before the gas is diluted by air), the temperature in the combustion zone of the incinerator, and the total hydrocarbon concentration in the exit gases. The rationale for each of these requirements is discussed below.

1. *Feed Rates.* The NSPS for sewage sludge incinerators require instruments for monitoring sludge feed rate for all sewage sludge incinerators built after 1973. The effect of today's proposal is to require the owners or operators of the 122 facilities that are not covered by the NSPS to install instruments that continually monitor the feed rate of sewage sludge, if they have not already done so.

The ability to monitor sludge feed rate continuously allows for more stable operation of the incinerator and provides the operator with advanced knowledge of a change in operating conditions. For example, a large increase in the sludge feed rate increases the drying load on the top hearths of a multiple hearth incinerator causing the combustion zone to drop to a lower hearth. This type of upset results in increased gas flow through the furnace and an increase in particulate emissions to the air pollution control system. A large decrease in the sludge feed rate will cause the combustion zone to rise to a higher hearth. The higher combustion hearth location reduces the overall residence time of the combustion gases in the incinerator and can increase the emissions of unburned organic pollutants from the incinerator.

Continuous monitoring of the sludge feed rate ensures that the furnace is not fed sludge in excess of the unit's design capacity. If the design capacity of the incinerator were exceeded, excessive emissions from the incinerator and incomplete combustion of organics and carbon could result.

EPA is including a requirement for owners and operators to provide access to the sewage sludge fed to the incinerator so that a well-mixed, representative grab sample of the sewage sludge can be collected easily. The representative sample allows periodic verification to be made that the facility is in compliance with the metal limits in its permit.

2. *Oxygen In Combustion Gases.* The Agency is proposing that owners and operators of incinerators continuously monitor and record the amount of oxygen in combustion gases leaving the combustion zone to avoid excess oxygen levels in the combustion gases. Excessive oxygen causes unnecessarily high gas velocities in the furnace. This phenomenon increases particulate matter in the gases, placing a greater load on the air pollution control system. Overloading the air pollution control system reduces the efficiency of the

system to remove organic and metal pollutants attached to the particulates.

3. *Combustion Zone Temperatures.* Owners and operators are also required to monitor and record the operating temperatures in the combustion zone. A proper operating temperature is the single most important control parameter of an incinerator. Temperatures that are too low result in incomplete combustion of organic pollutants. Temperatures that are too high result in excessive metal emissions.

For multiple hearth furnaces, EPA is proposing that every hearth have a temperature-measuring device (thermocouple) and that the burning hearth have two measuring devices. The requirement for two devices in the burning hearth is to provide redundancy in the case of the failure of one device. The high temperature of the burning hearth increases the rate of failure of the thermocouples. In addition, the burning hearth temperature is the most critical temperature in the furnace and requires the most control to minimize emissions. This requirement is consistent with the revised NSPS for sewage sludge incinerators (40 CFR 60.153(b) (3)).

For fluidized bed furnaces, the Agency is proposing two temperature measuring devices: one in the bed and one in the outlet duct of the fluidized bed. For electric furnaces and rotary kilns, the Agency is proposing one temperature measuring device in the drying zone and two in the combustion zone. These requirements are consistent with the revised NSPS for sludge incinerators (40 CFR 60.153(b)(3)).

4. *Total Hydrocarbons In Emission Gases.* The Agency is proposing that owners and operators continuously monitor and record the total hydrocarbon concentration in the emission gases of sewage sludge incinerators. As discussed later in this subpart of the preamble, EPA is proposing to limit the concentration of total hydrocarbons in the emissions in lieu of specifying the concentration of an organic pollutant that may be fed into the incinerator.

Total hydrocarbon emissions are to be measured with a flame ionization detector. The detector is a hydrogen-oxygen flame into which a small sample of the exhaust gases from an incinerator is introduced. If there are any hydrocarbon gases present in the sample, they will burn in the hydrogen-oxygen flame. When any carbon-to-carbon or carbon-to-hydrogen bonds are broken and oxidized in the flame, an ion is released. An electrical detection system senses the release of the ion. The electrical signal strength is a direct measure of the number of carbon-to-carbon and carbon-to-hydrogen bonds that are oxidized in the flame. The direct readout of this signal is calibrated to indicate the concentration of hydrocarbons in the sample stream by use of a series of calibration gases of known hydrocarbon concentration which are periodically introduced into the sample stream. The flame ionization detection system is described by Method 25A in Appendix A of 40 CFR Part 60.

The Agency is requiring that a flame ionization detector include a 150 degrees Celsius heated sample line and inlet system for measuring total organic emissions. The 150 degree heated sample line keeps the semi-volatiles in the gas sample in the vapor phase and prevents their reduction in the sample transportation and conditioning system. EPA estimates that, without the heated sample line, only 50 to 60 percent of the total hydrocarbons would be detected by the flame inonization detector. With the heated sample line, at least 75 percent of the total hydrocarbons present in the exit gases can be detected. This reading is then multiplied by a correction factor and adjusted to 7-percent oxygen to obtain the true concentration of total hydrocarbons. Further discussion of the flame ionization detector system is in the "Technical Support Document for the Incineration of Sewage Sludge" (Reference number 56).

Incineration—National Pollutant Limits (§ 503.63)

As described in Part III of the preamble, the Agency initially evaluated 34 pollutants. With simple models using the worst combination of conditions, the Agency found that the following pollutants did not pose an unreasonable risk to human health in the concentrations shown in the "40 Cities Study": copper, selenium, and zinc. These pollutants are among the pollutants listed in Subpart H of the proposed rule that are eligible for removal credits when sewage sludge is incinerated.

Equations

EPA is proposing to use one equation for beryllium, a second equation for mercury, a third equation for lead, and a fourth equation for arsenic, cadmium, chromium, and nickel to calculate the allowable concentration of these pollutants in sewage sludge that may be incinerated. A fifth equation is used to calculate an acceptable concentration of total hydrocarbons in the combustion gases exiting the incinerator.

The Agency found that it could not establish a specific concentration for each pollutant in the sludge or a specific concentration for total hydrocarbons in the emissions that would be applicable to all facilities. Key variables could make a significant difference in the allowable pollutant concentration. Such variables include the physical characteristics of the facility (e.g., feed rate of the facility, stack height, control efficiency of the incinerator and air pollution control system), and the terrain and meteorology where the facility is located.

1. *Beryllium.* The equation for beryllium is:

$$C = \frac{10}{(1 - CE) \times SF}$$

Where:

C = Maximum allowable concentration of beryllium in sewage sludge, in milligrams per kilogram (dry weight basis).

CE = Sewage sludge incinerator control efficiency (from Table 1 in the proposed rule).

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

This equation is used to calculate the maximum allowable concentration of beryllium in sewage sludge that may be incinerated at a facility without exceeding the beryllium NESHAP emission of 10 grams over a 24-hour period (see 40 CFR 61.32).

The owner or operator provides the permitting authority with the design capacity of the facility (i.e., the combined feed rate of all the incinerators at a facility) to insert into the equation. The NESHAP emission limits are developed with a numerical value that relates a level of emission to a ground level concentration that will not cause undue risk to an individual exposed to the maximum pollutant concentration in the plume. Thus, the Agency did not include a dispersion factor in the equations for beryllium or mercury.

The Agency assumed a 0.99 control efficiency to convert the beryllium NESHAP emission limit to an allowable concentration in sludge. This control efficiency, the result of the test, is the only data available to the Agency because beryllium is not generally found in incinerated sewage sludge and therefore, analyses have not been conducted for beryllium. If owners or operators demonstrate a greater or lesser control efficiency for beryllium in a performance test of the facility, the actual control efficiency demonstrated will be inserted into the equation. The Agency is seeking data that demonstrates the efficiency with which sewage sludge incinerators and air pollution control devices control the emission of beryllium.

Using the equation with the sludge feed rate of the facility and 0.99 control efficiency, the permitting authority calculates the maximum allowable beryllium concentration. This concentration is compared with the concentration of beryllium found in the sludge to be incinerated at the facility. Sludge that exceeds the maximum allowable concentration may not be incinerated.

2. *Mercury.* The equation for mercury is:

$$C = \frac{3200}{(1-CE) \times SF}$$

Where:
C = Maximum allowable concentration of mercury in sewage sludge, in milligrams per kilogram (dry weight basis).
CE = Sewage sludge incinerator control efficiency (from Table 10 in the proposed rule).
SF = Sewage sludge feed rate, in metric tons per day (dry weight basis).

This equation is used to calculate the maximum allowable concentration of mercury in sewage sludge that may be incinerated at a facility without exeeding the mercury NESHAP emission limit of 3,200 grams per 24-hour period (see 40 CFR 61.52).

As in the previous equation, the owner or operator provides the permitting authority with the design capacity of the facility or the combined sewage sludge feed rates of all the incinerators at the facility. The permitting authority then inserts this facility-specific feed rate into the equation.

The permitting authority inserts a zero into the equation for the mercury control efficiency. A zero control efficiency is included in the proposal because, in developing the NESHAP for mercury, the Agency assumed a zero control efficiency. If owners or operators can demonstrate a greater level of control based on a performance test, the permitting authority will use the control efficiency demonstrated in the performance test. Using the sewage sludge feed rate of a facility and either a zero control efficiency or a control efficiency demonstrated in a performance test, the permitting authority calculates the maximum allowable mercury concentration in sewage sludge that may be incinerated at a facility. This maximum allowable concentration of mercury is then compared with the concentration of mercury found in the sewage sludge incinerated at the facility. If the facility's sludge exceeds the allowable concentration, the owner or operator may not incinerate the sludge containing the excessive concentrations of mercury.

3. *Lead.* The equation for lead is:

$$C = \frac{.25(NAAQS) \times 86{,}400}{DF \times (1-CE) \times SF}$$

Where:
C = Maximum allowable concentration in sewage sludge, in milligrams per kilogram (dry weight basis).
NAAQS = National Ambient Air Quality Standard for lead (1.5 micrograms per cubic meter maximum arithmetic mean averaged over a calendar quarter).
86,400 = Number of seconds in a day.
DF = Dispersion factor, in micrograms per cubic meter per gram per second (from Table 9 in the proposed rule).
CE = Sewage sludge incinerator control efficiency (from Table 10 in the proposed rule).
SF = Sewage sludge feed rate, in metric tons per day (dry weight basis).

To insert a value for the dispersion factor, the owner or operator selects the dispersion factor corresponding to the stack height of the incinerators at the facility from Table 9 of the proposed rule, if the height of the incinerator stack is 65 meters or less. If the stack exceeds 65 meters, the creditable stack height above 65 meters is determined in accordance with 40 CFR 51.100(ii)(1)(ii). The results of this calculation would be used in the EPA-approved air dispersion model, such as the ISCLT (appropriate for the facility's surrounding terrain and meteorology), to calculate a dispersion factor for the equation. Owners or operators whose incinerators have stacks less than 65 meters also may conduct their own air dispersion modeling at the facility to establish a facility-specific dispersion factor in accordance with EPA's "Guidelines on Air Quality Models" (Reference number 44).

The control efficiency for lead is listed in Table 10 of the proposed rule. The owner or operator may conduct performance tests of the facility, in accordance with the requirements specified by EPA, to demonstrate an alternative control efficiency. If a performance test is conducted, the actual control efficiency demonstrated will be included in the equation.

As in the previous equations, the owner or operator provides the permitting authority with information on the design capacity of the facility or the combined sewage sludge feed rates of all the incinerators at the facility. Using the above information, the permitting authority would calculate a facility-specific numerical limit for lead. This calculation is then compared to the concentration of lead found in the sewage sludge to be incinerated at the facility.

4. *Arsenic, Cadmium, Chromium, And Nickel.* The equation for arsenic, cadmium, chromium, and nickel is:

$$C_i = \frac{RSC_i \times 86{,}400}{DF \times (1-CE_i) \times SF}$$

Where:
C_i = Maximum allowable concentration of metal pollutant in sewage sludge, in milligrams per kilogram (dry weight basis).
RSC_i = Risk specific concentration for the metal in sewage sludge, in micrograms per cubic meter.
86,400 = The number of seconds in a day.
DF = Dispersion factor, in micrograms per cubic meter per gram per second (from Table 9 in the proposed rule).
CE_i = Sewage sludge incinerator control efficiency (from Table 10 in the proposed rule).
SF = Sewage sludge feed rate, in metric tons per day (dry weight basis).

The permitting authority would select the appropriate risk specific concentration from Table 8 in the proposed rule. As discussed earlier, the risk specific concentrations are derived from EPA's cancer potency values ($Q_1{}^*$). The owner or operator would then follow the same process as described above for lead.

5. *Total Hydrocarbons.* EPA is proposing to limit the concentration of total hydrocarbons in the emissions of incinerators for two reasons. First, this approach controls the emission of individual organic compounds found in sludge fed into the incinerator, and second, the approach controls the emission of organic compounds that are created during the combustion process (i.e., products of incomplete combustion—PICs). The Agency recognizes that setting limits on total hydrocarbons is an innovative approach that may be applicable to other incinerator programs. Therefore, the Agency will carefully review and consider the issues raised and the comments submitted on this approach.

(a) *Human Health Criterion For Organic Components of Total Hydrocarbons.* To develop a risk specific concentration for total hydrocarbons, the Agency developed a weighted carcinogenic potency ($Q_1{}^*$) value for the organic compounds that are projected to be in the emissions of a sewage sludge incinerator. In developing the $Q_1{}^*$ value, the Agency multiplied the $Q_1{}^*$ value of every carcinogenic organic pollutant listed in IRIS by the weighted fraction of the compound in the emissions of sewage sludge incinerators. Calculating a weighted fraction of a compound in the emissions required a two-step process. First, the Agency determined the concentration (in $\mu g/m^3$) for the pollutant in the emissions in one of three ways. If the compound was measured in the emission of the sludge incinerator, the concentration of the compound was used. In the case of compounds expected to be present, but not detected, the observed detection limit ($\mu g/m^3$) was used. Finally, for the remaining pollutants listed in IRIS and detected in emissions from other sources, an analytical detection limit of 0.1 $\mu g/m^3$ was assigned to those pollutants. The Agency then calculated a weighted fraction for each pollutant by dividing the sum of all the pollutant concentrations into each individual pollutant concentration. EPA multiplied the weighted fraction of each pollutant by the pollutant's $Q_1{}^*$ value and then added the products of the multiplication to give a weighted carcinogenic potency value for all carcinogenic pollutants detected or not detected.

Weighted fractions were also calculated for all non-carcinogens that have RfDs in IRIS. However, the Agency assumed that the actual ambient air concentration of the non-carcinogens (i.e., threshold pollutants) would not exceed their inhalation RfDs and, therefore, do not contribute to the weighted $Q_1{}^*$ value or cause adverse health effects.

The Agency is seeking comments on its determination that the expected concentration of non-carcinogens would not be associated with adverse health effects. The weighted average $Q_1{}^*$ value for total hydrocarbons is 0.013 (mg/kg/day). All the data and calculations used in developing the weighted $Q_1{}^*$ value are in Appendix E of the "Technical Support Document: Incineration of Sewage Sludge" (Reference number 56). The Agency is soliciting comments on the approach used.

From the weighted $Q_1{}^*$ value, the Agency developed a risk specific concentration for total hydrocarbons using the same equation that was used to develop the risk specific concentrations for metals. The risk specific concentration for total hydrocarbons was derived as follows:

$$RSC = \frac{RL \times BW \times 1{,}000}{Q_1{}^* \times Ia}$$

Where:

RSC=Risk specific concentration of total hydrocarbons, in micrograms per cubic meter.

RL=Risk level of 1×10^{-5}.

BW=Body weight of 70 kilograms.

$Q_1{}^*$=Weighted average $Q_1{}^*$ value of 0.013 for all carcinogens with $Q_1{}^*$ values in IRIS and all non-carcinogen (threshold) pollutants in IRIS, in $(mg/kg/day)^{-1}$.

Ia=Inhalation rate of 20, in cubic meters per day.

1,000=Factor to convert milligrams to micrograms.

Therefore:

$$RSC = \frac{(1 \times 10^{-5}) \times (70\ kg) \times 1{,}000}{(0.013) \times 20\ m^3/day} \text{ or}$$

$$= 2.69\ \mu g/m^3$$

The risk specific concentration is extremely sensitive to the analytical limits of detection selected for individual carcinogenic organic compounds not detected in emissions tests of sewage sludge incinerators. A relatively high analytical detection limit will generate a high risk and a low detection limit will generate a lower risk. This is particularly true for dioxins, PCBs, and aldrin/dieldrin.

The risk specific concentration is then used to develop a numerical limit for the concentration of total hydrocarbons in the emissions.

(b) *Measuring Total Hydrocarbons.* The instrument used to monitor total hydrocarbons is a flame ionization detector. Questions have been raised about the capability of a flame ionization detector to monitor continuously the total hydrocarbons emissions from an incinerator. Moreover, there is uncertainly about the relationship of the reading of the flame inonization detector to the risk specific concentration that will protect individuals to an incremental carcinogenic risk of 1×10^{-5}.

Introduced in the mid-1960's, flame ionization detectors have a number of applications, such as detection systems in gas chromatographs located in laboratories around the world. Their wide use in the analysis of organic compounds has resulted in a substantial body of literature on using the detector to monitor total hydrocarbons. However, there are problems with the system as a regulatory compliance method.

First, organic compounds with very high boiling points tend to condense in the sampling line between the stack and the detector system, escaping detection. As a result, the detector system does not accurately measure these high-boiling compounds. Most of this problem can be overcome by the use of a heated sampling system operated at 150 degrees Celsius. Moreover, a correction factor has been applied in EPA's equation for calculating the total hydrocarbon limit to account for the loss of the high-boiling organic compounds.

A second problem with the flame ionization detector system is the differing response of the detector to different compounds incinerated. The detector system primarily measures the oxidation of carbon-to-carbon and carbon-to-hydrogen bonds. Organic compounds with differing numbers of these bonds will give different responses. Fortunately the relative response of a large number of the organic compounds are known. The Agency is calculating a weighted average response factor for the flame ionization detector analogous to our weighted $Q_1{}^*$ calculation for the risk specific concentration. This weighted average response factor is incorporated into the conversion factors in the equation used to calculate a numerical limit for total hydrocarbons thereby relating the reading of the device to an incremental carcinogenic risk level of 1×10^{-5}.

EPA has initiated tests to verify the long-term reliability of the detectors. The equipment requires routine maintenance and daily calibration, which are well within the expertise of personnel at sewage sludge incinerator facilities. Flame ionization detectors, including the 150-degree Celsius sampling line cost approximately $20,000. Annual operating costs are expected to be $6,000.

(c) *Calculating A Numeric Limit For Total Hydrocarbons.* The equation to be used in developing a numerical limit for total hydrocarbons is:

$$THC = \frac{RSC \times 3{,}240{,}000{,}000}{DF \times CF}$$

Where:
THC=Maximum allowable total hydrocarbon concentration in a sewage sludge incinerator stack, in parts per million, at 7-percent oxygen.
RSC=Risk specific concentration for THC, in micrograms per cubic meter.
DF=Dispersion factor, in micrograms per cubic meter, per gram per second.
GF=Maximum gas flow from the sewage sludge incinerator, in gram moles per day.
3,240,000=Correction factor in gram moles, per gram per second per day.

The conversion factor of 3,240,000 is derived from:

$$CF = \frac{86{,}400 \times 0.75 \times 1.7 \times 1 \times 10^{6}}{34}$$

Where:
86,400=Number of seconds in a day.
0.75=Correction factor for the estimated loss of organic compounds in the flame ionization detector system (dimensionless).
1.7=Ratio of the flame ionization detector of propane (3.0) to the weighted average flame ionization detector response of the list of compounds (1.8), used to determine the weighted average unit risk.
1×10^{6}=Conversion parts of per million to concentration.

The derivation of this equation is explained more fully in Appendix E of the "Technical Support Document: Incineration of Sewage Sludge" (Reference number 56).

As with the equation for the metals, the owner or operator has two options for inserting a value for the dispersion factor. A dispersion factor corresponding to the stack height of the facility's incinerators may be selected from either Table 9 of the rule or the owner or operator may conduct air dispersion modeling of the facility to establish a facility-specific dispersion factor in accordance with EPA's "Guidelines on Air Quality Models" (Reference number 44).

The maximum gas flow (GF) is calculated using the work sheet in Appendix D of today's proposed rule. This work sheet uses the following: (i) The maximum sludge feed rate; (ii) the average calculated combustion temperature of the sewage sludge based on the percent volatiles, heating value of the sludge volatiles, and percent solids; and (iii) the average auxiliary fuel usage. The result of the Appendix D calculation is expressed in gram moles of combustion gases at 50 percent excess air (seven percent oxygen) and zero percent moisture.

When the flame ionization detector system actually measures the total hydrocarbons, the measurement must be converted to 50 percent excess air (seven percent oxygen) before it is compared to the facility's numerical limit for total hydrocarbons. Unless this conversion is done, the hydrocarbons would be diluted by the excess air and not represent the actual hydrocarbon concentration in the exit gases. The oxygen correction is an engineering correction expressed as:

$$THC_{(corrected)} = THC_{(actual)} \times \frac{14}{21 - Y}$$

Where:
Y=Measured oxygen concentration, percent.

The correction factor is developed at 50 percent excess air. The correction is easily made because EPA is proposing that sewage sludge incinerators have instruments that continuously monitor the oxygen concentration in combustion gases (§ 503.62(f)). The calculated total hydrocarbon limit is then compared to the oxygen-corrected total hydrocarbon reading from the flame ionization detector to determine if the incinerator is in compliance.

(d) *Effect of the Proposed Approach.* There are those who believe that by limiting total hydrocarbons, the Agency is establishing more stringent emission controls than if the Agency were to regulate the concentration of organics in sewage sludge by developing numerical limits on a pollutant-by-pollutant basis. They reason that the total hydrocarbon limit is based on the sum of the weighted average $Q_1{}^*$ values for all carcinogenic organic pollutants listed in IRIS. A pollutant-by-pollutant approach would control the concentration of individual carcinogenic organic pollutants to a pollutant-by-pollutant individual risk level of 1×10^{-5}. Potentially, the summed risk of ten organic pollutants could be 10×10^{-5} or 1×10^{-4}, depending on the actual concentration of a pollutant in the emissions.

Based on the Agency's examination of the ten model plants, 122 facilities that operate 219 incinerators are projected to be out of compliance with the pollutant limits in today's proposal. Of those 122 facilities, a subset of 28 facilities that operate 61 incinerators are projected to exceed the total hydrocarbons numerical limit. However, these facilities also would exceed the numerical limit for one or more metals. Therefore, the approach does not affect the number of facilities that would be in or out of compliance.

The compliance mechanism for a pollutant-by-pollutant approach and for total hydrocarbons is the installation of after-burners. After-burners cost approximately $1 million.

(e) *Alternatives Considered.*—(i) *Organic Pollutant-by-Organic Pollutant Approach.* EPA originally considered controlling the concentration of organic pollutants fed into an incinerator on a pollutant-by-pollutant basis, similar to the approach that the Agency is proposing for metals. However, the approach was not feasible for organic pollutants because the Agency could not establish a destruction and removal efficiency for sewage sludge incinerators. The series of tests on four sewage sludge incinerators revealed that organic destruction and removal efficiencies of the incinerators ranged from 99.7 percent to negative efficiencies of −1,314 percent (see Table IX-G.2). A negative efficiency means that compounds were formed during the combustion process (i.e., a product of incomplete combustion—PIC). Some of these PICs are known or suspected carcinogens. Organic destruction and removal efficiencies (DREs) of an incinerator are needed to relate the emission of an organic pollutant to its risk specific concentration and to an allowable concentration in sewage sludge. Without consistent DRE data from sewage sludge incinerators, the Agency had no basis on which to construct an equation which could be used to calculate allowable organic concentration.

TABLE IX-G.2.—ORGANICS IDENTIFIED IN SLUDGE INCENERATOR TESTING

Compounds	DE range	
	Hi	Low
Semivolatiles:		
Bis (2-ethylhexyl)phthalate	95.7	ND
1,2-Dichlorobenzene	97.3	[1] 94.2
1,3-Dichlorobenzene	99.7	[1] 67.5
1,4-Dichlorobenzene	95.7	87.4
2-Nitrophenol	97.2	ND
Phenol	81.7	ND
Naphthalene	90.9	ND
Volatiles:		
Acrylonitrile	[1] −1.9	−349.0
Benzene	[1] 25.3	[1] −1314.0
Carbon tetrachloride	99.8	79.1
Chlorobenzene	99.8	23.0
Chloroform	−39.4	−527.5
1,2-Dichloroethane	97.0	ND
Trans 1,2-Dichloroethene	99.4	[1] 76.0
Ethylbenzene	99.3	[1] 6.0
Methylene chloride	98.6	[1] −145.0
Tetrachloroethene	98.6	[1] −175.0
Toluene	99.7	[1] −256.0
1,1,1-Trichloroethane	99.6	70.0

TABLE IX-G.2.—ORGANICS IDENTIFIED IN SLUDGE INCENERATOR TESTING—Continued

Compounds	DE range	
	Hi	Low
Trichloroethene	97.9	-67.0
Vinyl chloride	-112.0	-426

The pollutant was detected in the stack, but not in the sludge. Efficiency is calculated using the analytical detection limit of the pollutant in sluge.

The data from the four incinerator tests shows a strong correlation between the concentration of organic compounds in the emissions and the concentration of total hydrocarbons in the emissons (See Figure IX-G.1). The "Technical Support Document: Incineration of Sewage Sludge" (Reference number 56) includes all the data used in developing the Figure.

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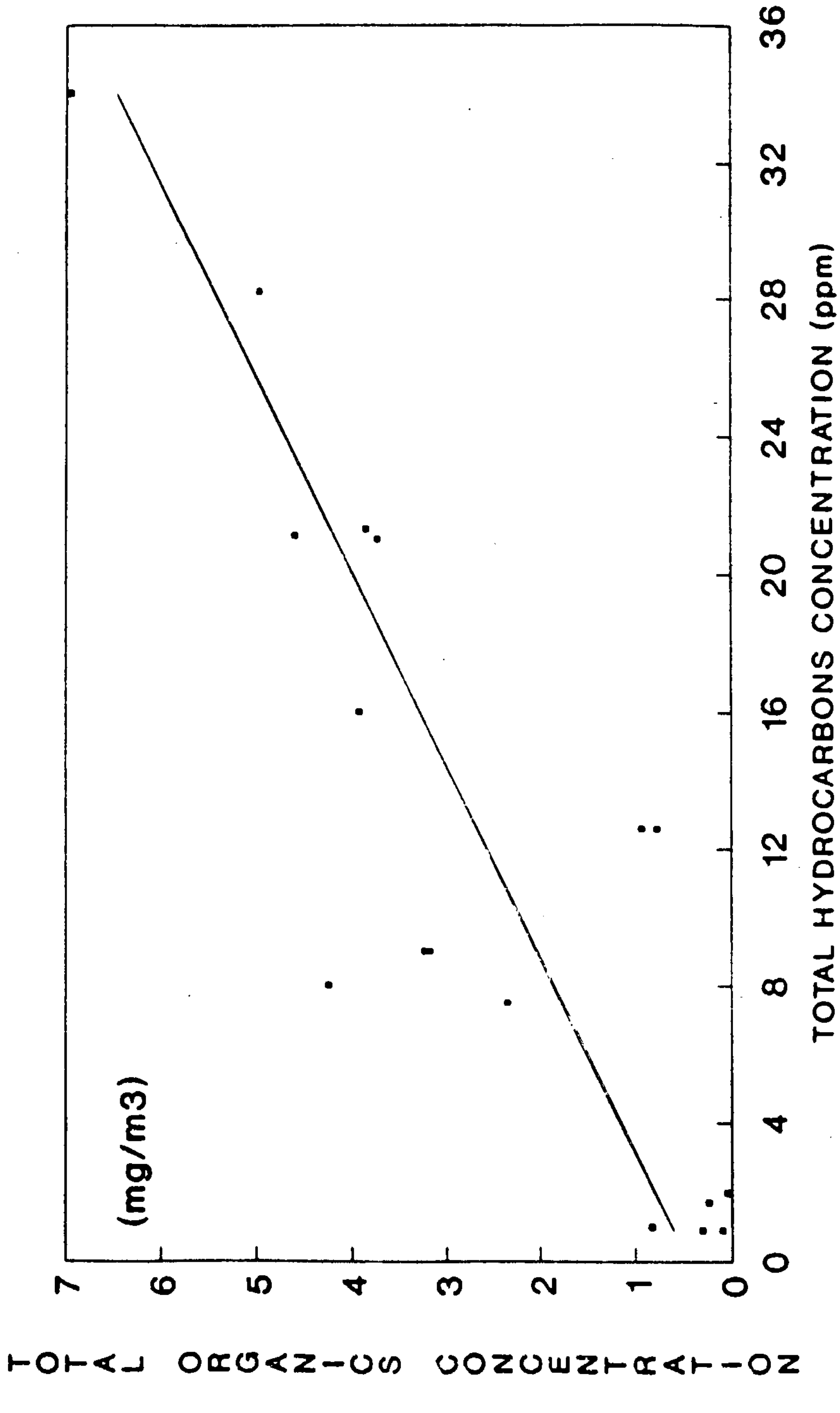
Figure IX-G.1

TOTAL HYDROCARBONS VS. TOTAL ORGANICS



Correlation Coefficient • .741

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The ability to correlate concentrations of organic compounds emitted with the concentration of total hydrocarbons in the emission gases persuaded EPA to propose a numerical limit for the concentration of total hydrocarbons in the emission gases. Setting numerical limits for total hydrocarbons has several advantages over setting numerical limits for individual organic compounds in sewage sludge fed into an incinerator. By setting a numerical limit based on the concentration of total hydrocarbons in the emissions, the Agency does not need the DRE of an incinerator. EPA could have proposed that owners or operators conduct performance tests of their incinerators to determine the efficiency of their units and then calculate an allowable pollutant concentration based on the results of the performance test. Such performance tests cost approximately $20,000 per facility.

If the Agency had based limits on the concentration of organic pollutants in sewage sludge, PICs created during the combustion process would not have been controlled. By setting numerical limits on the basis of the total hydrocarbon concentration in the emissions, however, EPA will be limiting the emission of the organic compounds fed into the incinerators, as well as those compounds formed during the combustion process. In addition, setting numerical limits on the basis of total hydrocarbons allows the Agency to propose a more comprehensive rule sooner. The proposed rule for the incineration of sewage sludge covers all organic pollutants that have a human health criterion listed in IRIS. If the Agency were to establish, propose, and promulgate a pollutant-by-pollutant concentration for potentially hundreds of organic pollutants in sewage sludge, the process would take many years. Furthermore, such a technology-based approach is inconsistent with the requirements of section 405(a) of the CWA to establish pollutant limits that are adequate to protect human health and the environment.

(ii) *Establish A DRE For The Operation Of Sewage Sludge Incinerators.* The Agency's existing incinerator regulations are primarily based on the performance of well-operated incinerators. However, as indicated above the Agency does not have sufficient data to determine the DRE for a well-operated incinerator.

(iii) *Carbon Monoxide.* EPA considered, but rejected, setting numerical limits for carbon monoxide (CO) in lieu of setting limits for total hydrocarbons. The Agency will propose that hazardous waste incinerators limit the emission of carbon monoxide to 100 ppm. If the 100 ppm limit is exceeded, facilities would be required to monitor total hydrocarbons. The Agency based the 100 ppm carbon monoxide limit on a review of the emissions of PICs from a number of hazardous waste incinerators and boilers that burn hazardous wastes. The data support the conclusion that low carbon monoxide levels (i.e., less than 100 ppm) are associated with low rates of PICs in hazardous waste incinerators. However, the Agency could not draw the same conclusion for sewage sludge incinerators (see Table IX–G.3).

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TABLE IX-G.3

SUMMARY OF EMISSIONS DATA FROM 1987 INCINERATOR TESTS

SITE	RUN	THC (ppm)	CO (ppm)	B,2,6,PH (ug/M3)	1,2,DICHL OROBENZENE (ug/M3)	1,3,DICHL OROBENZENE (ug/M3)	1,4,DICHLORO BENZENE (ug/M3)	2-NITRO PHENOL (ug/M3)	PHENOL (ug/M3)
1	1	9	320	2.5			22		
1	2	16	450						
1	3	9	450	22.1	15.6				
1	4	7.5	360				25.9		
1	5	8	325	14.2		11.5	43.8		
2	1	21.1	821	191	34	0	50.7	89.4	173
2	2	21	821	35.8	15.8	0	24.7	42.6	107
2	3	34	1490	36.4	36.4	0	41.7	91	208
2	4		1563	15	13.5	0	16.6	0	61.7
2	5		1037	7.2	35.4	3.1	29.7	91.5	153
2	6		888	7.3	25.8	2.2	36.2	112	50.1
3	1	0.9	168	5.2	0	0	0	0	0
3	2		71	30.5	0	0	0	0	0
3	3	2	132	10.1	0	0	0	0	0
4	1		256						3.6
4	2	21.3	1503						6.9
4	3	182	1841						8.8
4	4	1.01	250						
4	5	1.72	98						
4	6	0.91	221						
4	7	12.6	1230						
4	8	12.6	1230						
4	9	28.2	2838						

TABLE IX-G.3 (CONT'D)

SUMMARY OF EMISSIONS DATA FROM 1987 INCINERATOR TESTS

SITE	RUN	NAPHTHAL. (ug/M3)	ACRYLONITRIL (ug/M3)	BENZENE (ug/M3)	CCL4 (ug/M3)	CHLORO BENZENE (ug/M3)	CHLOROFORM (ug/M3)	1,2 DICHLOROETHANE (ug/M3)
1	1		454	883	8.1	50.7	218	0.6
1	2		884	948	5.6	75.5	214	0.2
1	3		574	774	3.1	47.6	276	0.5
1	4		439	528	3.4	27	226	0.9
1	5		1073	1287	6.8	69.4	325	4.6
2	1	65.6	2159	507	0.4	29	0.34	0
2	2	124	1892	283	0.31	18	0.38	0
2	3	85.3	3159	511	0.44	19.5	1.1	0
2	4	0	2594	573	0.46	53.8	0.49	0
2	5	282	3351	730	0.1	43.3	0	0
2	6	62.6	3869	4191	0	33.3	0	0
3	1	0	0	37	0	0.29	244	0
3	2	0	0	62	0	0.6	745	0
3	3	0	0	7.4	1.1	0	4.1	0
4	1	1.3	8737	902	0	255	0	0
4	2	3.4	2429	433	4.41	102	11.4	0
4	3	3.6	8566	2224	5.02	324	25.1	0
4	4		504	142	2.16	5.91	5.84	0
4	5		145	57.8	0.242	2.63	0.617	0
4	6		0	54.9	0.384	0	1.6	0
4	7		693	52.7	0.92	7.11	0.823	0
4	8		816	68.2	0	6.35	3.7	0
4	9		4555	307	7.18	16.3	13.1	0

TABLE IX-G.3 (CONT'D)

SUMMARY OF EMISSIONS DATA FROM 1987 INCINERATOR TESTS

SITE	RUN	TRANS 1,2 DICHLOROETHANE (ug/M3)	ETHYL BENZENE (ug/M3)	METHYLENE CHLORIDE (ug/M3)	TETRA CHLORO ETHENE (ug/M3)	TOLUENE (ug/M3)	1,1,1 TRICHLOROETHANE (ug/M3)	TRICHLORO ETHENE (ug/M3)	VINYL CHLORIDE (ug/M3)	DIOXIN EQUIVALENTS (ug/M3)
1	1	7.2	34.1	82.4	898	232	10.1	44.1	225	
1	2	7.3	31	103.2	962	252	14.4	81	335	
1	3	12.8	249.6	176.8	572	201	15.6	78.7	211	
1	4	11.3	37.1	154.9	450	193	25.5	46.8	175	
1	5	14	69.3	43.4	300	441	7.9	101.1	430	
2	1	0.74	10.5	0	23.6	341	0	2.8	913	
2	2	0.77	0.79	2.7	16.1	241	0	3	918	
2	3	1.1	29.8	0.14	22.4	2005	0.27	8.7	693	
2	4	0.36	91.7	323	27.9	2389	0.59	8.7	1389	
2	5	0.46	34.1	181	54.3	1322	0	4.6	1101	
2	6	0.77	11.6	29.5	114	4437	0	9.6	1273	
3	1	0	0.49	11	0	2.2	5	0.62	0	
3	2	0	0	6.9	0	2.7	2.9	0	0	
3	3	0	3.3	1.9	3.9	11.3	3.7	1.2	0	
4	1	0	579	20.1	174	744	4.62	37.3	944	
4	2	0	61.3	4.96	73.5	193	1.66	7.19	511	
4	3	0	444	33.5	350	1316	24.4	141	465	
4	4	0	27.4	2.73	0.263	136	1.33	0.836	0	0.983
4	5	0	3.84	0	0.174	25.2	1.13	0.191	0	1.214
4	6	0	5.83	0	0.503	31.9	0.39	0.377	0	0.995
4	7	0	0	1	6.59	2.38	2.96	9.45	0	0.271
4	8	0	0	5.32	11.1	1.54	9.94	9.21	0	1.148
4	9	0	0	0.44	7.6	29.5	5.44	1.87	20.1	

NOTE: DIOXIN SAMPLES TAKEN AFTER THE AFTER-BURNER

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The carbon monoxide levels measured in the four sewage sludge incinerator tests were much higher than those measured in hazardous waste incinerators. The four sludge incinerators tested had carbon monoxide concentrations ranging from 71 ppm to levels over 2,000 ppm and an overall average carbon monoxide level of 795 ppm. The Agency also found that, even though the carbon monoxide level was high for a particular sewage sludge incinerator, the total hydrocarbon concentration was low for the same incinerator. Thus, EPA was unable to correlate carbon monoxide levels in sewage sludge incinerators to the concentration of organics in the emissions. This may be caused by the differences between the composition of sludge and hazardous waste and differences in incinerator design.

Sewage sludge is mostly water, with the combustible portion typically making up only 20 percent or less. Multiple hearth incinerators typically used for the incineration of sewage sludge are designed to remove the water content of sludge as efficiently as possible and to handle the large amount of ash left from sewage sludge incineration. The design configuration of multiple hearth incinerators results in incomplete combustion due to oxygen starvation and poor gas mixing and therefore, is not efficient for the combustion of organic pollutants.

Hazardous waste generally contains significant amounts of organic chemicals. To destroy these chemicals, hazardous waste incinerators are designed to achieve turbulent gas mixing, high combustion temperatures, and adequate gas residence times. When hazardous waste incinerators are operated properly, they normally achieve carbon monoxide levels well below 100 ppm.

(iv) *National Total Hydrocarbon Limit.* Another alternative on which the Agency is soliciting comment is the use of a single national total hydrocarbon limit applicable to all incinerators. This limit would be based on the information from all of the model plants in our database to calculate a reasonable worse case limit that would be protective at an incremental carcinogenic risk level of 1×10^{-5} at most incinerators. For example, if the Agency selected a total hydrocarbon level of 20 ppm our data indicates that approximately 80 percent of incinerators would meet 1×10^{-5} MEI risk. This approach would replace site-specific total hydrocarbon calculations at each facility. EPA solicits comments on the merits and implications of this type of approach.

(f) *Limitations of the Proposed Approach.* EPA recognizes that limited data exist to quantify public health risks, particularly for total hydrocarbon emissions. For sewage sludge incinerators, the Agency has been able to identify and quantify eight to nine percent in the compounds of the total hydrocarbon emissions. The compounds which were identified, represented some organic carcinogens of great concern. As previously noted, the risk specific concentration is extremely sensitive to the compounds not detected and their assumed concentration. EPA believes its approach of assigning undetected carcinogen detection limit value for the purpose of developing the weighted $Q_t{}^*$ value is consistent with the CWA section 405 requirement to protect human health and the environment. The Agency is continuing to conduct emission testing to improve the data base in support of today's proposal.

Other concerns raised about today's approach are that it accounts for only inhalation health impacts, but does not account for health impacts resulting from the indirect exposure to incineration emissions (e.g., through food or water) or for environmental impacts. At this time, the Agency has not yet developed procedures for quantifying indirect exposure or environmental impacts for purposes of establishing regulatory emission limits. However, work is underway to refine these procedures.

Example

The following example is to be used to illustrate how a sewage sludge incinerator facility would determine if it could meet the proposed numerical limits. The hypothetical facility has two incinerators with a total capacity of 25 dry metric tons per day each and a single stack that is 22 meters high. The sludge to be incinerated has an average volatile fraction of total solids of 0.5 and an average volatile solids fraction heating value of 5.5 kilocalories per gram. The two incinerators burn 24,000 pounds per day of fuel oil calculated on an annual basis. The sewage sludge to be incinerated contains the following pollutant concentrations:

Pollutant	Concentration (mg/kg)
Arsenic	4.79
Beryllium	0.548
Cadmium	9.54
Chromium	275.91
Lead	182.04
Mercury	2.15
Nickel	69.82

Table 9 in the proposed rule was used to obtain the dispersion factor of 14.78 micrograms per cubic meter, per gram per second for a 22-meter stack. The numerical limits for the metals listed above were then calculated using the equations described earlier, which are in § 503.63. For example, the numerical limit for arsenic was calculated as follows:

$$C_{As} = \frac{RSC_{As} \times 86{,}400}{DF \times (1 - CE_{As}) \times SF}$$

Where:
RSC_{As} = 0.0023 μg/m³ from Table 8.
DF = 14.78 μg/m³/g/s from Table 9.
CE_{As} = 0.97 from Table 10.
SF = 50 dry tons per day capacity of both incinerators.
Therefore:

$$C_{As} = \frac{0.0023 \times 86{,}400}{14.78 \times (1 - .97) \times 50}$$

C_{As} = 8.96 mg/kg.

Using the same procedure, but with appropriate risk specific concentrations from Table 8 and combustion efficiencies from Table 10, the following numerical limits were calculated:

Pollutant	Calculated numerical limit (mg/kg)	Measured sludge concentration (mg/kg)
Arsenic	8.96	4.79
Cadmium	1.90	9.54
Chromium	248.44	275.91
Lead	134.63	182.04
Nickel	77.16	69.82

The beryllium and mercury values were calculated using the equations (1) and (2) in § 503.63.

Pollutant	Calculated numerical limit (mg/kg)	Measured sludge concentration (mg/kg)
Beryllium	20	0.548
Mercury	64	2.15

Comparing the calculated numerical limits with the measured sludge concentrations, the facility's sludge is found to exceed the concentrations for cadmium, chromium, and lead.

The numerical limit for total hydrocarbons was calculated using equation 5 as follows:

$$THC = \frac{RSC \times 3,240,000,000}{DF \times GF}$$

Where:
RSC = 2.69 micrograms per cubic meter (from Table 8).
DF = 14.78 micrograms per cubic meter per gram per second (from Table 9).
GF = 1.74×10^7 gram moles per day.

The gas flow of 1.74×10^7 gram moles per day was computed using the procedure in Appendix D of the rule as follows:

Sludge Gas Flow = SF × VF × VEHC × 7.01×10^4
Where:
SF = 50 dry tons per day sludge feed rate.
VF = average sludge volatiles fraction.
VEHC = 5.5 kilocalories per gram heating value of the sludge volatiles fraction.
Therefore:
Sludge Gas = $50 \times 0.5 \times 5.5 \times 7.01 \times 10^4$ or
Flow = 9.64×10^6 gram moles of combustion gas per day from sludge combustion. Fuel Gas Flow = FR × FC
Where:
FR = 24,000 pounds per day #2 fuel oil usage.
FC = 324.8 gram moles per day #2 fuel oil constant.
Therefore:
Fuel Gas = $24,000 \times 324.8$ or
Flow = 7.79×10^6 gram moles of combustion gas per day from the fuel combustion.
Therefore:
Fuel Gas = $9.64 \times 10^6 + 10^6$
Flow = 1.74×10^7 gram moles per day

The gas flow would be inserted into the equation as follows:

$$THC = \frac{2.69 \times 3,240,000,000}{14.78 \times 1.74 \times 10^7} \text{ or } THC = 33.9 \text{ ppm}$$

Therefore, the facility would have to be operated to meet a 34 ppm total hydrocarbon concentration in the stack emissions. The 34-ppm limit is calculated on the basis of 50 percent excess air, which then requires that the actual readings from the flame ionization detector be corrected to 50 percent excess air before the measured concentration of total hydrocarbons can be compared to the limit calculated above This correction was calculated using the equation in Section 503.63(f)(iv):

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

Where:
Y = percent oxygen in combustion gases

The average total hydrocarbon concentration reading for the hypothetical facility was 37 ppm, at 10 percent excess oxygen. This total hydrocarbon concentration reading was corrected as follows:

$$THC_{(corrected)} = 37 \text{ ppm} \times \frac{14}{21 - 10}$$

$THC_{(corrected)} = 47$

Therefore, in this example, the facility exceeds the 34 ppm total hydrocarbon limit.

The owners and operators of the hypothetical facility could be expected to conduct air dispersion modeling to obtain a site-specific dispersion factor for inclusion in the equations for cadmium, chromium, lead, mercury, and total hydrocarbons. If air dispersion modeling were conducted, the owners and operators would need site-specific information, including:

- Stack exit diameter,
- Stack exit gas temperature,
- Stack exit gas velocity,
- Adjacent building dimensions,
- Characteristics of the area around the facility to determine if the urban or rural modelling option should be used and whether any terrain features need to be considered, and
- Meteorological data from a nearby meteorologic station or airport.

With the site-specific values for the above parameters, the owner or operator would use the ISCLT model to obtain a site-specific dispersion factor of 10.10 micrograms per cubic meter per gram per second. Therefore, the total hydrocarbon limit is re-calculated for the site-specific dispersion factor to obtain 5.0 ppm concentration. The hypothetical facility now would meet the total hydrocarbon limit because the actual reading from the flame ionization detector corrected to 50 percent oxygen was 47 ppm.

The site-specific dispersion factor was also used to re-calculate the allowable sludge concentrations for the following three pollutants:

Pollutant	Re-calculated numerical limit (mg/kg)	Measured sludge concentration (mg/kg)
Cadmium	2.79	9.54
Chromium	363.57	275.91
Lead	197.01	182.04

These calculations show that the hypothetical facility would now meet its pollutant limits for lead and chromium, but not for cadmium. The owners and operators would be, therefore, likely to conduct a test of the incinerator to determine the facility-specific control efficiency for cadmium. After performing the tests for the hypothetical facility, the average sludge-to-stack emissions removal efficiency was found to be 79.0 percent for cadmium. The numerical limit for cadmium was then re-calculated, using the actual control efficiencies and the site-specific dispersion factor of 10.10 micrograms per cubic meter per gram per second to yield:

Pollutant	Re-calculated concentration (mg/kg)	Measured sludge concentration (mg/kg)
Cadmium	4.64	9.54

This calculation indicated that the concentration of cadmium in the sludge was still above the re-calculated numerical limit. The owners or operators would have to take some action or combination of actions to bring the incinerator into compliance. Among the actions they could consider to reduce the actual sludge concentration would be applying more stringent pretreatment limits or:

- Restricting the feed to the incinerators to lower the sludge feed rate (SF) in the equation;
- Increasing the incinerator control efficiency by installing a more efficient air pollution control system; or
- Increasing the stack height, the stack exit temperature, or the stack exit

velocity to reduce the value of the site-specific dispersion factor in the equation.

If the owners or operators decided to upgrade the air pollution control system, however, they would have to retest the incinerator to obtain new emission control efficiencies.

If the facility had encountered difficulty in meeting the total hydrocarbon concentration limit, several corrective actions would be possible:

- Optimize the incinerator operation to obtain higher combustion temperatures and higher excess air rates to improve combustion of the organics in sludge;
- Reduce the sludge feed rate and the fuel rate to lower the total gas flow rate;
- Install an afterburner to further burn the excess total hydrocarbons and lower the concentration to an acceptable level; or
- Increase the stack height, stack exit temperature, or stack exit velocity to reduce the value of the site-specific dispersion factor.

Stack Height Option

The Agency is soliciting comments on whether to deny owners and operators of incinerators an opportunity to raise the height of their stacks, after the effective date of the rule, as the means of complying with the numerical limits in the rule. Raising the stack height increases the amount of dispersion, thereby reducing the concentration of the pollutants that reach the MEI. However, increasing the height of stacks does not reduce the mass emissions of the pollutants. Therefore, national cancer incidence (the number of cancer cases due to the pollutants being emitted) may not change significantly, if owners or operators choose to meet these requirements by merely increasing the height of their stacks.

Today's proposed regulatory approach is designed to limit the exposure of the MEI to a level that does not exceed an incremental carcinogenic risk of 1×10^{-5}. The legislative history of section 405 of the CWA directs the Agency to establish numerical limits that protect the health of individuals or populations which are at higher risk than the population as a whole (Cong. Rec., S1624, October 16, 1986). If, in complying with this risk level, all incinerators in the regulatory universe install pollution control equipment (such as after-burners and wet ESPs), EPA's analysis shows that, in addition to protecting the MEI, reductions would incur in the total number of projected cancer cases (from 12 to 3) as well as the number of projected adverse lead health effects (from 5,800 to 800).

However, the possibility exists that, in lieu of installing pollution control equipment to meet the metal and hydrocarbon limits, some owners or operators would only raise the height of their incinerators' stacks to comply with the pollutant limits. While such an approach would protect the MEI to the 1×10^{-5} risk level, it would not reduce the projected number of cancer cases (incidence) nationwide as much as the installation of treatment technology. How much reduction could be expected would depend on the number of facilities choosing to use pollution control equipment rather than merely increasing the height of the stacks. EPA has no information at this time indicating whether some, all, or none of the facilities that cannot meet the proposed requirements would choose stack height increases over the use of air pollution control equipment. Factors involved in that local determination include whether it is structurally possible to raise the height of the stacks, comparable costs, local citizen concerns, and State and local requirements. EPA will try to gather more information and requests technical data and public comments on the environmental and human health impacts, and the feasibility and relative cost, of stack height increases versus the installation and use of pollution control equipment.

In addition, the Agency invites public comments on whether the final rule should reflect an alternative approach and be directed at not only the MEI's risk, but should also be directed toward reducing the projected nationwide cancer incidence associated with incinerator emissions. The Agency further invites comments on whether specifying compliance methods is consistent with Section 405 of the CWA.

The Agency is concerned that refusing credit for stack height increases puts EPA in the anomalous position of permitting dispersion credit for existing tall stacks, while denying credit to others for stack height increases, without any clear rationale for distinguishing the two cases. Consequently, the proposal allows for the calculation of a dispersion factor based on the actual height of the stack. However, the Agency invites comments on the alternative of whether to include, in this and other rules, the alternative of imposing a stack height ceiling of approximately 25 meters for all incinerators (e.g., tall enough to prevent down wash) for the purposes of determining compliance with standards.

While dispersion credit for stack emissions is granted under certain conditions under the Clean Air Act (Section 123), the extent of credit is limited. The intent and practice of granting such credit has been with regard to criteria pollutants (i.e., particulates, ozone, nitrogen oxides, sulfur dioxide, lead, and carbon monoxide), not for many of the potentially toxic air pollutants emitted from sewage sludge incinerators, municipal solid waste combustors, and hazardous waste incinerators.

Finally, in setting requirements for technology-based effluent standards under other sections of the CWA, the Agency does not allow the dilution of pollutants as a means of pollution control. EPA requests comment on the basis of such a prohibition under Section 405.

Compliance

The Agency projects that 122 of 194 incinerator facilities will fail to comply with today's proposed numerical limits. Some of the facilities may meet the numerical limits without additional air pollution control devices, if owners or operators can demonstrate (e.g., by air dispersion modeling or by a performance test of the incinerators) that dispersion factors other than those in Table 9 of the proposed rule or the control efficiencies for metals other than those in Table 10 of the proposed rule are applicable to their facilities.

Eligible POTWs that comply with the proposed requirements in this rule would be authorized to issue removal credits for the compounds under § 503.72 (Tables 11 and 12) of the rule. In addition to the metals (e.g., arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel) for which numerical limits are proposed in this part, removal credit authority would be available for metals that have been determined to pose no hazard (e.g., copper, selenium, and zinc) when incinerated. Removal credit authority would also be available for the organic pollutants that are listed in IRIS (see Table 11 in § 503.72 of the proposed rule). The Agency is limiting removal credit authority to organic pollutants listed in IRIS because the human health criterion (weighted $Q_1{}^*$ value) for total hydrocarbons was based on the existing $Q_1{}^*$ values listed in IRIS.

Section 405(d)(2)(D) of the CWA requires that compliance be as expeditious as practicable, but in no case later than 1 year after promulgation of the regulations, unless construction is required, in which case compliance is to be within 2 years. The Agency urges all sewage sludge incinerator facility owners or operators to evaluate whether their facilities would be able to comply with the numerical limits included in today's proposal. While incinerator performance tests are not required in this proposal, a facility may wish to conduct a performance test to develop site-specific data demonstrating that it complies with the requirements of the regulation. Based on the Agency's experience, the time required to plan, conduct, and evaluate the results of incinerator tests may extend beyond a year. Therefore, if owners or operators decide to test their incinerators, waiting until final promulgation of this rule before starting to plan a performance test may not allow sufficient time to demonstrate compliance.

Incineration—Management Practices (§ 503.64)

Combustion Zone Temperature

Today's proposal specifies that incinerators not exceed a temperature of 898 degrees Celsius (1,650 degrees Fahrenheit) in the combustion zone. This value would apply unless the owners or operators conducted a performance test of the incinerator, in which case the temperature recorded during the test would apply. The temperature proposed is based on EPA-sponsored sewage sludge incinerator tests and data from the tests of other sewage sludge incinerators. These data are included in the "Technical Support Document: Incineration of Sewage Sludge" (Reference number 56).

There is considerable evidence that the emission of metals increases when temperatures exceed those designed for the incinerator. Evaluation of the incinerator tests discussed earlier indicate that, for several metals, the control efficiencies of the incinerators and air pollution control systems decrease as the combustion zone temperature increases. The relationship between combustion zone temperature and control efficiency is particularly significant for lead, arsenic, and cadmium. Therefore, EPA is proposing a limit on the maximum temperature in the combustion zone of sludge incinerators to control metal emission levels.

Oxygen Content of the Exit Gas

Today's proposal specifies that the oxygen content of the exit gas, is not to exceed 12 percent (dry basis) for multiple hearth incinerators, 7 percent (dry basis) for fluidized bed incinerators, 9 percent (dry basis) for electric incinerators, and 12 percent (dry basis) for rotary kiln incinerators. These values would apply unless the owners or operators conducted a performance test of the incinerator. If a performance test of an incinerator is conducted, the values recorded during the test would apply.

The Agency is proposing to limit the oxygen content of the exit gas because too much excess air causes an increase in the total amount of suspended particulates in the exhaust gas. Twelve percent oxygen, on a dry gas basis, corresponds to an excess air (oxygen) level of approximately 150 percent. The 12 percent (dry basis) oxygen limit for multiple hearth incinerators is based on generally accepted design and operating principles for this type of incinerator (Reference numbers 62 and 35). In addition, results from the four sludge incinerator tests indicate that lead emissions from multiple hearth furnances become excessive at excess air rates over 150 percent (12 percent oxygen). Seven percent oxygen, on a dry gas basis, for fluidized bed incinerators corresponds to approximately 50 percent excess air. Operating experience indicates that this limit is typical for fluidized bed incinerators (Reference numbers 35 and 62). Electric furnaces are to be controlled to a maximum oxygen limit of 9 percent, on a dry gas basis. This limit corresponds to an excess air rate of approximately 70 percent, a value that was obtained from the design and operating experience of a manufacturer of an electric furnace (Reference number 67).

No information on the appropriate excess air level for rotary kiln incinerators was available to the Agency. Therefore, the 12 percent oxygen limit established for multiple hearth furnaces is proposed for any rotary kiln incinerators burning sewage sludge.

EPA is seeking comments on whether values specified for the combustion zone temperature and the oxygen content of the exit gases are reasonable for sludge incinerators. The Agency is soliciting data from tests that may support or question the proposed values.

Air Pollution Control Systems

EPA is not requiring that the air pollution control systems for sewage sludge incinerators maintain a specific minimum pressure drop. Rather, EPA is requiring that owners or operators install the appropriate air pollution control systems and instrumentation and that the equipment be operated to maintain the numerical limits for metals that EPA is proposing today.

Most sewage sludge incinerators have wet scrubbers. The major variable affecting particulate emissions from sewage sludge incinerators is the operating pressure drop of wet scrubbers. Particulate emission rates also are affected by the design of the incinerator, the type and design of the control device used, the characteristics of the sludge that is incinerated, and the method of operation of the incinerators and control devices.

The particulate removal efficiency of a given wet scrubber increases as the pressure drop of the scrubber increases. Emission of particulates and metals will increase as the pressure drop is decreased for a given incinerator and a given scrubber. Proper operation and maintenance of emission control devices is a key factor in minimizing particulate emissions from sewage sludge incinerators. However, the appropriate operating parameters are incinerator-specific and cannot be generalized on a nationwide basis. Therefore, EPA is not requiring that a specific minimum pressure drop be maintained. Instead, owners or operators must install the appropriate air pollution control systems and instrumentation and must operate the equipment to meet the numerical limits for metals that EPA is proposing today.

Other Management Practices Considered

EPA also considered specifying minimum combustion zone and exit temperatures for combustion gases from sludge incinerators to ensure adequate destruction of organic pollutants. This requirement would have been appropriate if the Agency had proposed setting concentrations for specific organic pollutants with an assumed DRE for the organic pollutants. However, since the Agency has decided to propose the continuous monitoring of total hydrocarbons to measure compliance, specifying minimum combustion system temperatures is not required. As a consequence of requiring all sewage sludge incinerators to meet a total hydrocarbon emission concentration, minimum combustion temperatures will have to be maintained for adequate organic destruction.

The Agency also considered specifying minimum excess air rates to ensure adequate destruction of organic pollutants. A minimum level of excess air (oxygen) is required in an incinerator to obtain complete combustion of organic compounds. This minimum requirement is different for the various incinerators used for the incineration of sewage sludge. Multiple hearth incinerators usually require higher levels of excess air to destroy organic compounds than fluidized bed and electric incinerators. However, because the Agency is proposing that owners and operators continuously monitor for total hydrocarbons in the exhaust gases, sludge incinerators will need to provide sufficient excess air to achieve adequate organic pollutant destruction to meet the total hydrocarbon limits.

The proposed rule does not specify any special requirements for scrubber water, which is usually treated to reduce its solids content. Fly ash residue produced during scrubber water treatment is de-watered and disposed of with the incinerator bottom ash. After solids are removed, treated scrubber water effluent is generally recycled back to the wastewater treatment plant influent. Scrubber water effluent is treated along with the wastewaters, and, when discharged, must meet the facility's effluent limits. Therefore, the scrubber water should not pose risks to human health or the environment.

Monitoring, Record Keeping, and Reports (§§ 503.81 and 503.86)

Owners and operators of sewage sludge incinerators are to measure the concentrations of arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel in accordance with the frequencies established for the treatment work and with the sampling and analysis procedures in § 503.81. In addition, owners and operators must continuously monitor the total hydrocarbon concentration in the incinerator stack gases, the rate at which sewage sludge is fed to an incinerator, the combustion temperature in the incinerator, the oxygen content of the exit gas, and the pressure drop across the air pollution control system, if applicable. The Agency's rationale for these requirements was explained earlier in the discussion of the requirements for sewage sludge incinerators.

The records to be kept are those of the parameters to be monitored as well as the results of any site-specific air modeling or performance tests conducted. These records are to be kept for 5 years, the period of time specified in the State program management regulations (see 40 CFR Part 501). Reports are to be submitted whenever one of the following occurs:

- The combustion temperature in the incinerator remains outside the allowable range for 15 minutes or longer;
- The oxygen content of the exit gas from the incinerator stack remains outside the allowable range for 15 minutes or longer;
- The pressure drop across the air pollution control device exceeds the allowable drop for longer than one hour, if applicable.

The time periods specified are those required in amendments to the NSPS for sewage sludge incinerations. The rationale for the time periods may be found in 53 FR 39412 (October 6, 1988).

In addition to the requirements mentioned above, reports are to be submitted at the frequencies specified in § 503.81(c) for the total hydrocarbon concentration in the stack gases of the incinerator and for the sewage sludge feed rate.

Removal Credits (Subpart H)

Pollutant-contaminated industrial wastewater that is discharged to POTWs can inhibit or upset POTW treatment systems and pass through the facility to surface waters or into the sludge generated by these facilities. To prevent this interference, pass through, and sludge contamination, Congress directed EPA to establish national pretreatment standards for industrial discharges into POTWs (see section 307(b)(1) of the CWA, 33 U.S.C. 1317(b)(1)). These pretreatment standards limit the amount of a pollutant that plants in an industrial category may discharge into a POTW. However, to avoid redundancy in treatment capacity, the Act authorized the POTW to revise a categorical pretreatment standard for an industrial user by adjusting the amount of a pollutant the plant may discharge to the POTW. The revision in the categorical pretreatment standard is based on the percentage of the pollutant removed by the POTW. A "removal credit" is the difference between the categorical pretreatment standard and the revised pretreatment standard. A removal credit allows the POTW's industrial user to discharge greater quantities of a particular pollutant than would otherwise be allowed by the categorical pretreatment standard. The CWA authorizes these revisions in the categorical pretreatment standards provided that certain criteria are met. Among these criteria is a requirement that the increased discharge to the POTW by the industrial user does not cause a deterioration in sludge quality or interfere with sludge use or disposal.

In 1984, EPA issued rules implementing the pretreatment removal credits provision (40 CFR 403.7). However, in a 1986 response to a challenge by the Natural Resources Defense Council, the United States Court of Appeals for the Third Circuit found the regulation invalid (*Natural Resources Defense Council, Inc.* v. *U.S. Environmental Protection Agency*, 790 F.2d 289, 3d Cir., 1986). EPA has now amended the regulations to respond to all but one of the Third Circuit's four holdings (52 FR 42434, November 5, 1987). Its fourth holding was that EPA may not authorize POTWs to grant removal credits to their industrial users until EPA promulgates the comprehensive regulation required by section 405(d). Thus, upon promulgation of regulation that is proposed today, POTWs that manage their sludge by the use or disposal methods covered in the proposed rule (land application, distribution and marketing, disposal in monofills and on surface disposal sites, and incineration) may apply to EPA for removal credit authority. EPA may grant such authority to any POTW that complies with the procedural and substantive requirements of the removal credits regulation and this part. Moreover, EPA may grant such authority to any POTW that disposes of its sewage sludge in a MSWLF in compliance with 40 CFR Part 258.

EPA's removal credit regulation (40 CFR 403.7) provides that, subject to the conditions of the regulation, any POTW receiving wastewater from an industrial user to which a categorical pretreatment standard applies, at its discretion, may grant a removal credit to reflect removal of pollutants specified in the categorical pretreatment standard by the POTW. A POTW is authorized to grant a removal credit if five conditions are met. First, the POTW must receive authorization to grant removal credits from EPA or the authorized approval authority in an NPDES State with an approved State pretreatment program. Next, the POTW must demonstrate and continue to achieve consistent removal of pollutants. Third, the POTW must have an approved pretreatment program. Fourth, the granting of a removal credit must not cause the POTW to violate local, State, or Federal sludge requirements for the sludge management method chosen by the POTW. Finally, granting removal credits must not cause a POTW to violate its NPDES permit conditions or limitations (40 CFR 403.7(a)(3)).

Pollutants for Which Removal Credits May Be Authorized (§ 503.72)

Provided a POTW complies with all other applicable requirements, removal credits would be available for the pollutants listed below.

The 65 Pollutants Regulated in One or More Use or Disposal Methods

If a POTW uses or disposes of its sludge through one of the methods for which standards are developed in today's proposal and meets the numerical limits and management practices for that use or disposal method, the POTW would then be authorized to grant a removal credit for the pollutants regulated in the practice employed by the POTW.

Many facilities may use one or more methods for disposing of their sewage sludge. EPA has concluded that certain pollutants may pose a greater threat to human health and the environment in particular use of disposal methods. For POTWs using one or more use or disposal methods, removal credits would only be available if the concentration of the pollutants do not exceed the lowest concentration for the use or disposal method employed by the POTW.

The 17 Pollutants Which EPA Examined Without Establishing Numerical Limits

Removal credits would also be available for 17 pollutants in one or more use or disposal methods because, at the highest concentrations shown, the pollutant did not pose an unreasonable risk. When a POTW uses or disposes of its sludge through one of the methods for which a pollutant was evaulated for adverse effect in accordance with the requirements of this part, a removal credit would be authorized for that pollutant. However, a removal credit would only be available so long as the concentration of the pollutant in the POTW's sludge did not exceed the numbers evaluated by EPA for adverse effects. These values are included on Table 12 in § 503.72 of the proposed rule. In most cases, these concentrations represent the very highest values, in excess of expected current sludge quality levels. EPA solicits comment on the appropriateness of the capping concentrations of these pollutants for the purpose of removal credits. EPA also solicits data concerning concentration of these pollutants in sludge.

Pollutants Disposed of in MSWLFs

A POTW that disposes of its sewage sludge in a MSWLF and meets the requirements of 40 CFR Part 258 would be eligible to issue removal credits for the pollutants in its sludge. EPA has made the determination that the requirements in 40 CFR Part 258 are adequate to protect human health and the environment from any reasonably anticipated adverse effects of each pollutant.

Some POTWs may employ other use or disposal methods in combination with disposal in a MSWLF. Under those circumstances, EPA is considering limiting removal credits to those pollutants for which specific numerical limits have been established in order to encourage the maximum beneficial reuse of sewage sludge. The Agency remains concerned that such an approach may have the opposite effect. It may encourage POTWs to dispose of all their sludge in landfills, rather than using some of their sludge in a beneficial manner. The Agency solicits comment on this concern.

Hazardous Sludge

EPA has also determined that compliance with the requirements in 40 CFR Parts 261 through 268 (promulgated under Subtitle C of RCRA) when disposing of hazardous sludge will constitute compliance with Section 405 of the CWA. Thus, this type of sludge disposal will be a regulated disposal method under the comprehensive section 405 system. It could be argued that hazardous concentrations of pollutants disposed of under RCRA Subtitle C, by definition, do not interfere with sludge use and disposal and, therefore, removal credits should be available for such pollutants. However, in the case of pollutant concentrations which result in a hazardous sludge, allowing industrial users to obtain removal credits for such pollutants would be inconsistent with statutory objections of improving sludge quality and encouraging beneficial reuse. The availability of removal credits would permit the industrial user to reduce its level or treatment, shifting the removal burden to the POTW and ensuring that the sludge was unavailable for a beneficial use. EPA does not intend that its comprehensive sludge management program and the availability of removal credits encourage any increase in the generation of highly contaminated sludge.

Phenolic Compounds

EPA is also requesting comment on another issue. Certain phenolic compounds (e.g., parent phenol) are regulated for a number of different use and disposal methods but are determined not to represent a threat to human health and the environment for other methods. Consequently, removal credits would be available for those pollutants. The Agency notes that its pretreatment standards regulated 4AAP, an indicator for parent phenol and certain other phenolic compounds. The Agency is considering whether or not removal credits should be available for the family of compounds represented by 4AAP. Only the parent phenol and certain other phenolic compounds were the subject of an environmental assessment. EPA believes that removal credits should be available only for that portion of 4AAP that measures the specific compounds which were subject to an environmental assessment. The Agency requests information on whether 4AAP will consistently reflect the levels of the different phenolic compounds present in the wastewater.

Monitoring, Record Keeping, and Reports (Subpart I)

Purpose (§ 503.80)

This subpart contains the minimum monitoring, record keeping, and reporting requirements necessary to ensure that treatment works, users, and disposers comply with the requirements of the rule. The Agency is requesting public comment on the appropriateness of placing these requirements with the Part 503 technical standards. As an alternative, the Agency is considering the consolidation of the record keeping and reporting requirements in today's proposal with the State program management requirements (40 CFR Part 501) and with the NPDES permitting requirements (40 CFR Parts 122 through 124). Such an approach would consolidate requirements that are primarily administrative. However, the argument can also be made that, along with the monitoring requirements, record keeping and reporting requirements are an integral part of the technical standards.

The Agency is proposing that treatment works monitor a representative sample of their sewage sludge for two classes of pollutants. The first class entails pollutants with specific numerical limits for the use or disposal method employed by the treatment work (i.e., 25 pollutants for the land application of sewage sludge, 22 pollutants for the distribution and marketing of sewage sludge, 18 pollutants for the disposal of sewage sludge in monofills and on surface disposal sites, and seven pollutants for the incineration of sewage sludge). The second class contains those pollutants listed on Table 12 of § 503.72, i.e., those pollutants for which the POTW may grant a removal credit.

Monitoring frequency is based on the wastewater flow of the facility. Facilities that have a wastewater flow of less than one million gallons per day (mgd) would monitor once a year. Those with a wastewater flow of 1 to 10 mgd would monitor quarterly. Those with a wastewater flow over 10 mgd would monitor monthly. The Agency is considering alternatives such as monthly monitoring the first year and then specifying alternative frequencies in a treatment work's permit, based on the variability of the first-year's monitoring results. Sludge with pollutant concentrations that constantly fluctuate would be monitored more frequently than sludge with uniform pollutant concentrations. Another approach that the Agency is considering, is to specify monitoring frequencies based on the industrial flow into the facility.

Permitting authorities may impose more comprehensive and more frequent monitoring requirements than those in today's proposal. Nothing in this subpart precludes the establishment of more stringent requirements. The Agency encourages permitting authorities to recommend alternative monitoring and reporting frequencies as part of their comments on today's proposal.

The discussion included in this section of the preamble is limited to the general requirements that are applicable to treatment works, irrespective of the method by which they use or dispose of their sewage sludge. Monitoring, recording keeping, and reporting requirements that are specific to a particular method were discussed in connection with that method.

General (6,503. 81)

Sampling Protocols

EPA is proposing that treatment works collect and analyze their sewage sludge samples in accordance with "Sampling Procedures and Protocols for the National Sewage Sludge Survey," EPA, Office of Water Regulations and Standards, March 1988 (Reference number 55). The sampling procedures and protocols included in this document were compiled specifically for the National Sewage Sludge Survey described elsewhere in this preamble. The procedures are specific to sewage sludge and describe the type of representative samples to be collected, sample locations, sample collection procedures, equipment to be used, procedures for handling liquid and solid samples, and procedures for sample handling and preservation.

Prior to the Survey, these procedures were extensively reviewed within the Agency and by the Association of Metropolitan Sewerage Agencies, Association of State and Interstate Water Pollution Control Administrators, Chicago Metropolitan Sanitary District, and the Iowa Department of Natural Resources. In conducting the Survey, EPA has found that the procedures worked well, irrespective of the size and complexity of the plant sampled. EPA believes that these standard procedures will improve the quality and consistency of data and ensure the integrity of samples collected prior to analysis.

These procedures are also found in Chapter 2 of "POTW Sludge Sampling and Analysis Guidance Document" (Reference number 87). This document includes other relevant information that POTWs may find helpful.

Analytical Methods

The preferred analytical methods for determining the concentration of organic and inorganic compounds in sewage sludge and for the determining the fraction of total, dissolved, and suspended solids in sewage sludge are listed in "Analytical Methods for the National Sewage Sludge Survey," Office of Water, Sample Control Center, March 1988 (Reference number 51). These procedures are also found in Chapter 3 of "POTW Sludge Sampling and Analysis Guidance Document" (Reference number 87).

Methods 1624 and 1625 are isotope dilution, gas chromatography-mass spectrometry (GC/MS) methods for analyzing volatile and semi-volatile organic pollutants amenable to GC/MS. Isotope dilution uses a stable, isotopically labeled analog as an internal standard for the analysis of a compound. As an alternative to Methods 1624 and 1625, EPA lists Methods 624 and 625 found in 40 CFR Part 136. However, Methods 624 and 625 do not have the same precision and accuracy as do Methods 1624 and 1625. Methods 624 and 625 can not distinguish between similar compounds in a sludge matrix. Therefore, the Agency is soliciting public comment on whether it should limit acceptable methods to 1624 and 1625.

Method 1618, used for pesticides, is undergoing further validation as part of the National Sewage Sludge Survey. EPA requests laboratories that have used Method 1618 to provide the Agency with an evaluation of the method in conjunction with their comments on today's proposal. Any changes in Method 1618 will be published in the "Federal Register" as part of the Notice on the results of the National Sewage Sludge Survey.

The methods for analyzing inorganic pollutants in "Analytical Methods for the National Sewage Sludge Survey" are fully validated methods and were compiled from:

• "Methods for Chemical Analysis of Water and Wastes," EPA, Cincinnati, OH, March 1983 (EPA-600/4-79-020), currently available from National Technical Information Service, Springfield, VA 22161 (PB84-128677); and

• "Test Methods for Evaluating Solid Waste," EPA, Washington, DC, November 1986 (SW-846), currently available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402.

The methods for analyzing pathogenic bacteria, animal viruses, fecal coliform, fecal streptococci, protozoa, helminth ova, volatile solids, volatile suspended solids, and SOUR were described in the discussion of the pathogen and vector attraction reduction requirements. The equation for calculating the percent volatile solids reduction was also described in that subpart of this part of the preamble.

The Agency is seeking public comment on the proposed methods for measuring the parameters included in today's proposal. Alternative methods will be carefully evaluated and may be included in the final rule.

PART X: IMPLEMENTATION OF 40 CFR PART 503

Clean Water Act

The 1987 amendments to the Clean Water Act (CWA) included significant changes to section 405 of the CWA with regard to the implementation of the technical standards for the use and disposal of sewage sludge. Prior to the 1987 amendments, the CWA required that EPA develop standards for the use and disposal of sewage sludge, but did not specify whether the standards were to be implemented through permits and, if so, under what authority. Traditionally, National Pollutant Discharge Elimination System (NPDES) jurisdiction arises when there is a discharge of pollutants to navigable waters from a point source. Thus, there was some question about the applicability of NPDES permits to regulate sewage sludge disposal that did not involve discharges to navigable waters. Likewise, other permits either are media-specific (e.g., permits issued under the Clean Air Act) or regulate particular substances or methods of disposal (e.g., Subtitle D of the Resource Conservation and Recovery Act—RCRA). Therefore, they were also ill-equipped to comprehensively regulate across all media the use and disposal of sewage sludge.

The 1987 amendments establish a program with the objective of protecting public health and the environment from the adverse effects of pollutants in sewage sludge. This is to be accomplished by developing technical standards that establish pollutant limits and management practices for each use and disposal method and implementing these standards through permits. The 1987 amendments make it plain that the technical standards are to be implemented through NPDES permits, unless the standards are included in a permit issued either under one of the listed Federal programs or by an approved State sludge program. Section 405(f)(1), as amended, provides:

Through Section 402 Permits.—Any permit issued under section 402 of this Act to a publicly owned treatment works or any other treatment works treating domestic sewage shall include requirements for the use and disposal of sludge that implement the regulations established pursuant to subsection (d) of this section, unless such requirements have been included in a permit 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, or the Clean Air Act, or under State permit programs approved by the Administrator, where the Administrator determines that such programs assure compliance with any applicable requirements of this section * * *.

Thus the Act provides authority to implement the standards through NPDES permits where the standards are not included in a Clean Air Act permit, a RCRA subtitle C permit, a Marine Protection, Sanctuaries, and Research Act permit, an Underground Injection Control permit under the Safe Drinking Water Act, or an approved State program permit. It is clear that permit coverage among the programs is to be complementary, not duplicative. However, it is also clear that permit coverage of publicly owned treatment works (POTWs) and other treatment works is to be comprehensive and that no facilities are to go unpermitted because they fall outside the traditional jurisdiction of media-specific programs. If the POTW or other treatment work treating domestic sewage does not have an NPDES permit or any of the other permits listed in section 405(f)(1), the CWA authorizes the issuance of a permit solely to implement the sludge standards (see CWA section 405(f)(2)).

In addition to the requirement that the standards be implemented through permits, the other important provision of section 405(f)(1) allows a State to issue permits to implement the technical standards where the State permit program has been approved by the Administrator. The Administrator may approve State programs that he finds will assure compliance with the requirements of section 405.

Regulations For Implementation Of The Technical Standards And For State Program Approval

EPA proposed State sludge management program regulations that appeared in the **Federal Register** on February 4, 1986 (51 FR 4458). These regulations set forth minimum program requirements and procedures for States to obtain approval of their sludge management programs. These regulations would have required that the States develop sludge management programs which would assure that sludge use and disposal complied with the technical standards. Because these regulations were proposed prior to the Water Quality Act (WQA) of 1987, they did not require that the States develop permit programs.

On March 9, 1988, EPA proposed new State program and permitting requirements (53 FR 7642). These regulations will implement the WQA requirement that permits issued to POTWs and other treatment works treating domestic sewage contain the sludge standards and the requirement that EPA promulgate procedures for the approval of State programs. The purpose of the State program and permitting rules is to provide the implementation framework for the sludge technical standards proposed today by: (1) Providing permit conditions to incorporate the standards into permits, as well as additional requirements to track compliance with the standards; and (2) setting approval requirements for State sludge programs so that they can implement the Section 405 requirements. The March 9, 1988 proposed rules contained three principal sections. First, the proposed rules would revise the existing NPDES permitting regulations at 40 CFR Part 122 and 124 to include sludge conditions in NPDES permits. Second, the proposed rules contained revisions to 40 CFR Part 123 for States with NPDES authority that wish to modify their existing NPDES program to include the regulation of sewage sludge. Third, the March 9, 1988 proposal contains a separate section with requirements for State sludge programs that are not based on NPDES. Thus, these regulations reflect the CWA's stipulation that the sludge standards may be included in any of a number of permits under different programs, so long as they are addressed in a permit. The regulations do not require that States implement the sludge standards through the NPDES program. Where EPA is the permitting authority (i.e., where the State has not sought and obtained approval of its sludge program), the sludge requirements will be primarily implemented through NPDES permits, unless the requirements are contained in one of the other listed Federal permits. These regulations are scheduled to be promulgated in April 1989.

Requirements Prior To Promulgation Of The Technical Standards

The WQA also requires that, prior to promulgation of the technical standards, NPDES permits issued to POTWs are to contain sludge conditions. Moreover, the Administrator is authorized to take other appropriate measures to protect public health and the environment from the adverse effects of sewage sludge (see CWA section 405(d)(4)). In response to this call for controls before promulgation of the technical standards, EPA has developed an interim strategy for sludge permitting. The "interim" or "pre-technical standards" sludge program for implementing section 405(d)(4) of the CWA is contained in a document entitled "Strategy for Interim Implementation of Sludge Requirements in Permits Issued to POTWs" (see Notice of Availability of this document, 53 FR 1987, May 31, 1987). Once the technical standards proposed today are promulgated, the use and disposal of sewage sludge will be regulated by those standards and by the permitting and State program requirements. The "interim" program will continue to apply to those facilities, pollutants, and use and disposal methods not covered by the technical standards. EPA's authority to impose permit limits developed on a case-by-case basis will continue with respect to pollutants and management practices not regulated by the technical standards.

EPA is sensitive to the problems that may arise if "interim" conditions significantly differ from those that will be required by the technical regulations. Thus, in developing its interim permitting strategy, the Agency has sought to adopt approaches which are consistent with the anticipated direction of the technical standards. In addition, a primary emphasis of the interim strategy will be ensuring compliance with existing federal requirements, such as 40 CFR Part 257. Generally, additional limits will be required only for POTWs with known or suspected sludge use or disposal problems. The recommendations for additional limits are based on existing federal guidance and State requirements, and consist in most cases of best management practices, rather than numerical limits. EPA has adopted this approach in recognition that such measures are interim only. EPA's primary objective under section 405(d)(4) remains the protection of public health and the environment.

The anti-backsliding provision of section 402(o) of the CWA does not apply to sewage sludge use and disposal activities. This means that if the permit contains limits developed on a case-by-case basis (i.e., based on the permit writer's best professional judgement) under EPA's interim sludge permitting strategy which are more stringent than subsequently promulgated Part 503 standards, the reissued permit could include limits based on the less stringent Part 503 standards rather than the more stringent case-by-case interim limit. This would be true not only for pollutant concentration limits, but also for monitoring or testing requirements or management practices in Part 503. Because the Part 503 standards (and permit conditions implementing them) must protect public health and the environment, from reasonably anticipated adverse effects, "backsliding" from more stringent interim limits should not result in any significant adverse public health or environmental effects.

PART XI: BENEFITS AND COSTS OF THE PROPOSED RULES

Administrative and Statutory Requirements

As explained in Part II of this preamble, section 405(d) of the Clean Water Act (CWA), directs EPA to publish information on the costs of sludge use and disposal. In addition to this legislative requirement, Executive Order 12291 directs EPA to analyze and consider the cost and impact associated with this proposed regulation. This Executive Order, signed in February 1981, addresses various concerns about Federal regulations, including a requirement to develop a Regulatory Impact Analysis for all major regulations, which are defined as those that impose an annual cost to the economy of $100 million or more or that meet other economic impact criteria. Based on the Agency's estimates of the incremental costs of complying with the proposed regulation, the Agency considers today's action to be a major rule as defined in Executive Order 12291, and has prepared an extensive analysis of the benefits, costs, and other impacts associated with the proposed regulations. This analysis, "Regulatory Impact Analysis of the Proposed Regulations for Sewage Sludge Use and Disposal" (hereafter referred to as the RIA), is part of the record for this rulemaking and copies are available for review and comment (see Part XIII on availability of technical information). The RIA was transmitted to the Office of Management and Budget (OMB) with the notice of proposed rulemaking. OMB's comments are presented in the public record for this rulemaking.

Overview of the RIA

The RIA presents an evaluation of the costs, benefits, and economic impact associated with the proposed regulation. Although the proposed regulation applies to all treatment works except privately owned treatment works treating domestic sewage along with industrial waste and wastewater, the RIA pertains only to publicly owned treatment works (POTWs). This is due to the lack of data indicating the nature and extent of private ownership of such treatment works.

The analysis begins with an assessment of the sludge disposal methods currently used by POTWs and then evaluates the impact of new or additional requirements imposed by the proposed regulation. The RIA also presents the costs and impacts of three other regulatory options that the Agency considered. Each of the options reflects a separate set of regulatory requirements. The impacts of each of these three options are briefly discussed earlier in the preamble (Part VIII, see Table VIII-1) and are covered in detail in the RIA. The following discussion focuses only on the regulatory option that is the basis for today's proposed rulemaking.

The Agency's overall approach to the RIA recognizes that, in addition to compliance costs for testing, monitoring, record keeping, and other requirements, a POTW may be required to alter its current method of sludge use or disposal to achieve compliance with the regulation. These changes could include shifts to a new or different combination of disposal methods, installation or operation of pollution control equipment, or increased reliance on industrial pretreatment. The costs of these changes are evaluated for each of the use and disposal methods. The benefits associated with complying with the regulation in the form of reduced health risks are also evaluated. The RIA presents quantified estimates of these benefits, expressed as a reduction in as the number of cancer cases and other health effects.

There are more than 15,000 POTWs in the U.S. processing nearly 28 billion gallons of wastewater a day. POTWs provide various degrees of pollutant removal depending on the level of treatment in place. The levels of treatment are generally described as pretreatment, preliminary treatment, primary treatment, secondary treatment, advanced treatment, and no discharge. The level of treatment employed in a given facility determines, in part, the purity of the plant's effluent and the quantity and pollutant content of the facility's sludge. The more than 15,000 POTWs in the United States generate an estimated 7.7 million dry metric tons of sewage sludge annually.

The proposed regulations are expected to cover 5,367 POTWs, which is an estimate of the facilities currently using the use and disposal methods that are specifically addressed by the proposed regulations. These facilities produce about 56 percent of the total sludge volume. Of the remaining POTWs, an estimated 6,664 (accounting for 41 percent of the total sludge volume) dispose of sludge in landfills that are specifically controlled by other statutory requirements and are covered in today's regulation by the requirements in proposed Part 258 of RCRA (see Part IX and Part XIV of the preamble). In addition, 3,274 POTWs use other disposal practices that will be addressed in future rulemakings.

Summary of Impacts of the Proposed Regulation

For the disposal practices covered by the regulation, the Agency projects incremental annual compliance costs of $157.7 million (1987 dollars), or an average of $5 per household served by these facilities. The total annual costs include costs for management practices (e.g., sludge testing, record keeping, emissions testing) and, in some cases, incremental costs for a change in the method of use or disposal. In addition, the regulation will result in benefits consisting of reduced effects on human health resulting from reduced exposure to pollutant contaminants. The Agency estimates that the benefits of this proposed rule will be an annual reduction of 9.5 cancer cases and 5,266 cases of other health effects. The proposed regulations are also expected to create certain environmental benefits as a consequence of the improved use and disposal practices. Table XI-1 is a summary of the costs and benefits for each disposal practice.

TABLE XI-1—SUMMARY OF COSTS AND BENEFITS ASSOCIATED WITH THE PROPOSED REGULATIONS

Disposal practice	Number of POTWS	Annual Incremental Cost ($ million)	Human Health Benefits		
			Cancer cases avoided	Other health effects avoided	Total cases avoided
Land application	2,623	15.2	0.06	21	21.06
Distribution and marketing	106	7.8	0.02	56	56.02
Monofill	49	25.5	0.02	26	26.02
Surface disposal	2,395	5.5	(1)	(1)	(1)
Incineration	[2] 194	103.8	9.4	5,163	5,172.40
Total	5,367	157.7	9.5	5,266	5,275.50

[1] Not estimated.
[2] In lieu of the current legislation affecting ocean disposal of sewage sludge in the ocean, 25 POTWs currently known to dispose of sewage sludge in the ocean were re-categorized into incineration for purposes of the RIA.

It is important to note that the Agency is not projecting that specific facilities will discontinue their current practice and immediately undertake an alternative practice. Data pertaining to the manner in which specific facilities would react to the proposed regulations are not available. Instead, the compliance strategies for which costs were calculated represent an estimate of the incremental cost of compliance that POTWs face overall.

In light of the uncertainties associated with any particular POTW's compliance strategy, the Agency estimated the incremental cost of compliance as follows. For land application, the estimated compliance cost is based on either a shift to municipal solid waste landfills (MSWLFs) or a change in end uses and sludge processes (e.g., composting). For distribution and marketing, the costs represent a shift in practice to non-agricultural land application under a contractual arrangement or incineration for those POTWs that are not expected to be in compliance. For monofills, the costs reflect a shift to either co-disposal landfills (i.e., landfills accepting sludge and municipal waste) or incineration for the facilities estimated to be in non-compliance. For the facilities currently using sewage sludge surface disposal, the compliance costs reflect a shift to co-disposal in MSWLFs or to composting and non-agricultural land application. For the facilities that currently use incineration but are not expected to be in compliance, the costs are based on additional pollution control equipment.

The feasibility of pretreatment by industrial dischargers as a compliance alternative was also evaluated as part of the RIA. Depending on site-specific conditions, the effects of industrial pretreatment on sludge quality could be significant. The Agency currently lacks sufficient information to reach widely applicable conclusions regarding the improvements to sludge quality (and, therefore, the ability to attain compliance) from locally-imposed, industrial pretreatment requirements.

In an effort to highlight the potential importance of pretreatment, the Agency conducted a limited number of case studies on the effect of industrial pretreatment on municipal sludge quality as part of the RIA. Pollutant removals were estimated for all industrial dischargers covered by categorical standards. Estimates were also made reflecting treatment levels beyond that represented by the standards. (The pretreatment case studies are described in the RIA.) The Agency found, in these particular cases, that an increase in industrial pretreatment provides a significant reduction in the amount of pollutants in the sludge. The portion of pollutant pounds removed from sludge in the case studies ranged from 6 to 96 percent. The reduction in pollutant levels from pretreatment enabled one of the case study POTWs to achieve compliance with the sludge disposal criteria.

The case studies' findings are limited by the site-specific nature of the analysis. The results are dependent on the type and size of the industrial dischargers. The analysis is also limited in that the improvements in sludge quality were based on removals for only a subset of pollutants in the sludge—those for which categorical standards have been established. Other pollutants that may be affected by local limits were not included in the case studies. Thus, industrial pretreatment could potentially be more of a solution to reducing pollutant levels in municipal sludge than is indicated by these case study results.

Limitations of the RIA

The regulatory analysis described here is limited by the general scarcity of current and reliable data on sewage sludge use and disposal methods and pollutant concentrations in municipal sewage sludge. The analysis is also constrained by a lack of specific information as to how POTWs would react to resolve or eliminate compliance difficulties, particularly where changes in use of disposal methods are indicated. Lacking such detailed information, the Agency relies on a number of baseline assumptions pertaining to sludge volumes for each use or disposal method, the costs of existing methods, compliance with the proposed regulation, and potential shifts in methods that may occur. The RIA results, including incremental compliance costs, are strongly influenced by these analytical assumptions.

The most significant limitation is related to the scarcity of data concerning sewage sludge quality. In the absence of a comprehensive data base, and lacking facility-specific information about sludge quality, the Agency relied on an EPA study completed in 1981, "Fate of Priority Toxic Pollutants in Publicly Owned Treatment Works" (Reference number 36, hereafter referred to as the "40 City Study"). Although the study provided data from the largest available sample of nationally distributed treatment plants, it was not specifically designed to support the sewage sludge regulation. Thus, use of this study for sludge quality data is limited by such factors as the locations in the plant where sludge samples were taken, the analytical methods used for measuring the pollutant concentrations, the pollutants analyzed, and the use of the analytical results. The study also only provided data for POTWs.

The Agency used the data from the "40 City Study" to develop three profiles of sludge quality to represent sludge from all publicly owned wastewater treatment plants. In addition to the limitations of the data mentioned above, the sludge quality profiles are further limited by the procedure used to assign the profiles to each of the POTWs. One of the three sludge quality profiles was assigned to each POTW, based on the percentage of industrial influent in the POTW's wastewater. This procedure assumes there is an association between high percentages of industrial influent and high concentrations of pollutants in the sludge. In fact, this intuitively logical relationship has not been convincingly verified by the Agency's analysis of the "40 City Study". We believe our assumption is valid, and that the failure of the "40 City Study" data to support this conclusion further demonstrates the limitations of the data.

The quality of sewage sludge is the basis for determining (1) the ability of POTWs to comply with the proposed regulation, (2) the subsequent impact of non-compliance, and (3) the risks associated with sludge use and disposal. The actual sludge quality at POTWs (i.e., the concentrations of pollutants in sludge) could be significantly different from the sludge quality data used in developing the RIA. Based on the limitations of the sludge quality data, it is possible that the quality of sewage sludge has been misinterpreted and the impact of the proposal over- or understated.

There are other limitations to the RIA that result from the scarcity of data. The RIA does not include any analysis for treatment works other than POTWs. In addition, the volume of sludge generated by POTWs using the various sludge disposal practices was estimated based on the volume of wastewater processed as reported in the "1986 Needs Survey". These estimates may not be accurate because they may not reflect up-to-date wastewater treatment process information. This information affects the estimates of volume of sludge generated.

Other limitations tied to the scarcity of facility-specific information include an inability to evaluate those parts of the proposed regulation that establish maximum pollutant limitations using site-specific parameters. When addressing site-specific criteria in the RIA, the Agency again relies on sludge quality profiles and model plants to represent actual facilities. The lack of facility-specific data also limits the Agency's ability to determine how POTWs will achieve compliance with the regulation. The decision to adopt an alternative disposal practice, to add pollution control equipment, or to require additional pretreatment from industrial dischargers will be made by individual POTWs based on a variety of site-specific conditions and considerations. In the absence of facility-specific information, the Agency relied on a limited number of assumptions concerning the effect of local factors on compliance strategy. As an example, shifts to MSWLFs from other methods of use or disposal were considered to be unlikely for large volume POTWs located in areas where landfill capacity is constrained.

Another limitation of the RIA relates to the distribution of disposal methods among POTWs. The Agency estimated the distribution of disposal practices using original research and a limited amount of existing data (sources are identified in the RIA). For analytical purposes, each facility was assumed to employ only one use or disposal method. In reality, many POTWs use more than one method.

These limitations are important because they affect the compliance cost estimates—some of them to a significant degree. Some of the limitations tend to overstate compliance costs. For example, some POTWs that incinerate sludge are likely to be able to change operations (e.g., decrease feed rate) or depend on other site-specific characteristics (e.g., very high stack height) to avoid the expenditures that the RIA projects for out-of-compliance units to install additional pollution control technologies. In fact, EPA expects that POTWs producing sludge which fails to meet the numerical limits will try any and all low-cost solutions rather than use higher-cost alternatives such as changes in their basic use or disposal method.

Some of the other limitations used in the RIA may have the result of understating the impacts of the proposed regulations. For example, EPA has assumed that the smaller POTWs currently operating sludge monofills that are out of compliance will shift to MSWLFs. This assumption is based on the premise that these smaller POTWs are located in non-metropolitan or rural areas that have land available for new and existing landfill sites. We recognize, however, that the availability and cost of landfilling are becoming serious problems in virtually all areas of the country due to increased public resistance to siting new landfills or expanding current landfills.

Given the scarcity of data that might better indicate how affected POTWs will react to the sewage sludge use and disposal regulations, EPA is confident that the compliance costs provided in the RIA are reasonable estimates of such reactions and costs. Taken together, the Agency believes that the RIA methodology neither understates nor overstates the regulations' costs.

In an effort designed, in part to eliminate many of the limitations of the analysis, the Agency has initiated an information collection effort designed, in part, to provide national estimates of sludge quality, sewage sludge use and disposal practices, and general characteristics of individual facilities (see discussion of the National Sewage Sludge Survey in Part III of this preamble). The Agency is also soliciting comments on several aspects of the procedures and assumptions in the RIA to improve the analysis and better assess the impact of the proposed regulations.

Description Of The Methodology

To evaluate the costs of compliance and benefits associated with the proposed regulations, the RIA first outlines the general characteristics of the wastewater treatment industry. This covers the types of treatment facilities, the number and size of facilities, the quantity of sewage sludge generated, the quality of sewage sludge, the amount of sludge used or disposed of by each method, and the costs of each use and disposal method. Estimates of the number, size, and types of treatment facilities are based on the "1986 Needs Survey". National estimates of the distribution of sewage sludge use and disposal methods among POTWs and the quantity of sludge disposed by each method were developed using original research and existing data (see the previous section of this part). For analytical purposes, each facility was assumed to use only one use or disposal method.

The Agency used data from the "40 City Study" for developing sludge contaminant levels. Three sludge profiles were developed to represent sludges from all publicly owned wastewater treatment facilities. The percent industrial influent of each POTW, as reported in the "Needs Survey", was used to assign one of the sludge quality profiles to each POTW. The three profiles represent three levels of pollutant contamination in sludges. First, a typical or expected level is set at the 50th percentile of the distribution of concentrations in the "40 City Study". Second, a more highly contaminated level is set at the 90th percentile. Third, a very highly contaminated level, representing a small number of facilities with very contaminated sludges, is set at the 98th percentile. Before finalizing the assignment of POTWs to a profile, adjustments were made to the percent industrial influent data to correct for inconsistently reported values in the "Needs Survey." Once the adjustment was made, the typical sludge profile was assigned to those POTWs having an industrial contribution of 17 percent or less (90 percent of the POTWs). POTWs with higher industrial contributions—i.e., greater than 17 percent but less than 55 percent (accounting for approximately 8 percent of the POTWs)—were assigned to the 90th-percentile category. Finally, those POTWs with an industrial contribution greater than 55 percent (2 percent of the POTWs) were assigned to the 98th-percentile category.

Baseline sewage sludge use and disposal costs were developed from several sources. The most extensive data base was developed by SCS Engineers and published in "Handbook for Estimating Sludge Disposal Costs at Municipal Wastewater Treatment Facilities" (EPA 430/9-81-004). Table XI-2 presents sludge use and disposal costs for representative facility size categories. These costs include annualized capital and operation/maintenance costs for each method and transportation of sludge to the use or disposal site, if applicable.

TABLE XI-2.—BASELINE DISPOSAL COSTS BY DISPOSAL PRACTICE

(Annual Disposal Costs Per Dry Metric Ton of Sludge)

POTW size (MGD)	Annual sludge generation per POTW (tons/yr)	Incineration	Distribution and marketing	Monofill	Dedicated land application	Crop application	Reclamation	Surface disposal [1]
		($/dry metric ton [2])						
0.1	22	[3] na	813	301	279	238	636	238
0.5	111	2,422	458	183	196	179	356	179
2	445	772	326	245	205	176	312	176
14	3,116	283	163	83	57	46	173	46
128	28,478	153	147	55	42	42	161	42

[1] Costs assumed to be similar to crop application.
[2] 1987 dollars.
[3] There are no POTWs using incineration in this size class.

The sludge quality profiles were used to determine compliance with the proposed regulations for each use and disposal method. Once a compliance strategy is assumed, the associated compliance costs are estimated. Estimated costs of compliance are compared to the baseline costs to determine the incremental cost of complying with the criteria. The sum of the incremental costs and the costs associated with management practices and sludge testing are the total costs for each use and disposal method.

Regulatory Impacts for Land Application

Land application is defined in Subpart B of the proposed regulations as the application of liquid, dewatered, dried, or composted sludge to either agricultural or non-agricultural land. A more detailed discussion of land application and the various end uses is presented in Part IX of this preamble and in the RIA.

The regulatory requirements pertaining to land application include pollutant-specific numerical criteria and management practices. These criteria and management practices differ for agricultural and non-agricultural applications. The criteria for agricultural land limit both the application rate (the maximum amount of sludge that can be applied at one time to a unit area of land) and the pollutant loading rate (the maximum amount of a pollutant that can be applied to a unit area of land either during a calendar year or cumulatively). For non-agricultural land, the regulation defines maximum sewage sludge pollutant concentrations. Management practices include various restrictions on access to and use of land. These restrictions vary depending on the level of pathogen reduction attained.

Compliance with the regulation was estimated by comparing the numerical criteria for both agricultural and non-agricultural land applications to the three sludge quality profiles. Non-agricultural land appliers that could not meet the maximum pollutant concentrations, as well as agricultural land appliers that could not meet either annual or cumulative application rates, were assumed to shift to another disposal method.

The results of the analysis for typical sludge quality indicate compliance with all of the criteria for agricultural land application. For the 90th- and 98th-percentile sludges to meet the criteria, sludge applications rates are considered too low to be practically feasible. Therefore, the POTWs that have been assigned to the 90th- and 98th-percentile sludge qualities are projected to be out of compliance with the agricultural land application criteria. The results of the analysis for non-agricultural criteria indicate that the maximum allowable concentrations can be met for the typical and 90th-percentile sludge quality. Only the 98th-percentile sludge fails to meet the non-agricultural land application criteria.

The 266 POTWs that cannot meet the agricultural land application criteria are assumed to shift to either non-agricultural land application (dedicated sites), MSWLFs, or composting in combination with non-agricultural land application. The 12 POTWs that fail to meet the maximum concentration limits for non-agricultural land are assumed to shift to MSWLFs or to add composting processes prior to dedicated land application. The total incremental cost associated with shifting agricultural ($7.0 million) and non-agricultural ($1.0 million) land applications to alternative practices is $8.0 million annually.

Pathogen and vector attraction reduction and access and use restrictions are not expected to result in any incremental costs for POTWs in this category. These management practices are thought to be currently required by existing State and Federal regulations. There is an estimated total annual cost of $500,000 associated with pathogen testing for all POTWs applying sludge to land. Because many POTWs perform vector attraction tests, the cost of such testing is assumed to be negligible. Sludge testing and record keeping and monitoring are required for all POTWs applying sludge to both agricultural and non-agricultural land. Those 25 POTWs shifting to co-disposal landfill would not incur costs of sludge testing and record keeping and monitoring. The total annual cost of sludge testing is approximately $4.4 million. Record keeping and monitoring are estimated to cost $2.2 million annually. Thus, the total estimated compliance costs associated with land application are $15.2 million annually.

The baseline risks associated with land application (i.e., the risks associated with current practice) are estimated to be 0.18 cancer cases and 42 cases of other health effects. The benefits of complying with the proposed regulation are expressed as reductions in the risk—the number of baseline cases that are avoided. For land application, the benefits are estimated to be 0.06 cancer cases avoided and 21 cases of other adverse health effects avoided.

Regulatory Impacts for Distribution and Marketing

The proposed regulation defines distribution and marketing as the use of sewage sludge or a product derived from sewage sludge (e.g., composted sewage sludge) primarily as a soil amendment or fertilizer. The sludge or product may be sold or given to users or distributed in containers, such as bags, or in bulk form. The end user and, therefore, the ultimate end use of the sewage sludge is usually not controlled (either directly or indirectly through a contract or similar mechanism) by the POTW. For purposes of the RIA, distribution and marketing has been distinguished from land application on the basis of whether or not the sludge has been composted. POTWs known to compost sewage sludge and the quantities of sewage known to be composted were used to approximate the number of POTWs and volumes of sludge involved in distribution and marketing.

A total of 106 POTWs currently practice distribution and marketing. These POTWs generate an estimated 705,500 metric tons of sewage sludge per year, roughly nine percent of the total sewage sludge generated in the United States annually.

The proposed regulation defines maximum pollutant concentrations in the distributed and marketed product as a function of application rates. The pollutant concentrations of the 106 POTWs, as represented by sludge quality profiles, were compared to the regulatory limitations to determine maximum rates of application. Since composted sludge is mixed with bulking agents before being distributed, the final concentration of pollution in composted sludge was calculated using a dilution factor. The application rate analysis indicates that a typical quality sludge, when applied at 10 dry metric tons per hectare, complies with the maximum allowable concentrations. For higher pollutant concentrations, the application rates would be too limiting. Thus, the 35 POTWs associated with the 90th- and 98th-percentile sludge are assumed to shift to alternative disposal methods.

An estimated 70 percent of these 35 POTWs (25 POTWs) are expected to shift to non-agricultural land application. These POTWs currently dispose of their sludge by using non-agricultural end uses, they either have some level of control or are expected to gain contractual control of the end use of their sludge. The remaining 30 percent of the 35 POTWs are assumed to shift to incineration. The total incremental cost for these 10 POTWs to shift their current method to incineration is $7.1 million. This includes $180,000 for continuous monitoring and recording and a one-time cost of $130,000 for performance testing and air dispersion modeling.

Management practices required by the proposed regulation include preparing labels and information sheets for the distributed sludge, testing sludge, and reducing pathogens. The level of pathogen reduction required by the regulation is assumed to be achieved when sewage sludge is properly composted. Thus, no incremental costs are expected for pathogen reduction in this case. The 71 POTWs that will continue distribution and marketing incur a total cost of about $23,000 for labels or sheets. All 106 POTWs in this distribution and marketing category will test their sewage sludge at a cost of $500,000 annually and will incur annual costs of $140,000 for record keeping and reporting annually. In sum, the total estimated compliance costs for distribution and marketing are $7.8 million for the first year and $7.7 million annually for subsequent years.

The baseline risks associated with distribution and marketing (i.e., the risks associated with current practice) are estimated to be 0.02 cancer cases and 95 cases of other health effects. The benefits of complying with the proposed regulation are expressed as reductions in the risk—the number of baseline cases that are avoided. For distribution and marketing, the benefits are estimated to be 0.02 cancer cases avoided and 56 cases of other adverse health effects avoided.

Regulatory Impacts For Monofills

As discussed in Part IX of the preamble, Subpart D of the proposed regulations apply to landfills that are used only for the disposal of municipal wastewater sludge (monofills). The methods of landfilling sewage sludge and the basis for regulatory requirements are discussed more fully in the RIA and in Part IX of this preamble. The following is a summary of the methodology used in the RIA to assess the impact of the regulation on facilities disposing of sewage sludge in monofills.

The Agency has identified 49 POTWs that use or maintain monofills. These POTWs account for approximately 100,000 metric tons of sewage sludge per year (about one percent of the total sewage sludge generated in the United States).

To determine the number of POTWs in compliance with the proposed criteria for monofills, each of the POTWs using monofills was assigned to one of the three sludge profiles based on the percent industrial contribution to each plant. The three sludge profiles were then compared to the maximum allowable sludge concentration specified in the proposed regulation for monofills overlying Class II ground waters. Although the proposed regulation specifies separate criteria for Class I, and Class II and Class III ground waters, the criteria for Class II were used for this analysis based on studies indicating a high probability that existing monofills overlie Class II ground waters. This comparison resulted in none of the 49 POTWs passing all of the pollutant limits for any sludge profile.

A POTW that does not meet the numerical criteria for one or more pollutants can request that EPA run a computer model to generate criteria based on the POTW's site characteristics. In the absence of the individual facility data required to demonstrate compliance by running a site-specific model, all plants failing to meet a regulation's numerical criteria were assumed to switch to a different method of sewage sludge disposal. The smallest facilities (0.1 to 0.5 million gallons per day (mgd) model facilities) are assumed to shift to MSWLFs. The larger facilities, because of their potentially significant impact on municipal landfill capacity problems, are assumed to shift to incineration.

The estimated total incremental cost for the 19 smaller-size facilities to shift from monofills to MSWLFs is approximately $170,000 annually. For the 30 POTWs currently monofilling that are in the larger size classes, the incremental cost to shift to onsite incineration is estimated to be $24.3 million annually.

Those POTWs shifting to MSWLFs will not be required to test their sludge quality continually. But, the 30 facilities shifting to incineration will be required to test for the pollutants specified in the proposed regulation as it pertains to incineration. The total cost associated with sludge testing for these facilities is approximately $22,000 per year. In addition, the POTWs shifting to incineration will have to perform continuous monitoring, record keeping, and reporting tasks at a cost of $600,000 annually. POTWs shifting to incineration will also incur a one-time cost of approximately $400,000 for performance testing and air dispersion modeling.

The total incremental compliance costs associated with sewage sludge monofills for the first year are $25.5 million annually. The annualized cost in subsequent years are estimated to be $25.1 million.

The baseline risks associated with monofills (i.e., the risks associated with current practice) are estimated to be 0.02 cancer cases and 26 cases of other health effects. The benefits of complying with the proposed regulation are expressed as reductions in the risk—the number of baseline cases that are avoided. For the monofill disposal practice, benefits are estimated to be 0.02 cancer cases avoided and 26 cases of other health effects avoided.

Regulatory Impacts for Surface Disposal Sites

A surface disposal site is defined in the proposed regulation as an area of land on which only sewage sludge is placed without vegetative or other cover and on which sewage sludge remains for a period of one year or longer. The Agency has identified 2,395 POTWs that use sewage sludge surface disposal sites for managing the disposal of their sludge. Most of these POTWs are in the smallest size categories (0.1 and 0.5 mgd) and generate approximately 197,000 metric tons of sewage sludge per year, less than three percent of the total generated in the United States.

The proposed regulation defines maximum allowable pollutant concentrations for surface disposal sites. To determine the number of POTWs in compliance with the proposed criteria, the three sludge quality profiles were compared to the pollutant concentration limits defined in the regulation. Based on this comparison, 25 POTWs with 98th-percentile sludge quality failed to meet the numerical limits for one or more pollutants. The 20 smallest facilities that cannot meet the criteria are assumed to shift to MSWLFs. The five largest facilities that do not meet the criteria are assumed to compost their sludge and land apply it to dedicated sites.

The total incremental cost for the smaller facilities to shift from sewage sludge surface disposal to MSWLFs is approximately $150,000 annually. The total incremental cost for the larger facilities to apply composted sludge to dedicated land is $1.2 million annually. Management practices required by the proposed regulations for surface disposal include sludge testing, record keeping and reporting, and pathogen and vector attraction reduction. Sludge testing required for all of the POTWs using surface disposal sites is estimated to cost $2.3 million annually. The annual cost of record keeping and reporting is estimated to be $1.7 million. These POTWs will also incur an annual cost of $0.2 million to meet the pathogen and vector attraction reduction requirements. Other management practice requirements include use and access restrictions, runoff controls, and limits for methane gas generated. The costs for complying with these requirements are expected to vary by site; some POTWs may already be subject to similar requirements imposed by local or State authorities. The Agency does not have sufficient information to estimate the costs for methane control and for runoff requirements and solicits comment on the compliance costs associated with all surface disposal site management practice requirements. For purposes of the proposed rulemaking, the Agency estimates the total incremental cost of compliance for surface disposal to be $5.5 milllion, annually. The Agency has not yet estimated human health benefits for this method of disposal.

Regulatory Impacts for Incineration

A detailed discussion of sewage sludge incineration and the regulatory requirements pertaining to incineration can be found in Part IX of this preamble. The following is a brief discussion of the methodology used in the RIA for developing the compliance costs and risk estimates for incineration.

The proposed regulation requires sewage sludge that is incinerated to meet pollutant limits for seven metals and for total hydrocarbons (THC). Compliance with the proposed criteria is demonstrated in the RIA using a two-step process. First, maximum concentration limits for the metals and for THC are calculated using the equations specified in the regulation. The maximum concentration limits for the metals are based on the sludge feed rate and incinerator control efficiencies. For THC, the limits are based on the gas flow rate and a dispersion factor. All of the equation parameters used to establish limitations, except for the sludge feed rates and the gas flow rates, are given in the regulation. If any of the pollutant concentrations in the sludge of a POTW are above the calculated maximum concentration values, the incinerator at that POTW is not in compliance. Compliance must be demonstrated through incinerator emissions testing and air dispersion modeling.

Parameters provided by incinerator performance tests and computerized air-dispersion modeling are used to calculate maximum allowable concentrations for metals. For THC, the air dispersion model is used to calculate the dispersion factor, which is used to re-calculate the equation given in the regulation. If compliance is not achieved through these two steps, POTWs are assumed to upgrade the incinerator's pollution control equipment. For purposes of the RIA, the pass/fail analysis uses the 10th-percentile metal control efficiency values specified in the regulation to determine how many facilities would have to test their facilities and conduct air dispersion modeling. Then, typical values were used as a proxy to determine the number of facilities that would be out of compliance with the numerical limit after performance testing and modeling.

EPA identified 169 POTWs that use 282 sewage sludge incinerators as a method of disposal. These POTWs generate slightly more than 20 percent (1.7 million dry metric tons per year) of the total municipal sewage sludge produced in the United States. For purposes of this analysis, 10 actual incineration facilities were selected as models to represent the variety of geographic, meteorological, and operating conditions relevant to all incineration facilities. Each of the 169 facilities is represented by the one facility in the group of ten it most closely resembles in terms of location, stack parameters, and capacity.

The Ocean Dumping Ban Act of 1988 prohibits the dumping of sewage sludge into ocean waters after December 1991. To account for the 400,000 dry metric tons of sewage sludge currently disposed of in ocean water, the 25 POTWs that currently use this method have been included in the incineration category. The volume of sludge generated by these POTWs will eventually be covered by today's proposed regulation. At present, incineration is the most likely disposal method. The 25 POTWs were assigned to one of the 10 models as were the other 169 POTWs currently incinerating their sewage sludge. It is assumed that 34 additional incinerator units will be required. Therefore, for the purposes of the RIA, the Agency assumes 194

POTWs generating 2.1 million metric dry metric tons of sewage sludge per year, using 316 sewage sludge incinerators.

Compliance costs were estimated using a two-stage process. First, an analysis was performed to determine the number of facilities currently in compliance with the proposed regulatory criteria. The three sludge quality profiles (previously discussed in the methodology section) formed the basis for comparison to the criteria. Second, compliance costs were aggregated for monitoring, record keeping, other management practice modifications, performance tests, and pollution control systems.

When the sludge feed rates from the 10 model facilities were used to calculate the maximum allowable pollutant concentration, all three of the sludge quality profiles exceeded the limits for several pollutants. All of the incinerator facilities are then assumed to incur the costs of emission testing and air dispersion modeling to demonstrate compliance. When maximum allowable concentrations are calculated using typical, rather than worst-case 10th-percentile, removal efficiencies and dispersion factors (to provide a better representation of site-specific conditions at the model plants), 122 POTWs (with 219 incinerators) are projected to fail to meet the numerical limits for metals. Of these, 28 POTWs (with 61 incinerators) are also projected to fail to meet hydrocarbon emissions requirements.

The cost of complying with the proposed regulation includes the costs of management practices required of all sewage sludge incinerator facilities, the costs of performance testing, and the costs of retrofit technologies if facilities do not comply after performance tests and air dispersion modeling. Management practices include sludge testing for regulated pollutants and continuous monitoring of several incinerator parameters. Performance testing costs include emissions testing and air dispersion modeling.

The total annual cost of sludge testing for all POTWs with incinerators is approximately $180,000. The total incremental costs of monitoring and recording (some facilities are believed to have monitoring devices in place to meet New Source Performance Standards requirements already) are estimated to be $4.1 million annually. These costs reflect annualized capital costs plus annual operating and maintenance expenses. Record keeping and reporting is estimated to cost $350,000 annually. Thus, the total annual costs for management practice requirements are $4.6 million.

The total costs associated with performance testing for 169 POTWs are $2.6 million. Theoretically, these costs are one-time expenditures by all POTWs that want to show compliance through performance tests and air dispersion modeling and avoid the cost of retrofit pollution control devices.

A total of 219 incinerator units are projected to incur the cost of upgrading their air pollution controls. Aggregate costs were estimated for the following three retrofit technology options to control metals emissions; (1) Wet electrostatic precipitators (ESPs); (2) fabric filters; and (3) dry scrubbers with fabric filters. Removal efficiency data for these technologies are very limited. The Agency has obtained and evaluated several studies of these technologies as applied to municipal solid waste combusters, but has no comparable studies of sewage sludge incinerators. Still, EPA believes that improved incinerator performance is achievable with the addition of these air pollution control devices. In the absence of better information, however, the Agency is unable to differentiate among the three retrofit technologies for purposes of assigning an improved removal efficiency. In order to estimate costs for this rulemaking, installation of wet ESPs was assumed to be appropriate for all incinerators that fail to meet the criteria for metals.

Total annual incremental costs for the retrofit technologies include annualized capital costs, installation and engineering expenses, and yearly operation and maintenance costs. The total costs assuming all POTWs choose the wet ESP option are $24.0 million annually. The costs associated with the addition of fabric filters are $21.5 million annually. The most expensive option is the dry scrubber/fabric filter option, which is estimated to cost $186.2 million annually. The 28 POTWs (with 61 incinerators) that are also estimated to fail to meet hydrocarbon emission limits are assumed to require afterburners to effect removal of hydrocarbons. The total annual cost of after-burners with heat exchangers (energy recovery system) for these POTWs is estimated to be $72.6 million.

The aggregate compliance costs associated with incineration for the first year, including management practice costs, performance testing costs, and costs of all of the wet ESP retrofit technology, are $103.8 million. The performance testing is a one-time cost. The annualized costs in subsequent years are estimated at $101.2 million.

The baseline risks associated with incineration (i.e., the risks associated with current practice) are estimated to be 12.0 cancer cases and 5,976 cases of other health effects. The benefits of complying with the proposed regulation are expressed as reductions in the risk—the number of baseline cases that are avoided. For incineration, the benefits are estimated to be 9.4 cancer cases avoided and 5,163 cases of other adverse health effects avoided, for a total of 5,172.4 disease cases avoided.

Pretreatment

One section of the RIA is a separate analysis of the potential for application of industrial pretreatment as a compliance option for the proposed sewage sludge regulations. The assumption here is that stricter enforcement and requirements for pretreatment (beyond the categorical standards for indirect dischargers) would reduce the amount of pollutants entering the POTW and, consequently, would reduce the amount of pollutants in the sludge. In the RIA, the pretreatment case studies are used to determine whether compliance with the proposed regulation could be achieved through tighter pretreatment controls on categorical dischargers rather than shifts to alternative disposal methods.

To date, EPA has analyzed eight POTWs to determine the effect of stricter pretreatment measures on a POTW's ability to comply with the sludge disposal criteria. The eight POTWs were selected on the basis of data availability, while also trying to cover a variety of geographic regions, sludge disposal practices, and mix of contributing industries. Of the eight case studies, two POTWs use incineration, one uses a monofill, one uses a MSWLF, three use land application, and one uses ocean disposal for sludge disposal. The case study POTWs range in size from 2 to 300 mgd and the percent of industrial influent ranges from 4 to 52 percent. Fourteen industry segments and eight pollutants were included in each case study.

The case studies consider the effect of categorical pretreatment standards and, when applicable, more stringent technologies. At each POTW, the annual loading rates of several pollutants were estimated for each industrial contributor. Then, the reduction in pollutant loadings was estimated for the additional control provided by pretreatment. The major sources of information for pretreatment technologies and their pollutant reductions were the technical support documents for the effluent guidelines covering each industry. Pollutant reductions as a result of stricter pretreatment will vary for each POTW depending on the types and sizes of the industrial contributors.

The results of the case studies show that only one of the eight facilities can achieve compliance for all pollutants if additional pretreatment by categorical industries is achieved. This POTW uses land application to dispose of its sewage sludge. For the POTWs that incinerate and monofill their sewage sludge, the criteria in the proposed regulations are stringent enough that even substantial reductions in certain pollutant levels were insufficient to attain compliance. The general conclusion of this analysis is that significant reductions in pollutants can be achieved by strict pretreatment, but that compliance with the sludge disposal criteria may not necessarily be attained through pretreatment actions alone.

The case study analysis and its conclusions are limited by the site-specific nature of the analysis, making it difficult to extrapolate results to all POTWs. The results are dependent on the type and size of the dischargers. The analysis is also limited in that the only improvements in sludge quality were among the categorical dischargers. Further, the pollutant removals were limited to those contaminants for which categorical pretreatment standards have been established.

This study of pretreatment also raises another question that may affect the Agency's policy on sewage sludge disposal. The issue is whether industrial pretreatment will merely shift pollutant problems from the sludge at the POTWs to the sludge at industrial facilities. The Agency plans to study this question before promulgating the final technical regulations and invites comment on the issue.

Reduction In Risk

In addition to the costs associated with the proposed regulations, the RIA also discusses the benefits that can be attributed to control of sewage use and disposal. The presentation in the RIA is limited to a summary description of the methodology used to calculate benefits and a summary of the results. A detailed description of the methodological approach and findings are presented in a companion document entitled "Aggregate Risk Assessment of Municipal Sewage Sludge".

The risk assessment used in the analysis follows the process outlined by the National Academy of Sciences. The assessment begins with a hazard identification and a source assessment and continues with fate and transport estimates, exposure assessments, pharmokinetics analysis, and dose response assessments. These components are used to develop the changes in health, measured as morbidity and mortality.

The first step in identifying the benefits from the proposed sewage sludge regulation involves estimating the baseline human health risks of sludge use or disposal. These health risks are presented as cases of cancer and other health effects, such as lead-related diseases. The key inputs for estimating baseline risks include source (POTW) information, sludge contaminants, and ultimate disposal site characteristics. Baseline risks from the sludge disposal practices are characterized based on the sludge quality profiles presented earlier, the quantity of sludge generated by each POTW, and the fate and transport of the pollutants subsequent to disposal, depending on a number of different environments that vary with each disposal practice.

On the basis of the above inputs, the analysis estimates the potential pathways of human exposure and models the fate and transport of the key sludge constituents for these primary pathways. The study then estimates the potential population exposed. This information, along with dose-response data for each of the sludge contaminants of concern, is used to characterize baseline human health risks.

Once baseline risks are derived, risk estimates are recalculated based on the level of control imposed by the proposed regulation. The regulatory compliance strategies for the health risk assessment parallel those used to estimate the compliance cost. The same risk assessment process is used to derive the change in the baseline risk as a result of each control option by use or disposal method. This change in the baseline is the measure of benefit. The estimates of the benefits are presented in the analysis for each use of disposal method and are expressed as the number of disease cases avoided. These disease cases include cancer cases avoided, but the results of the analysis also specify non-cancer human health effects that are avoided as a result of the proposed regulation.

Based on the analysis, the Agency estimates the benefits for this proposed rule to be a reduction of 9.5 cancer cases and 5,266 cases of other health effects. The quantitative benefits for each disposal practice are presented earlier in this part of the preamble and in Table XI-1.

There are a number of limitations that affect the estimates of risk reduction, including the exclusion of certain exposure pathways, contaminants, and health effects. The analysis is also limited by the reliability of sludge quality data, the uncertainty of the distribution of disposal practices by POTWs, and the lack of ability to account for population growth and mobility.

Environmental Effects

The proposed regulation is expected to result in certain environmental benefits, in addition to the benefits associated with reducing the incidence of adverse human health effects. These environmental benefits are an outgrowth of the general reduction in the amount and toxicity of sludge that is used or disposed of by ways damaging to the environment, particularly that which is placed in environmentally sensitive areas. These environmental benefits consist mainly of improved habitats for wildlife and other species in the areas where methods of disposal and use practices occur.

For example, the regulations affecting land application of sewage sludge are likely to result in some level of improvement in the quality of water bodies in the watershed for these areas. The management practices specified in the regulation provide for set-backs from water bodies. This will tend to decrease runoff of pollutants, thereby improving water quality in the area's streams, rivers, or lakes. Similarly, monofills and surface disposal sites are prohibited from wetland areas. Together, these improvements, while they may be small, will nevertheless benefit the aquatic species present and other species in the food-chain that are dependent on the water bodies and wetlands for food (e.g., waterfowl). To some extent, sport fishermen and hunters are likely to gain some benefit due to the improved habitats for fish and wildlife.

Changes in incineration practices are also likely to provide some marginal environmental gain for wildlife. In addition, emissions reductions in the vicinities of the incinerators may reduce particulate and other chemical deposition on buildings, automobiles, and structures, providing for a reduction in the extent to which these items are damaged by air pollution. Commerical farms and home gardens located in areas affected by deposition from sludge incinerators may experience some increase in crop vitality due to lower levels of pollutants that are discharged.

Small Entity Analysis

In addition to the analytical requirements imposed by the statute and by Executive Order 12291, the Regulatory Flexibility Act requires all

Federal agencies to analyze the impact of a proposed regulation on small businesses, small governmental jurisdictions, and small organizations. The purpose of this analysis is to determine whether the proposed regulation will have a significant impact on a substantial number of small entities. For purposes of the proposed sludge regulation, the Agency defines small entity as a small POTW. The size distinction is based on daily influent flow, which is a frequently used parameter for describing the size of a POTW. There is also a direct relationship between the amount of flow and the quantity of sludge generated.

Throughout the RIA, costs have been estimated for five size classes of POTWs represented by 0.1 mgd, 0.5 mgd, 2 mgd, 14 mgd, and 128 mgd. For the purpose of evaluating the impact of the sludge regulation on small entities, a POTW in the 0.1- or 0.5-mgd size class is defined as a small entity. The Agency solicits comment on this definition. Eighty-one percent (4,337 POTWs) of the POTWs covered by the proposed regulations are in these two size classes. The majority (98 percent) of these small entities practice land application or use surface disposal sites.

The small POTWs will not incur significant costs if their sludge is considered to be of typical quality, which is the Agency's projection for approximately 90 percent of all POTWs. In addition, the Agency has limited the compliance burden for small entities in the area of sludge testing. The proposed regulations are tiered such that smaller POTWs are subject to less frequent monitoring and reporting requirements. Small entities make up 81 percent of all POTWs subject to the regulation, but only incur six percent of the total compliance costs for the proposed regulations. The total annual compliance costs per POTW averaged over all disposal practices are about $1,600 per year for POTWs in the 0.1-mgd size class and about $3,000 per year for those in the 0.5-mgd size class.

Request for Comments

The Agency has initiated an information collection effort through the National Sewage Sludge Survey. The survey collects data that will be used to develop the final numerical limits by testing the assumptions on which those limits are based and to better estimate the effects of this regulation on the methods of sewage sludge use and disposal. Approximately 470 POTWs are expected to participate by completing a questionnarie. In addition, any other treatment works interested in answering the survey should call or write for a copy of the questionnaire, as directed in the "For Further Information, Contact" section at the beginning of this preamble.

As discussed earlier, the RIA was limited by data constraints in several areas. Therefore, the cost and benefit results are partly based on a number of assumptions about sewage sludge use and disposal. In an effort to increase the accuracy of the Agency's projections and improve the analysis, EPA is soliciting comments on the following issues concerning the RIA. (These issues are described in detail in the appropriate segment of the RIA.)

Number of POTWs and Volumes of Sludge

As part of the National Sewage Sludge Survey, the Agency is collecting information on the number of POTWs, the volume of sludge currently generated, and the amount going to each method of use or disposal. As part of this request for comment, however, the Agency further solicits information on these estimates.

Multiple Practices

The RIA simplifies current estimates by assigning a single use or disposal method to each facility, although the Agency is aware that some POTWs use multiple methods of use or disposal. The Agency requests comment on the extent to which multiple methods are being used and the extent of error that might be associated with the RIA's simplification.

Small Entity Analysis

The RIA includes a small entity analysis. The Agency solicits comment on the definition of small entity, both in terms of using the flow size of a POTW as the means to define small and also on the levels selected to define small POTWs for regulatory purposes.

Baseline Costs

All of the compliance cost estimates are based on baseline costs for each of the methods of use or disposal. The major source of these baseline costs was an engineering study published by the Agency in 1981. The Agency solicits comment on the accuracy of these baseline costs and requests updates on any of the cost values that have changed.

Privately Owned Treatment Works

The RIA is limited to the impact that may be incurred by POTWs, but the regulation applies to all treatment works. The Agency requests comment on the number, location, size, and sludge use or disposal methods at privately owned treatment works.

Pretreatment

The Agency believes that industrial pretreatment will be a means of compliance for many municipalities, but lacks sufficient information to make a quantitative assessment of the number of POTWs that will use local limits, either alone or with other compliance strategies, to comply with these regulations. Comment is requested on all aspects of industrial pretreatment as it pertains to compliance with sewage sludge use and disposal limitations (e.g., the extent of industrial pretreatment as a means of compliance). The Agency also solicits suggestions or additional data to evaluate pretreatment as a means of compliance.

Sludge Quality Data

One of the more serious data limitations associated with the RIA is a lack of sludge quality data. As described above, the assumptions concerning the concentrations of pollutants currently found in sewage sludge are critical to many phases of the RIA's conclusions. One objective of the National Sewage Sludge Survey, in its analytical sampling component, is to collect sludge quality information. Even in light of this planned data collection effort, the Agency requests comments on other sources of sludge quality data to use for comparative purposes and for verification. The Agency is also requesting comment on how the sludge profiles are used to represent sludge quality at individual treatment plants because, even when the sampling effort is completed, some assignment of sampling results to actual facilities may be required to conduct the Regulatory Impact Analysis.

Site-Specific Factors and Compliance

Another limitation of the RIA is an inability to assess compliance when site-specific factors will be used to establish the regulatory limitations. For example, the regulatory limitations for monofills may be adjusted on the bases of depth to ground water. The RIA does not account for such adjustments. Similarly, actual operating parameters at an incinerator may affect the allowable pollutant concentrations. The RIA accounts for conditions at ten model facilities, but not for distinctions at individual locations. The Agency requests comments on the extent to which site-specific factors will affect compliance.

Cost for Monofills To Change Practices

For monofills, the compliance cost estimates are based on the assumption that facilities unable to comply with the concentration limits will shift their disposal of sludge to a MSWLF or to incineration, depending on the size of the facility. The Agency solicits comments on the reasonableness of these presumed shifts in practice. Are suitable landfill sites available? What tipping fees would the POTW face to dispose of sewage sludge in a MSWLF? Would existing sewage sludge incinerators within reasonable distances accept sludge from this facility? Would sludge now disposed on monofills likely to go to practices other than municipal landfills or incinerators?

Distribution and Marketing Factors

For distribution and marketing, the RIA used a limited amount of information from POTWs to determine the final end use of the sewage sludge product (e.g., application to home gardens, parks, highway medians). While the National Sewage Sludge Survey is designed to increase the accuracy of this final end use information, the Agency is requesting comment on the distribution and marketing of sludge products among the end uses presented in the RIA.

Also for distribution and marketing, the Agency is soliciting comment on the shifts that are assumed for POTWs that would not comply with the sludge application rates and pollutant concentrations. The RIA assumes various shifts, depending on the size of the POTW, the quality of the sludge, and the final end use. Comments are requested on the land availability assumptions, opportunity to control the final end use, and reasonableness of shifts to alternatives.

Land Application Cumulative Loading Notes

The cumulative loading rates for land application were considered to be "passed" if one application (i.e., 1 year) was possible. However, in the results presented in the RIA, the lowest passing rate actually used was 10 years, which was based on the calculations specified in the regulation and on the sludge quality profiles used throughout the RIA. The Agency solicits comment on the reaction of POTWs to cumulative loading rate limitations. How many years of application reflect common land application practices? Will a cumulative loading rate be interpreted differently than an annual loading rate?

Incinerator Factors

For incineration, site-specific conditions could significantly affect the limitations for a particular facility (e.g., incinerator stack height and sludge feed rate). In the absence of more information, the RIA cannot project compliance for individual facilities. The Agency solicits comment on the various parameters that affect compliance (i.e., meeting more of the individual pollutant limitations, given the conditions at and around the facility).

The analysis of incineration relies on various air pollution control devices as the treatment technologies that facilities could use to comply with emissions limitations. Several retrofit technologies (e.g., wet ESPs, fabric filters) were used to estimate compliance costs (e.g., effectiveness of retrofit technologies in reducing the pollutant emissions). The Agency solicits removal efficiency data for the technologies used in the RIA and for other air pollution control devices. EPA also requests comments on the cost estimates used in the RIA for installing and operating these treatment systems.

Surface Disposal Site Management Practices

For surface disposal sites, the Agency solicits comment on management practices that facilities use to control access, prevent runoff, reduce pathogens, and control the generation of methane gas. EPA has found that the use of surface disposal sites is not well-documented. The Agency requests information on the number of facilities using surface disposal sites (as defined in this proposed rule), the volume of sludge disposed of, and expected compliance strategies if the pollutant concentration limits are not met.

Paperwork Reduction Act

The public reporting burden for the collection of information imposed by this proposal, averaged over a 3-year period, is estimated to be 336 hours for POTWs land-applying sewage sludge, 981 hours for POTWs distributing and marketing sewage sludge, 152 hours for POTWs disposing of sewage sludge on surface disposal sites, and 4,751 hours for POTWs incinerating sewage sludge. The average time per response per POTW is estimated to be 408.9 hours. The information collection requirements have been submitted for approval to OMB under the Paperwork Reduction Act, 44 U.S.C. 3501 *et seq.* An Information Collection Request document has been prepared by EPA (ICR No. 1489) and a copy may be obtained from Eric Strassler, Information Policy Branch; EPA; 401 M Street, SW. (PM-223); Washington, DC 20460 or by calling (202) 382-2709. Submit comments on these requirements to EPA and: Office of Information and Regulatory Affairs; OMB; 726 Jackson Place, NW; Washington, DC 20503 marked "*Attention: Desk Office for EPA*". The final rule will respond to any OMB or public comments on the information collection requirements.

PART XII: SUMMARY OF ISSUES AND DATA REQUESTED

In the foregoing preamble discussion, EPA solicited public comment on a broad range of issues and requested specific data and information. The Agency believes that it has provided sufficient information in the preamble and in technical support documents to support today's proposal. Public comments and data and information submitted to the Agency will be thoroughly evaluated to refine the proposal. In addition during the comment period, EPA will solicit the assistance of experts both inside and outside the Agency in the review of the scientific and technical bases of the rule. If new information alters the premises of today's proposal, the Agency will publish the new information along with a revised proposal in the **Federal Register**.

The broad issues, data and information discussed in the preamble are summarized below and are organized into the following categories: principles used in developing today's proposal, coverage of the rule, methodologies, level of protection, establishment of the standards, related requirements, and impacts.

Principles Used in Developing Today's Proposal

The fundamental principles underlying today's proposal follow.

Expand the Standards Later

While not delaying the proposal to wait for more current information, the Agency is conducting a National Sewage Sludge Survey, as well as gathering other data to assist in revising and expanding the scope of today's proposal.

Coordinate With Other Programs

Use the regulatory standards and tools developed for other Agency programs, where appropriate, in developing standards for a use or disposal method.

Control Sludge Quality

Set numerical limits on a pollutant-by-pollutant basis to prevent the contamination of sewage sludge before it is used or disposed of and to create incentives for treatment works to generate clean sludge.

Emphasize Waste Reduction and the Beneficial Reuse of Sewage Sludge

By reducing the generation of sewage sludge (e.g., by home composting of food scraps rather than putting them down a garbage disposal) and by creating incentives for the generation of clean sludge, treatment works have more options to manage their sewage sludge beneficially.

Preserve a Local Community's Choice of a Use or Disposal Method

Although the Agency's preference is for local communities to reuse sludge for its nutrient and soil conditioning properties of sewage sludge, the Clean Water Act (CWA) reserves the choice of a use or disposal method to local communities. However, the protection of public health and the environment, where risks are significant, still dictates stringent pollutant limits. Therefore, some communities may not be able to continue with their current method of disposal, if, for example, a monofill is located over Class I ground water.

Base the Rule on Minimizing Risks to Individuals

In cases where exposure to pollutants is likely to be high or where there are significant scientific uncertainties, pollutant limits are derived using exposure assessment models designed to protect the most exposed individual, plant, or animal (MEI). If a use or disposal method poses insignificant risk of pollutant exposure to individuals through food, water, or air, base the numerical limits on "current sludge quality."

Propose Reasonable Standards

To protect human health and the environment from reasonably anticipated adverse effects of each pollutant, design an approach that accounts for data inadequacies, but does not necessarily protect against every conceivable combination of adverse case conditions.

Propose an Implementable Rule

Balance the flexibility associated with site-specific analyses against the simplicity of national pollutant limits.

Solicit Comment on a Wide Range of Issues

In addition to explaining the proposal, the preamble should discuss alternative approaches that have been used by other Agency programs regulating pollutants in the various media and that were considered in developing the rule.

EPA is soliciting comment on these principles which it used in developing today's proposal.

Coverage of the Rule

The CWA recognizes that the development of standards for the use and disposal of sewage sludge is an iterative process. In section 405(d)(2)(C), the Administrator is directed to review the regulations from time-to-time, but no less frequently than every two years, to identify additional pollutants and to promulgate regulations for those pollutants. After evaluating a total of 50 pollutants, EPA is proposing specific numerical limits for 28 pollutants in one or more use or disposal methods. The National Sewage Sludge Survey will identify additional pollutants for the Agency to evaluate. However, are there pollutants that are not included in today's proposal which commenters believe should be evaluated immediately?

EPA did not evaluate the initial list of 50 pollutants for each use or disposal method because the Agency's expert advisory group did not believe that certain pollutants would interfere with a particular method of use or disposal. However, without evaluating whether or not a pollutant interferes with a particular disposal method, EPA could not authorize a removal credit when sewage sludge is disposed of by that method. In future rulemakings, the Agency plans to evaluate the interference of a pollutant with each method of use or disposal. The Agency is soliciting comment on the need to re-run its models for all the pollutants in every use or disposal method if a human health criterion exists.

The proposal does not set standards for sewage sludge that is generated or treated by privately owned treatment facilities that treat domestic sewage along with the facilities' industrial wastewater. At this time, the Agency does not believe that it has sufficient information on the characteristics of industrial sludge to use the models that were developed for municipal sewage sludge. However, are there types of industrial sludge, such as food processing wastes with a high organic content, that are sufficiently similar to municipal sewage sludge for the Agency to establish standards with the models developed for municipal sewage sludge? The data needed to determine the appropriateness of the exposure assessment models for industrial sludge include the viscosity, density, moisture content, and organic carbon content of the sludge.

Generally, when sewage sludge is incincerated, the sewage sludge is fired in sewage sludge-only facilities. The Agency is examining the co-firing of sewage sludge with solid waste in connection with the development of new source performance standards for municipal waste combustors. Under section 405(d) of the CWA, should the Agency set separate standards for sewage sludge fired with solid waste, even though sewage sludge is unlikely to be a significant portion of the waste fed into a municipal waste combustor? On the other hand, should the Agency develop standards under both section 111 of the CAA and section 405(d) of the CWA? Standards were proposed under the joint authority of sections 4004 and 4010 of RCRA and section 405(d) of the CWA in the case of the disposal of sewage sludge in municipal solid waste landfills (MSWLFs).

The Agency is proposing standards for five disposal practices. Are there other methods of using or disposing of sewage sludge that the rule does not, but should cover?

Methodologies

Exposure Assessment Models

The Agency developed a series of mathematical expressions or algorithms to simulate the movement of a pollutant into and through the environment to an MEI. These models were designed to calculate the long-term exposure to an individual, plant, or animal. Were the most appropriate models used or are there other more appropriate models that the Agency should consider prior to promulgating pollutant limits? How should the models EPA used be revised? In a rule such as this, is it appropriate to evaluate only the long-term effects or should the models be modified to also consider short-term fluctuations in exposure?

The technical support documents for land application, landfilling, and incineration list the values used in the models. Do these values support a rule that is "adequate to protect public health and the environment from any reasonably anticipated adverse effect of each pollutant"? The Agency is soliciting additional data in refining today's proposal.

The Agency used the accepted approach of evaluating the effect of 70 years of continuous exposure to an individual who receives the maximum exposure except for a child ingesting soil. For a child ingesting soil, the assumption is that the ingestion will occur over a 5-year period from the ages one through six. Are the scenarios for the MEI reasonable? Do they reflect scenarios which could occur? For example, is it reasonable to assume that for the application of sewage sludge to agricultural land that the MEI resides on the land where the sewage sludge is applied? For distribution and marketing, the MEI scenario is a rural non-farm family growing 60 percent of their fruits and vegetables in a sludge-amended home garden. For monofills, the assumption is that the MEI drinks 2 liters of water from a well located at the property boundary of the monofill and inhales 20 cubic meters of air a day while standing in the center of the plume at the property boundary of the monofill. For the incineration scenario, the MEI is located in the peak concentration of the plume, inhaling 20 cubic meters of air a day.

In addition to the MEI, each of the exposure assessment models has key parameters that affect the limit that is calculated. EPA is interested in comments on key parameters which may not have, but should have been considered. The key parameters on which the Agency is particularly interested in receiving public comment follow.

Land Application for Agricultural Lands

The key parameters for the land application of sewage sludge on agricultural lands include the following:

- The land receiving the sewage sludge will be converted to residential home gardens within 5 years;
- The sludge is mixed with soil to a depth of 15 centimeters (6 inches);
- The background concentration of metals in the soil corresponds to the average soil concentration of rural agricultural land;
- Over time, metals are absorbed by plants at the same rate as they were when first applied to the soil;
- Eight percent of the food intake of a grazing animal consists of a sludge-soil mixture;
- The most highly sensitive plants and animals were used in the analysis; and
- The ingestion rate of 0.1 grams per day for 5 years was used in analyzing the effect of children eating soils (as compared to 0.5–5.0 grams for a child exhibiting PICA behavior).

Distribution and Marketing

The key parameters for the distribution and marketing of sewage sludge include the following:

- Neither the raising of animals for human consumption nor the growing of feed crops for animals raised for human consumption were considered for this home garden scenario;
- The background concentration of metals in the soil corresponds to the average soil concentration of rural agricultural land; and
- The sludge is mixed with soil to a depth of 15 centimeters (6 inches).

Monofills

The key parameters for the disposal of sewage sludge in monofills include the following:

- All metals go into solution and leach to the ground water;
- For Class I ground water, the point of compliance is the point at which the leachate reaches the ground water—the depth to ground water is assumed to be zero;
- For Class II and Class III ground water, the point of compliance is 150 meters (450 feet) from the point of entry—the depth to ground water is assumed to be one meter;
- The effect of synthetic liners was not considered in the analysis; and
- The rate at which pollutants volatilize into the atmosphere is not attenuated by the adsorption or degradation of pollutants.

Incineration

The key parameters of the incineration of sewage sludge include the following:

- The metal control efficiencies of incinerators were assumed to correspond to the 10 percent worst-control efficiencies of the sewage sludge incinerators in EPA's data base;
- All incinerator emissions include the same constituents; and
- Short-term fluctuations of operations were not examined.

Other Exposure Assessment Models

The Agency is developing exposure assessment models for sewage sludge placed on surface disposal sites and for the development of health-based pathogen and vector attraction reduction requirements.

In developing the model for surface disposal sites, the Agency is soliciting additional data on the location and size of surface disposal sites. The Agency is also soliciting data on the key differences in the sewage sludge disposed of in monofills, on dedicated non-agricultural land, and on surface disposal sites (e.g., the viscosity, density, solids content, and pollutant concentrations). In addition, the Agency is soliciting information on the management practices, if any, generally associated with surface disposal sites. Comments are requested on the proposed definition of "surface disposal sites." Does it make sense to differentiate surface disposal sites from dedicated land application and from monofills?

For pathogens, the Agency is soliciting data on the movement of pathogenic organisms from a sewage sludge matrix and the attenuation of the organisms by dilution, temperature, moisture, sunlight, pH, presence of antagonistic organisms, and soil structure. In addition, the Agency is requesting information on reliable measurement techniques for pathogenic organisms. Also, data are requested on the relationship between infectious dose and disease.

Methodology for Evaluating the Aggregate Effects of Current Use and Disposal Practices

EPA did not look at the effects of concurrent exposure to more than one source of sewage sludge-borne pollutants. The Agency is interested in evaluating models that would take into account multiple routes of exposure and is requesting that information on such models be submitted to EPA as part of the comments on today's proposal.

The Agency relied on data from "Fate of Priority Pollutants in Publicly Owned Treatment Works" (the "40 City Study", Reference number 36) as the primary source of information on the pollutant concentrations in municipal sewage sludge. Recognizing the deficiencies in the data base, the Agency has initiated a National Sewage Sludge Survey to provide current and reliable data that will improve our analyses of risks of using and disposing of sewage sludge and, consequently, of appropriate pollutant limits. Given the lack of data on the quality of sewage sludge that is used or disposed of by a particular method, was it reasonable for the Agency to assume that a facility's sewage sludge corresponded to the 50th-, 90th-, or 98th-percentile concentrations in the "40 City Study"? Was it reasonable to assign the 50th-, 90th-, and 98th-percentile sludges to facilitates based on the industrial component of wastewater flow?

Until the Agency develops exposure assessment models for pathogens and for sewage sludge disposal on surface disposal sites, quantitative assessments of the effects of sewage sludge use and disposal will be incomplete. However, the Agency does not believe that surface disposal sites measurably increase the incidence of adverse human health or environmental effects. The Agency is interested in evaluating any documented evidence that pathogenic diseases have been transmitted through the application of sewage sludge to the land or through the disposal of sewage sludge in monofills or on surface disposal sites.

The Agency is interested in approaches others may have used in evaluating human health and environmental effects of disposing of sewage sludge on surface disposal sites.

In evaluating the effects of current methods of sewage sludge use and disposal, the Agency used average or typical conditions. Was this an appropriate approach or should the Agency consider other approaches in determining the effects of sewage sludge-borne pollutants? Are the assumptions that the Agency made in identifying typical conditions reasonable? Was it reasonable to assume complete mixing of food crops in the national market place and that sewage sludge would be applied only once to farm land? Are the percentages of food consumed from home gardens reasonable? Is it reasonable to use the rate normal children ingest dirt rather than the rate associated with a PICA child? Did the Agency select the appropriate-sized POTWs and the appropriated hydrogeologic characteristics in modeling the 49 monofills? Was it appropriate for the Agency to allocate all 194 sewage sludge incinerator facilities to one of 10 modeled facilities? Is the 25th-percentile metal control efficiency reasonable to use in evaluating the effects of metal emissions from incinerators? Given the lack of data on total hydrocarbon emissions, did the Agency use an appropriate approach in allocating the results from four tests to the 194 sewage sludge incinerator facilities?

The Agency is interested in alternative approaches that it should consider in estimating the number of cancer cases, in estimating the number of individuals exposed to concentrations above a reference dose (RfD), and in estimating the effects from exposure to lead. In addition, the Agency is interested in approaches that may have been developed to evaluate ecological effects, including farm economic losses caused by plant or animal toxicity.

Level of Human Health and Environmental Protection

In setting numerical limits with the exposure assessment models, EPA generally is using existing Agency criteria, where they exist, to ascertain that the numerical limits do not exceed human health criteria. Where the Agency has not published human health criteria, the approach used in this proposal was to select the values in the Agency's computerized Integrated Risk Information System (IRIS). Are there more appropriate human health criteria that the Agency should have evaluated? Was it appropriate for the Agency to assume that, if a value was not listed in IRIS, there was no human health criterion for a pollutant and to defer consideration of the pollutant until IRIS listed a human health criterion? In developing a human health criterion for lead, when food grown on sludge-amended soils is ingested, did the Agency make the appropriate assumption on the allowable food intake? Do the assumptions the Agency used in developing an exposure scenario (e.g., MEI is an adult male, 2.5 percent of whose diet is from food grown on sludge-amended soils) provide an adequate margin of safety for any uncertainties in the data? Or are these assumptions so limiting that they preclude the beneficial reuse of sewage sludge and force sewage sludge to be incinerated?

The Agency selected risk specific doses corresponding to an incremental carcinogenic risk of $1x10^{-4}$ for the land application of sewage sludge to agricultural land, for the distribution and marketing of sewage sludge, and for the disposal of sewage sludge in monofills and a carcinogenic risk of $1x10^{-5}$ for the incineration of sewage sludge. The Agency selected a lower risk for the incineration of sewage sludge in order to compensate for postponing the examination of indirect pathways of exposure (i.e., deposition of emissions on plants and their subsequent ingestion), because of the number of people who may be exposed to high emission levels (51 million), and because of the high levels of maximum individual and aggregate risk posed by incineration. Do the projected benefits (i.e., increase in health cases avoided) merit a lower risk level? Given the assumptions used in establishing the doses, the assumptions used in the exposure assessment models, and the projected risks posed by each use and disposal method are the carcinogenic risk levels and the RfDs for non-carcinogenic pollutants adequate to protect public health "from any reasonable anticipated adverse effect from each pollutant." EPA, in particular, requests comments on its approach to establishing a cancer potency value for total hydrocarbons.

In selecting environmental criteria, the Agency used the most sensitive plant and animal toxicity values reported in the scientific literature. Are the plants and animals that the Agency used appropriate? By selecting the toxicity values for the most sensitive species, is the Agency setting more stringent pollutant limits than is necessary to adequately protect human health and the environment when sewage sludge is applied to agricultural lands? When field data were not available, was it appropriate for the Agency to base numerical limits on the phytotoxicity pathway using pot studies with sludge spiked with metal salts? Are there data on wild plant and animal species that the Agency should evaluate?

Establishment of the Standards

EPA is proposing standards that include numerical pollutant limits, management practices, and other requirements that define the level of management control that treatment works, users and disposers must exercise over their sewage sludge to preclude adverse human health and environmental effects. The standards are established separately for each method of use or disposal.

In establishing the numerical limits, the Agency is proposing two approaches. The Agency is proposing to use the exposure assessment models to calculate pollutant limits when sewage sludge is applied to agricultural lands, distributed and marketed, disposed of in monofills, and incinerated because these practices are likely to result in high levels of pollutant exposure to an MEI or because there are significant scientific uncertainties about the effect of the disposal practice. The other approach is to use "current sludge quality" (i.e., the 98th-percentile pollutant concentrations shown in the "40 City Study") for the application of sewage sludge to non-agricultural lands and for disposing of sewage sludge on surface disposal sites. The Agency is using the "current sludge quality" approach for the later two practices because of its belief that human dietary exposure is unlikely to result from these practices.

Are these the appropriate premises for establishing the pollutant limits? Are there other premises that the Agency should consider? Is the Agency correct in assuming the implausibility of human dietary exposure, either through food or water, when sewage sludge is applied to non-agricultural lands or disposed of on surface disposal sites? Has the Agency over-estimated the amount of pollutant exposure likely to occur from the other practices warranting use of the 98th-percentile pollutant concentrations for other methods of use or disposal. Will the numerical limits or the definition of a use or disposal practice inhibit the beneficial reuse of sewage sludge (e.g., prohibiting the raising of crops for human consumption on non-agricultural lands)?

Will the 98th-percentile pollutant concentrations adequately protect the environment? The Agency's analysis shows that if 50 metric tons of sewage sludge were placed on a hectare of non-agricultural land, toxicity values for plants (lettuce) would be exceeded for copper and zinc at the 98th-percentile pollutant concentrations and toxicity values for predators (ducks) eating soil biota (earthworms) would be exceeded for lead at the 98th-percentile pollutant concentration. Because these are the most sensitive species, is the Agency correct in assuming that any adverse environmental effect is unlikely to be significant?

In calculating the numerical limits with the exposure assessment models, the Agency is allowing the use of site-specific data to calculate case-by-case limits for sewage sludge that is disposed of in monofills and that is incinerated. These methods involve site-specific physical conditions that make a significant difference in the pollutant limits.

For land application, there are no physical parameters related to the site that make a significant difference in the pollutant limits. However, the models could be used to re-calculate numerical limits based on site-specific data. Should the Agency allow site-specific data to be used to calculate pollutant limits for factors other than those related to the physical characteristics of the site or when there is less than a significant difference in the resulting pollutant limit? Will national limits for sewage sludge applied to agricultural lands significantly inhibit the use of sewage sludge? Should the Agency consider the use of case-by-case limits for agricultural lands based on soil pH or type of crop grown and consider the testing of crops to ensure that crop residue levels will not exceed a limit that would cause the pollutant concentration to exceed the human health criterion?

The Agency believes that it would be impractical to establish case-by-case limits for sewage sludge distributed and marketed because of the infinite number of possible site-specific conditions. Is this a logical assumption?

The Agency is requiring the application of management practices for each disposal method to prevent gross abuse of the environment where it could not reasonably be anticipated that individuals would follow these management practices as part of the final use and disposal method. The Agency is also requiring controls to prevent the exposure of individuals and animals to pathogenic organisms when sewage sludge is applied to the land, distributed and marketed, and disposed of in monofills and on surface disposal sites. For the most part, the Agency has assumed that good practices will be carried out by the user and disposer. Should the Agency specify additional practices or allow States and localities to specify additional practices?

A summary of comments on issues, data, and information that the Agency is requesting related to the definition of sewage sludge, to specific use or disposal methods, to the pathogen and vector attraction reduction requirements, and to the proposed pollutant limits follows.

Sewage Sludge

Septage and sewage sludge products are included in the definition of sewage sludge. By including septage in the definition of sewage sludge, the Agency does not wish to infer that it intends to regulate the location and operation of septic tanks. Therefore, septic tanks are specifically excluded from the definition of a treatment work. The Agency is regulating the use or disposal of the pumpings from septic tanks because of its concern with the levels of pathogenic organisms that may be in septage. However, are there other regulatory approaches that should be considered for septage that would tailor requirements to the Agency's specific concerns (e.g., pathogenic organisms) and would relieve sewage sludge haulers from monitoring for the 25 pollutants and calculating annual and cumulative pollutant loading rates? The Agency is uncertain about the extent and magnitude of any disruptions that today's approach may cause and is soliciting comment on the effect of defining septage as sewage sludge.

The Agency is also including sewage sludge products in the definition of sewage sludge. Sewage sludge products are mixtures of sewage sludge and other materials frequently added during composting. Today's proposal includes sewage sludge products within the definition of sewage sludge no matter how small the percentage of sewage sludge in the product. The Agency is soliciting comment on the possibility of sewage sludge products that contain so small a percentage of sewage sludge that they no longer have the characteristics of sewage sludge.

Land Application

EPA is proposing different approaches for calculating pollutant limits depending on the use of the land. If the land is used for agricultural commodities that are eventually consumed by humans, the Agency is proposing annual and cumulative pollutant loading rates calculated with the exposure assessment model. If the land is used for non-agricultural purposes, the "current sludge quality" (i.e., the 98th-percentile pollutant concentrations shown in the "40 City Study") is used as the basis of the pollutant limits unless the exposure assessment model calculated a higher pollutant limit. When the model calculated a higher pollutant limit, the higher limit is used. The Agency is also proposing to prohibit growing or taking food for human consumption on land used for non-agricultural purposes during the application of sewage sludge and for a 5-year period after the final application of the sewage sludge.

Several issues arise on which the Agency is seeking public comment. Is it logical to assume that food is generally not grown on forest lands, lands being reclaimed, and lands dedicated to sludge disposal? Will the prohibition of taking food (e.g., hunting or berry picking) significantly affect uses of non-agricultural lands such as forests? Is 5 years a reasonable period of time to preclude growing food or feed crops or grazing animals on non-agricultural land that has been amended with sewage sludge? Will the Agency's proposal inhibit the beneficial reuse of sewage sludge? If so, why?

In deciding how to meet the pathogen reduction and vector attraction reduction requirements, treatment works have more flexibility if they choose to apply sewage sludge to land rather than to distribute and market it. With the increased flexibility, the Agency is requiring an agreement, contract, or other instrument with the applier or distributor to ensure that the applier is aware of the requirements (e.g., the time periods for public access and use restrictions) and complies with the requirements. Are the provisions in the agreement appropriate? Do treatment works believe that they will have difficulty in negotiating such agreements with those applying or distributing the sewage sludge? Are there provisions which the Agency should add to the agreements? How should the Agency deal with situations in which an applier of sewage sludge receives sewage sludge from more than one treatment work?

The land application model calculates pollutant limits for 14 pathways. The limit that EPA is proposing is derived from the pathway which results in the most stringent limit. The "Land Application Technical Support Document" includes a matrix showing the limits for each pollutant in each pathway. Are there circumstances under which the limiting pathway is inappropriate for sewage sludge applied to agricultural lands?

Key assumptions in the model affecting the numerical limits were identified in the discussion on the exposure assessment models. The Agency is particularly interested in the values used in the exposure assessment models and whether the combination of assumptions used in the models and the requirements in today's proposal adequately protect human public health and the environment without over-regulating the beneficial use of sewage sludge.

The Agency proposed prohibiting the application of sewage sludge to frozen, snow-covered, or flooded land unless it is demonstrated that sewage sludge will not flow into nearby rivers, lakes, or streams. Are there circumstances when the application of sewage sludge to frozen, snow-covered, or flooded lands does not pose such a threat?

The models assume that certain practices such as incorporation into the soil to a depth of 15 centimeters or a soil pH of 6, are generally followed. Are these assumptions correct? While the Agency does not believe that it should mandate how landowers manage their land, are there other management practices directly tied to the protection of human health and the environment that the Agency has not specified, but should?

Do the pathogen reduction and vector attraction reduction requirements provide treatment works sufficient flexibility in meeting the goal of reducing the risk of transmitting pathogenic diseases from the use of sewage sludge? Are the time periods for restricting access to the land and grazing animals appropriate? Are the time periods for the growing and harvesting of crops sufficient to reduce the risk of transmitting pathogenic organisms into the food chain?

Distribution And Marketing

Is EPA's home garden scenario the appropriate assumption for the distribution and marketing of sewage sludge? The Agency is proposing that labels or information sheets accompany sewage sludge that is distributed and marketed. Is it also appropriate for the Agency to assume that use can be controlled with a product label? Are the provisions on the labels or sheets the appropriate provisions? Are there provisions that should be deleted? Are there provisions that should be added? Is it appropriate for the Agency to assume that users of the sewage sludge product will follow the type of label or sheet that the Agency is proposing?

Three key assumptions are used in calculating the pollutant limits. The first assumption is that sewage sludge is incorporated into the soil to a depth of 15 centimeters (6 inches). The Agency is uncertain that natural weathering processes will mix the sludge with the soil to that depth when the sewage sludge product is applied to a lawn. Are there studies on the depth to which natural processes mix sewage sludge into the soil profile? Should the Agency have the labels or sheets require users to incorporate the sewage sludge into the soil to a depth of 6 to 8 inches?

The second key assumption in the home garden scenario is that animals raised for human consumption, as well as the food and feed crops for such animals, are not exposed to sewage sludge. As a consequence of this assumption and the prohibition on the labels, the Agency eliminated pathways of exposure relating to animals raised for human consumption. Elimination of these animal pathways results in less stringent numerical limits for organic pollutants than those for agricultural lands. Was it logical for the Agency to assume that animals raised for human consumption were not a part of the home garden scenario?

Finally, the Agency assumed that 20 applications of sewage sludge would be applied to the land in calculating the pollutant limits for metals. Is this a logical assumption or is there documentation to show that greater or smaller number of applications are generally applied to home gardens?

Monofills

For the most part, EPA is using pollutant limits to protect human health and the environment from potential adverse impacts of the disposal of sewage sludge in monofills. However, the Agency has included restrictions on the location of monofills and on other practices to ensure human health and the environment are adequately protected. Are the requirements sufficient? Should the Agency include additional requirements, such as ground-water monitoring or corrective action, or eliminate some requirements as redundant or inconsistent with the primary approach of controlling what is disposed of in the monofill (i.e., pollution prevention as opposed to pollutant containment)?

The Agency has not analyzed the effect of synthetic liners in attenuating the migration of pollutants to the ground water. Neither has it factored in the use of synthetic liners in situations for which case-by-case limits are calculated. The soil characteristics of natural clay liners could be used in the site-specific analysis. How should the Agency analyze the attenuation factor of synthetic liners?

EPA is proposing that owners and operators of facilities develop a closure plan. Ther plan is to ensure that for 10 years a final cover is maintained, gas venting is monitored, and access restrictions are maintained. Since data show that sewage sludge decomposes within 4 to 5 years, does 10 years provide a sufficient margin of safety for owners and operators to restrict the use of the land for other purposes?

Owners and operators will be required to determine the class of ground water under their monofill. Are the definitions and guidance sufficiently clear to allow such determinations to be made? The class of ground water under the monofill has a major effect on the assumptions used to establish the pollutant concentrations.

Pollutant limits for monofills must be determined with site-specific data when the distance from the sewage sludge unit to the monofill boundary is less than 150 meters and where the background pollutant concentration in the ground water exceeds the maximum contaminant level (MCL). Under the latter case, pollutant concentrations would be established so that there is no further degradation of the ground water. Is this approach appropriate when, for monofills located over other classes of ground water, degradation is allowed as long as the pollutant concentrations in the ground water do not exceed the MCL? Should EPA establish pollutant limits such that there is no degradation of any ground water, whether or not that ground water is used for drinking water?

Pollutant limits may be determined using site-specific data if the parameters at the monofill differ from those on Table 6 in § 503.33. Are these the appropriate parameters? Will there be difficulties in measuring any of the parameters? Should other parameters, such as the use of synthetic liners, be included in case-by-case pollutant concentrations?

In today's proposal the Agency is seeking comment on whether it should use 5 micrograms per liter, the proposed MCL for lead which is measured at the water treatment facility, or 10 micrograms per liter, which is the threshold value for a treatment plan if a certain number of "morning first draw samples" exceed the value as the basis of the numerical concentration for lead in sludge disposed of in monofills. The Agency is soliciting comments on the appropriate value it should use.

The Agency is also proposing that sewage sludge placed in monofills meets the Class B pathogen reduction requirements. Are the pathogen reduction requirements appropriate?

Surface Disposal Sites

EPA is soliciting information on the size, location, and characteristics of surface disposal sites. The Agency has proposed that sewage sludge placed on surface disposal sites for more than a year come under the requirements of today's proposal. Is the Agency correct in assuming that sewage sludge placed on surface disposal sites for less than a year is more likely to be used in treating sewage sludge rather than in its disposal?

The Agency is proposing to use the 98th-percentile pollutant concentrations for sewage sludge disposed of on surface disposal sites because of its belief that surface disposal sites are small and that the pollutants in the sludge are unlikely to result in significant human health or environmental exposure. Are surface disposal sites usually small and are they generally located within the property boundary of the treatment work? As the Agency develops the exposure assessment model for surface disposal sites, it will be collecting information that should confirm or refute these premises.

Except for covers and a closure plan, the general requirements and management practices for surface disposal are similar to those for monofills and, in other cases, to dedicated, non-agricultural land application. Are the distinctions in these three methods of disposal appropriate? Should the three methods of disposal be consolidated? Or is there sufficient justification to maintain the distinction?

Pathogen Reduction and Vector Attraction Reduction Requirements

Until EPA establishes a relationship between infectious dose and disease and develops a model to simulate the movement and attenuation of pathogenic organisms in the environment, the Agency is proposing a combination of performance-based technology requirements and time periods during which access to the land and the growing and harvesting of certain crops is restricted. Are there other approaches that the Agency should consider?

The relative reductions in pathogenic organisms and the numbers of indicator organisms that the Agency is proposing are based on limited research and the Agency's experience with different types of treatment technologies. The Agency is requesting information that shows either that greater reductions are likely to occur or that the Agency's assessment of the reductions likely to occur was overoptimistic.

Incineration

A major issue on which the Agency is seeking public comment is the proposal to control the emission of organic pollutants through a limitation on the concentration of total hydrocarbons in the emissions. Should other organic pollutants have been used in deriving the risk specific air concentration for total hydrocarbon emissions? Does the flame ionization detector, in conjunction with the correction factors included in the equation, limit the level of organic emissions to an incremental carcinogenic risk level of 1×10^{-5}? Should the Agency establish a national cap for total hydrocarbon emissions or calculate, as proposed, a limit for each facility?

The Agency is soliciting data that correlates organic emissions, carbon monoxide levels, and total hydrocarbon emissions from multiple hearth, fluidized bed, and other types of incinerators which are similar to those firing sewage sludge. As an alternative to limiting hydrocarbon emissions, should the Agency consider using "good" performance standards, such as a 100-ppm limit, for carbon monoxide? Because data are lacking on good sewage sludge incinerator performance, should the Agency use the organic pollutant-by-organic pollutant health-based approach? Are there other approaches that the Agency should consider that would limit not only the organic pollutants that are fed into the incinerator, but also the organic pollutants that are formed by the combustion process?

In deriving the risk specific air concentrations for chromium and nickel, the Agency made the assumption that hexavalent chromium was one percent of the chromium emissions and that nickel subsulfide was 100 percent of the nickel emissions. Are there data to show that alternative percentages of hexavalent chromium and nickel subsulfide should have been used?

The Agency is requesting public comment on its proposal to use 25 percent of the NAAQS for lead as the basis for the lead limit. In light of the significant health effects from the emission of lead from sewage sludge incinerators, would 10 percent of the NAAQS have been a more appropriate basis?

Are the values that the EPA is proposing for temperature and oxygen content of the exit gas reasonable for sewage sludge incinerators? The Agency is soliciting data from tests that may support or question the proposed values. Should the Agency have specified requirements for incinerator ash and incinerator scrubber water? If so, how would these requirements differ from those already in place under other regulatory programs?

The Agency is soliciting comments on whether to deny owners or operators the opportunity to obtain credit for an increase in the height of their stacks, after the effective date of the rule, as a means of complying with the numerical limits in the rule. Raising the stack height increases the amount of dispersion, thereby reducing the concentration of the exposure that reaches the MEI. However, raising the stack does not reduce the mass emission of the pollutants. National cancer incidence, therefore, may not change significantly from increasing stack height rather than installing constant controls (e.g., wet electrostatic precipitators (ESPs) and after-burners).

Use Of The Numerical Limits

The pollutant limits included in today's proposal are based on extensive data and analysis. The proposal raises many precedential scientific, technical and policy issues. Therefore, depending on results of the National Sewage Sludge and comments on the proposed rule, the Agency may revise some of the limits. It would not be advisable for permit writers to use the proposed limits in permits in advance of the final issuance of the "Guidance For Writing Case-By-Case Permit Requirements for Municipal Sewage Sludge".

This Guidance Document was developed to assist permit writers in developing permits for sewage sludge prior to the technical standards in today's proposal. The Guidance document is based on existing Federal and State requirements. It is not inconsistent with today's proposal. Rather, today's proposal goes beyond the Guidance document. Revisions to the Guidance document will assist permit writers in giving the appropriate weight to the numerical limits in today's proposal. These revisions should be available by September 30, 1989.

Related Requirements

Monitoring, Record Keeping And Reporting

The Agency is proposing sewage sludge monitoring, record keeping, and reporting requirements with the Part 503 requirements. However, the Agency is also considering placing such requirements in the State program management requirements (40 CFR Part 501) and in the National Pollutant Discharge Elimination System permitting requirements (40 CFR Parts 222–224). Comments are solicited on this. In addition, the Agency is soliciting comments on the frequency with which it is proposing to have facilities test their sewage sludge, the sampling and analysis protocols that are to be used in testing and analyzing the sewage sludge, and the record keeping and reporting requirements that the Agency is proposing. The Agency recognizes that the proposed requirements are minimum requirements and that many States have much more frequent and extensive monitoring, record keeping, and reporting requirements. Should the Agency specify more frequent sewage sludge monitoring requirements? Should the Agency base the sewage sludge monitoring requirements on factors other than wastewater flow (e.g. percent industrial influent to the facility) or should the Agency establish a uniform frequency for the first year and then allow less frequent testing based on the variations seen in the facility's sludge quality?

The Agency is proposing different record retention requirements, depending on the use or disposal method. When sewage sludge is applied to agricultural land, the records must be kept for the life of the publicly owned treatment work (POTW) to ensure that the cumulative pollutant loading rates for metals are not exceeded. For the disposal of sewage sludge in monofills, records must be kept for 10 years, the proposed closure period. For all other use or disposal methods, the Agency is proposing that records be retained for 5 years, the period of time proposed for the State program management regulations. As an alternative, the Agency also considered record retention requirements of 3 years. Should the Agency have a single record retention requirements for all use or disposal methods? Do the distinctions among the use or disposal methods justify different record retention requirements.

Removal Credits

The Agency is proposing to allow eligible POTWs to revise pretreatment standards and issue removal credits for pollutants in three situations. First, removal credits would be available for the pollutants that are regulated under the use or disposal method employed by the POTW. Removal credits would also be available for the pollutants in sewage sludge disposed of in MSWLFs in compliance with 40 CFR Part 258. Finally, removal credits would be available for pollutants that the Agency evaluated without establishing numerical limits, if a POTW employs the disposal method for which the pollutant was evaluated, because EPA concluded that, even under the worst conditions, the pollutant did not interfere with the use or disposal method.

The list of organic pollutants on Table 11 in § 503.72 includes only those organic pollutants listed in IRIS. Some organic pollutants, such as vinyl chloride, are not presently listed in IRIS because their human health criteria are undergoing Agency review. IRIS changes periodically. How should the Agency revise and update Table 11? Adding pollutants to Table 11 will require recalculating a human health criterion for total hydrocarbons and adjusting the risk specific concentration.

The Agency is soliciting comment on the proposal to limit removal credits to pollutants regulated under a use or disposal method included in today's proposal when a POTW employs use or disposal methods other than disposal in MSWLFs. The Agency also solicits comments on its decision not to allow removal credits for pollutants when the concentration of those pollutants lead to the determination that the sewage sludge is hazardous, even though disposal of this sludge in conformance with 40 CFR Part 261–268 constitutes compliance with Section 405(d) of the CWA.

Impact

The Agency projected that the benefits of complying with this rule include the following: a reduction of 9.5 annual cancer cases (from 12.3 annual incremental cancer cases attributable to the use or disposal of sewage sludge); and a reduction of 5,266 incidences of individuals who experience adverse effects from lead (from 6,139). This projection is a net increase in benefits due to the fact that, in some instances (e.g., incineration), the anticipated compliance strategy poses greater risk. Furthermore, in projecting the reduction in cancer and lead cases, the Agency assumed that incinerators would install constant controls (e.g., after-burners and wet ESPs).

To come into compliance with the rule, the Agency projected that 5,300 POTWs will have annual incremental costs of approximately $157.7 million dollars. Some of these costs are pursuant to monitoring, reporting, and record keeping requirements. Other costs are due to the costs of putting on constant controls or using a different use or disposal method. It is anticipated that 509 POTWs will have to take positive actions to come into compliance with today's proposal. The projected cost figure does not account for site-specific modeling to bring some POTWs into compliance with the proposed numerical limits. Nor does it reflect that some POTWs may strengthen their pretreatment programs to improve the quality of their sewage sludge.

To improve the Agency's analyses, comments are requested on the following:

- Procedures for assigning a particular sludge quality to an individual facility;
- Relationship of industrial flow to the quality and amount of the sewage sludge generated;
- Procedures used to assign a use or disposal method to a particular facility;
- Baseline costs of the disposal practices;
- Baseline costs for testing, monitoring, and record keeping requirements;
- Assumptions in determining if a facility complies with the requirements, particularly the annual pollutant loading rates for agricultural land application;
- Assumptions concerning how facilities would comply with the requirements, particularly the assumptions made on the alternative practices that would be used;
- Assumptions used to determine the retrofit technologies owners and operators of sewage sludge incinerators would use to comply with today's proposal;
- Additional data needed to make assumptions on the feasibility of pretreatment by industrial dischargers;
- Assumptions used in projecting the benefits of the rule; and
- Definition of a small entity.

While the foregoing discussion lists the major issues, data and information of interest to the Agency, any provision of the rule is open for public comment. The Agency will carefully evaluate all public comments and will respond to the comments in the Notice modifying today's proposal and in promulgating the rule.

PART XIII. AVAILABILITY OF TECHNICAL INFORMATION ON THE PROPOSED RULE

Availability of Numerical Criteria Computational Programs

The following numerical criteria computational programs are available:

- Land Application/Distribution and Marketing—RAMS Model for terrestrial Pathways—PB 89–138739, Cost $55.00.
- Land Application/Distribution and Marketing—SLAPMAN Model for surface runoff—PB 89–138747, Cost $55.00.
- Landfill (Monofill)—Sludgeman Model—PB 89–138754, Cost $60.00.
- Incineration—Sludge Incineration Model—PB 89–138762, Cost $120.00.

Programs on IBM PC compatible disks may be ordered from: National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, ATTN: Sales, Telephone No. (703) 487–4650.

Please specify PB number when ordering.

Availability of the Proposed Rule and Preamble

The proposed rule and preamble may be obtained by contacting: Dr. Alan Rubin, Sewage Sludge Task Force (WH-585), United States Environmental Protection Agency, 401 M Street, SW., Washington, DC 20460, (202) 475-7301.

Availability of Technical Support Documents

The following technical support documents are available:

- Technical Support Document for Land Application and Distribution and Marketing of Sewage Sludge—PB 89-136576, Cost: $42.95 (A19, paper copy); $6.95 (A01, microfiche).
- Technical Support Document for Landfilling of Sewage Sludge—PB 89-136584, Cost: $15.95 (A05, paper copy); $6.95 (A01, microfiche).
- Technical Support Document for Incineration of Sewage Sludge—PB 89-136592, Cost: $49.95 (A22, paper copy); $6.95 (A01, microfiche).
- Technical Support Document for Surface Disposal of Sewage Sludge—PB 89-136600, Cost: $21.95 (A07, paper copy); $6.95 (A01, microfiche).
- Technical Support Document for Pathogen Reduction in Sewage Sludge—PB 89-136618, Cost: $13.95 (A03, paper copy); $6.95 (A01, microfiche).

These documents may be ordered from the National Technical Information Service.

Availability of Aggregate Impact Anaylsis Methodology

The following aggregate impact analysis methodology may be ordered from the National Technical Information Service:

- Human Health Risk Assessment for Municipal Sludge Disposal; Benefit of Alternative Regulatory Options—PB 89-136626, Cost: $42.95 (A18, paper copy).

Availability of the Regulatory Impact Analysis and Information Collection Request Documents

The following documents supporting this proposed regulation may be ordered from the National Technical Information Service:

- The Regulatory Impact Analysis—PB 89-136634, Cost: $42.95 (A20, paper copy); $6.95 (A01, microfiche).
- Information Collection Request Documents—PB 89-136642, Cost: $21.95 (A06, paper copy); $6.95 (A01, microfiche).

Availability of EPA's Science Advisory Board Review of Risk Assessment Methodologies

The following Science Advisory Board report may be ordered from the National Technical Information Service.

- The Review of the Risk Assessment Methodologies for Land Application/Distribution and Marketing, Landfilling, and Incineration of Sewage Sludge—PB 89-136659, Cost: $15.95 (A05, paper copy); $6.95 (A01, microfiche).

Access to IRIS

Those outside EPA can obtain an IRIS account by contacting: Mike McLaughlin, DIALCOM, Inc./Federal Systems Division, 600 Maryland Avenue, SW., Washington, DC 20024. Telephone: (202) 488-0550.

IRIS is also available through the Public Health Network (PHN) of the Public Health Foundation. Call Paul Johnson at (202) 898-5600 for more information. PHN is only available to local, State, and Federal public health officials.

IRIS is currently available on the NIH National Library of Medicine's TOXNET systems. Call (301) 496-6531 for details.

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PART XIV: CHANGES IN 40 CFR PART 257

As described in previous parts of the preamble, the proposed requirements in 40 CFR Part 503 establish standards to protect human health and the environment from any reasonably anticipated adverse effects of each regulated pollutant in sewage sludge. These standards provide specific pollutant concentrations, management practices, and other requirements for the final use or disposal of sewage sludge when the sewage sludge is applied to agricultural and non-agricultural land, distributed and marketed, disposed of in monofills or on surface disposal sites, or incinerated. The standards apply to publicly and privately owned treatment works that generate or treat domestic sewage sludge and to any person who uses or disposes of sewage sludge from such treatment works.

Existing requirements in 40 CFR Part 257 are applicable to all solid waste disposal facilities and practices regulated under sections 4004 and 4010 of the Resource Conservation and Recovery Act. With certain exceptions listed in § 257.1(c), the requirements in 40 CFR Part 257 apply to all types of facilities (i.e., landfills, surface disposal sites, land application units, and waste piles) used for disposal of solid waste, as well as all types of non-hazardous solid wastes (i.e., municipal, industrial, commercial, agricultural, mining, and oil and gas waste). Part 257 also applies to the disposal of sewage sludge from publicly and privately owned treatment works. However, because Part 257 covers only a limited number of pollutants and use and disposal practices and because EPA is proposing comprehensive regulations under 40 CFR Part 503, EPA proposes to amend 40 CFR Part 257 to exclude sewage sludge.

List of Subjects

40 CFR Part 257

Reporting and record keeping requirements, waste disposal.

40 CFR Part 503

Sewage sludge use and disposal, monitoring, reporting and record keeping requirements.

Dated: January 18, 1989.

Lee M. Thomas,
Administrator.

For reasons set out in the preamble, Title 40 of the Code of Federal Regulations is proposed to be amended as set forth below:

PART 257—CRITERIA FOR CLASSIFICATION OF SOLID WASTE DISPOSAL FACILITIES AND PRACTICES

1. The authority citation for Part 257 is revised to read as follows:

Authority: Section 1008(a)(3) and section 4004(a), Pub. L. 94-580, 90 Stat. 2803 and 2815 (42 U.S.C. 6907(a)(3) and 6944(a)).

2. Section 257.1 is amended by revising paragraphs (b), (c)(3) and (c)(4) to read as follows:

§ 257.1 Scope and purpose.

* * * * *

(b) These criteria do not apply to the use or disposal of sewage sludge under section 405(d) of the Clean Water Act, as amended.

(c) * * *

(3) The criteria do not apply to the land application of domestic sewage or treated domestic sewage.

(4) The criteria do not apply to the location and operation of septic tanks.

* * * * *

3. Section 257.2 is amended by revising the definition for "sludge" and "solid waste" to read as follows:

§ 257.2 Definitions.

* * * * *

"Sludge" means any solid, semi-solid, or liquid waste generated from a commercial or industrial wastewater treatment plant, water supply treatment plant, or air pollution control facility or any other such waste having similar characteristics and effect.

"Solid waste" means any garbage, refuse, sludge from a privately owned treatment plant operated in conjunction with commercial or industrial manufacturing or processing facilities, water supply treatment plant, or air pollution facility and other discarded material, included solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining and agricultural operations, and from community activities, but does not include solid or disssolved materials in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended, (86 Stat. 880), or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954, as amended (68 Stat. 923).

* * * * *

4. Section 257.3-4 is amended by revising paragraph (b)(1) introductory text to read as follows:

§ 257.3-4 Ground water.

* * * * *

(b)(1) For purposes of section 1008(a)(3) of the Act, a party charged with open dumping may demonstrate that compliance should be determined at an alternative boundary in lieu of the solid waste boundary. The court shall establish an alternative boundary only if it finds that such a change would not result in contamination of ground water which may be needed or used for human consumption. This finding shall be based on analysis and consideration of all of the following factors that are relevant:

* * * * *

§ 257.3-6 [Amended]

5. Section 257.3-6 is amended by removing paragraphs (b) and (c).

It is proposed to add Part 503 to proposed Subchapter O [1] to read as follows:

[1] 51 FR 4463, February 4, 1986.

SUBCHAPTER O—SEWAGE SLUDGE

PART 503—TECHNICAL STANDARDS FOR THE USE AND DISPOSAL OF SEWAGE SLUDGE

Authority: Sections 405 (d) and (e), Clean Water Act, as amended by Pub. L. 95–217, Sec. 54(d), 91 Stat. 1591 (33 U.S.C. 1345 (d) and (e)); and Pub. L. 100–4, Title IV, Sec. 406 (a), (b), 101 Stat. 71, 72.

Subpart A—General Provisions

§ 503.1 Purpose and applicability.

(a) *Purpose.* The purpose of this part is to establish standards for the use or disposal of sewage sludge that is generated during the treatment of domestic sewage in treatment works or that is treated in treatment works. This regulation contains numerical pollutant limitations, management practices, and other requirements for the use and disposal of sewage sludge which protects public health and the environment from any reasonably anticipated adverse effects of each regulated pollutant.

(b) *Applicability.* (1) This part establishes minimum requirements for the sewage sludge that is applied to agricultural and non-agricultural land, distributed and marketed, disposed of in monofills, disposed of on surface disposal sites, and incinerated.

(2) Any person who employs a method of final use or disposal identified in paragraph (b)(1) of this section must do so in accordance with this part.

(3) This part does not apply to processes used to treat municipal wastewater and domestic sewage or processes used to treat sewage sludge prior to the final use or disposal of the sewage sludge.

(4) The determination of the manner in which sewage sludge is finally used or disposed of is a matter for local communities. Any use or disposal method may be used as long as the use or disposal is carried out in accordance with the requirements of this part.

§ 503.2 Relationship to other requirements.

(a) Permits for the use and disposal of sewage sludge are addressed in 40 CFR Parts 122 through 124.

(b) Requirements for the approval of State sewage sludge management programs are included in 40 CFR Part 501.

§ 503.3 State authority.

Nothing in this part precludes States from imposing more stringent requirements for any sewage sludge use or disposal method covered by this part.

§ 503.4 Exclusions.

(a) *Industrial sludge.* (1) This part does not apply to any sludge that is generated or treated by industrial wastewater treatment works treating industrial waste or wastewater or treating domestic sewage along with industrial waste or wastewater.

(2) Standards for the use and disposal of non-hazardous industrial sludge are established in 40 CFR Parts 257 and 258.

(b) *Hazardous sewage sludge.* (1) This part does not apply to sewage sludge determined to be hazardous in accordance with Appendix II of 40 CFR Part 261.

(2) Standards for the disposal of sewage sludge determined to be hazardous are established in 40 CFR Parts 261 through 268.

(3) Use or disposal of hazardous sewage sludge in compliance with the requirements in 40 CFR Parts 261 through 268 will constitute compliance with the requirements of section 405 of the Clean Water Act.

(c) *Incinerator ash.* (1) This part does not apply to the ash generated during the incineration of sewage sludge.

(2) Standards for the use and disposal of ash generated during the incineration of sewage sludge are established in 40 CFR Part 257, Part 258, or Parts 261 through 268.

(d) *Disposal of sewage sludge in municipal landfills.* (1) This part does not apply to sewage sludge that is disposed of in a landfill with municipal solid waste. Standards for the disposal of sewage sludge in municipal solid waste landfills are established in 40 CFR Part 258.

(2) Treatment works disposing of their sewage sludge in municipal solid waste landfills must ensure that their sewage sludge meets the requirements of 40 CFR Part 258 and that the sewage sludge is sent to a State-permitted facility.

(3) Disposal of sewage sludge in compliance with 40 CFR Part 258 will constitute compliance with section 405 of the Clean Water Act.

(e) *Co-firing of sewage sludge.* This part does not apply to sewage sludge that is fired in an incinerator with other wastes.

(f) *Deepwell wet air oxidation systems.* The part does not apply to sewage sludge that is placed in deepwell wet air oxidation systems or to the location or operation of these systems.

(g) *Septic tanks.* This part does not apply to the location and operation of septic tanks, but does apply to septage that is pumped and collected for disposal.

(h) *Marine sanitation devices.* (1) This part does not apply to Type I or Type II marine sanitation devices, as defined in 33 CFR Part 159.

(2) This part does apply to the pumpings from Type III marine sanitation devices, as defined in 33 CFR Part 159, that are delivered to shore-side facilities for disposal.

§ 503.5 General definitions.

(a) CWA means the Clean Water Act (formerly referred to either as 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.

(b) Domestic sewage is waste and wastewater from humans or from household operations that are discharged to or otherwise enter treatment works.

(c) Ground water is water below the land surface in a zone of saturation.

(d) Industrial wastewater treatment works are privately owned treatment works that treat waste and wastewater generated by industrial, manufacturing, and commercial processing facilities.

(e) Municipality means a city, town, borough, county, parish, district, association, or other public body (including an intermunicipal Agency of two or more of the foregoing entities) created by or under State law; an Indian tribe or an authorized Indian tribal organization having jurisdiction over sewage sludge management; or a designated and approved management Agency under section 208 of the CWA, as amended. The definition includes a special district created under State law, such as a water district, sewer district, sanitary district, utility district, drainage district, or similar entity, and an integrated waste management facility as defined in section 201(e) of the CWA, as amended, that has as one of its principal responsibilities the treatment, transport, or disposal of sewage sludge.

(f) Person is an individual, association, partnership, corporation, municipality, State or Federal agency, or an agency or employee thereof.

(g) Pollutant means those organic or inorganic substances, or combinations of substances, including disease-causing agents, which after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism, either directly from the environment or indirectly by ingestion through the food-chain, will, on the basis of information available to the Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), or physical deformations in such organisms or their offspring.

(h) Pollutant limit is a numeric limit for a pollutant that describes the maximum amount of a pollutant allowed per unit amount of sewage sludge (e.g., milligrams of pollutant per kilogram of dry solids); the maximum amount of a pollutant that can be applied per unit area of land (e.g., kilograms per hectare); or the maximum amount of a pollutant per unit volume of air (e.g., micrograms per cubic meter).

(i) Publicly owned treatment works, or POTW, means any device or system used in the treatment (including recycling and reclamation) of domestic sewage or industrial waste of a liquid nature that is owned by a municipality or State entity.

(j) Septage is the liquid and solid material pumped from a septic tank, cesspool, or similar domestic sewage treatment system or a holding tank when the system is cleaned and maintained.

(k) Sewage sludge is any solid, semi-solid, or liquid residue removed during the treatment of municipal wastewater and domestic sewage or the treatment of domestic sewage. Sewage sludge includes, but is not limited to, solids removed during primary, secondary, or advanced wastewater treatment, scum, septage, portable toilet pumpings, Type III marine sanitation device pumpings, and sewage sludge products.

(l) State is one of the United States of America, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Trust Territory of the Pacific Islands, and the Commonwealth of the Northern Mariana Islands.

(m) Treatment works are publicly owned treatment works owned by a State, or municipal entity or federally or privately owned treatment works that treat domestic sewage. Treatment works do not include septic systems. Privately owned industrial waste treatment works that process industrial, manufacturing, or commercial waste and wastewater along with domestic sewage are not included in this definition.

Subpart B—Land Application of Sewage Sludge

§ 503.10 Applicability.

This subpart applies to the application of sewage sludge to either agricultural or non-agricultural land and to any person who uses, disposes of, or distributes sewage sludge by or for application to either agricultural or non-agricultural land. Sewage sludge which is distributed and marketed in compliance with Subpart C is not subject to this subpart.

§ 503.11 Specialized definitions.

(a) Agricultural land is land to which sewage sludge is applied, in order to use the nutrient and soil conditioning properties of sewage sludge, for crops which are intended for direct or indirect human consumption or for animal feed for animals intended for human consumption. This includes land used as pasture for the grazing of animals.

(b) Annual pollutant loading rate is the maximum amount of a pollutant that may be applied to a unit area of land during a 365-consecutive-day period.

(c) Annual whole sludge application rate is the maximum amount of sewage sludge that may be applied to a unit area of land during a 365-consecutive-day period.

(d) Applier is a person who receives sewage sludge from treatment works or distributors and who is responsible for the proper application of the sewage sludge.

(e) Base flood is a flood that has a one-percent or greater chance of recurring in any given year or a flood of a magnitude equalled or exceeded once in 100 years, on the average, over a significantly long period.

(f) Cumulative pollutant loading rate is the maximum amount of an inorganic pollutant that may be applied to a unit area of land.

(g) Dedicated land is land that is used for the disposal of sewage sludge. No attempt is made to use the nutrient and soil conditioning properties of the sewage sludge for a beneficial purpose on this land.

(h) Distributor is a person who receives sewage sludge from treatment works and delivers the sewage sludge to a user or another distributor.

(i) Feed crops are crops intended for consumption by animals.

(j) Floodplain is the lowland and relatively flat areas adjoining inland and coastal waters, including flood prone areas of offshore islands that are inundated by a base flood.

(k) Food crops are crops intended for human consumption.

(l) Forest land is land to which sewage sludge is applied in order to use the nutrient and soil conditioning properties of the sludge for the growth of the trees on the land.

(m) Land application is the application of liquid, de-watered, dried, or composted sewage sludge to the land. Sewage sludge may be sprayed or spread onto the surface of the land, injected below the surface of the soil, or incorporated into the soil.

(n) Non-agricultural land is land where sewage sludge is applied but where no food or feed crops are grown or animals are grazed. This includes, but is not limited to, forest land, reclaimed land, and dedicated land.

(o) Pasture land is land to which sewage sludge is applied in order to use the nutrient and soil conditioning properties of the sludge for the growing of crops, such as legumes, grasses, grain stubble, and stover, that are intended for animals grazing on the land.

(p) Reclaimed land is land that has been drastically disturbed (e.g., a strip mine) or that is marginally productive. As part of the reclamation process, sewage sludge is applied for its nutrient and soil conditioning properties to help re-vegetate and reclaim the land.

(q) Sewage sludge boundary is the outermost perimeter of an area of land to which sewage sludge is applied.

§503.12 Land application—general requirements.

(a) No person subject to this subpart shall use or dispose of sewage sludge by land application or distribute sewage sludge for use or disposal by land application except in accordance with this subpart.

(b) Treatment works shall enter into an agreement with the distributor or applier of sewage sludge that requires the distributor or applier to comply with the requirements in this subpart. Each distributor of sewage sludge shall enter into an agreement with the applier of sewage sludge to comply with the requirements in this subpart. All agreements must include the general provisions in paragraph (b)(1) and the provisions in paragraph (b)(2) or paragraph (b)(3) of this section.

(1) General provisions include the following:

(i) The name and address of persons receiving and applying the sewage sludge;

(ii) The location and legal description of the sites to which the sludge is to be applied;

(iii) The size of the sites (or portion thereof) to which the sludge is to be applied, in hectares or acres;

(iv) The nitrogen content of the sewage sludge;

(v) A prohibition on applying sewage sludge at rates in excess of the nitrogen requirements of the vegetation (food or feed crops, trees, grasses, etc.) and at rates that would cause the excess nitrogen in the sewage sludge to leach to the ground water;

(vi) The amount of sewage sludge to be applied to each site, in metric tons;

(vii) The class of pathogen reduction used in treating the sewage sludge and the applicable use and access restrictions set forth in 40 CFR 503.52 for that class of pathogen reduction;

(viii) The method used in complying with the vector attraction reduction requirements in 40 CFR 503.53;

(ix) The period of time after receipt within which the sewage sludge must be applied;

(x) The application method to be used (i.e., injection below the soil surface, spraying, surface application, etc.) and whether or not the sludge is to be incorporated into the soil;

(xi) The storage method to be used in case of inclement weather and the public health and environmentally protective practices to be used until the sludge is applied;

(xii) The provisions in § 503.12 (c), (d), and (e).

(2) Provisions for agricultural lands include the following:

(i) The concentrations of the pollutants in Table 1 and Table 2 of 40 CFR 503.13;

(ii) Specification of the amount of sewage sludge, in metric tons per hectare, that may be applied in a 365-consecutive-day period without exceeding the annual pollutant loading rates in Table 1 of 40 CFR 503.13 (see Appendix B of this part to determine the appropriate whole sludge application rate);

(iii) Specification of the number of years that sewage sludge may be applied to the land without exceeding the pollutant loading rates in Table 2 of 40 CFR 503.13 (see Appendix C of this part to determine the number of years that sewage sludge may be applied to the land); and

(iv) The management practices set forth at 40 CFR 503.14.

(3) Provisions for non-agricultural lands include the following:

(i) The concentrations of the pollutants in Table 3 of 40 CFR 503.15;

(ii) The management practices set forth at 40 CFR 503.16.

(c) Sewage sludge shall not be applied to the land if the application would cause or contribute to the harm of a threatened or endangered species of plant, fish, or wildlife or would result in the destruction or adverse modification of the critical habitat of a threatened or endangered species.

(d) Sewage sludge shall not be applied to the land if the application of the sewage sludge would restrict the flow of a base flood, would reduce the temporary water storage capacity of the floodplain, or would pose a hazard to human health, wildlife, or land or water resources because of sewage sludge in the runoff from the flood base.

(e) Sewage sludge shall not be applied to frozen, snow-covered, or flooded land unless it can be demonstrated that the application will not cause a discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the CWA.

(f) Owners or operators of treatment works or distributors of sewage sludge not from treatment works shall comply with the monitoring requirements in § 503.81 and the record keeping and report requirements in § 503.82.

§ 503.13 Agricultural land—national pollutant limits.

(a) Sewage sludge shall be applied to agricultural land at an annual whole sludge application rate that does not exceed the annual pollutant loading rates in Table 1. The procedure in Appendix B shall be used to determine the annual whole sludge application rate.

(b) Sewage sludge shall be applied to agricultural land in amounts that do not exceed the cumulative pollutant loading rates in Table 2. The procedure in Appendix C shall be used to determine the number of applications sewage sludge may be applied to the land.

TABLE 1.—ANNUAL POLLUTANT LOADING RATES

Pollutant	Annual pollutant loading rate [1] (kilograms per hectare)
Aldrin/dieldrin (total)	0.016
Benzo(a)pyrene	0.13
Chlordane	1.2
DDT/DDE/DDD (total) [2]	0.0055

TABLE 1.—ANNUAL POLLUTANT LOADING RATES—Continued

Pollutant	Annual pollutant loading rate [1] (kilograms per hectare)
Dimethyl nitrosamine	0.039
Heptachlor	0.073
Hexachlorobenzene	0.039
Hexachlorobutadiene	0.34
Lindane	4.6
Polychlorinated biphenyls	0.0056
Toxaphene	0.048
Trichloroethylene	0.013

[1] Maximum amount of a pollutant that can be applied per hectare of land per 365-consecutive-day period.
[2] DDT-2,2-Bis(chlorophenyl)-1,1,1-trichloroethane
DDE-1,1-Bis(chlorophenyl)-2,2-dichloroethane
DDD-1,1-Bis(chlorophenyl)-2,2-dichloroethane

TABLE 2.—CUMULATIVE POLLUTANT LOADING RATES

Pollutant	Cumulative pollutant loading rate [1] (kilograms per hectare)
Arsenic	14
Cadmium	18
Chromium	530
Copper	46
Lead	125
Mercury	15
Molybdenum	5
Nickel	78
Selenium	32
Zinc	170

[1] Maximum amount of an inorganic pollutant that can be applied to a hectare of land.

§ 503.14 Agricultural land—management practices.

The application of sewage sludge to agricultural land must meet the following requirements:

(a) Sewage sludge shall be applied to agricultural land at an annual whole sludge application rate that is 50 metric tons per hectare or less (on a dry weight basis).

(b) Sewage sludge shall only be applied to land in accordance with the crop and land access restrictions of § 503.52(b) (3) and (4) or in § 503.52(c) (3) and (4).

(c) Sewage sludge shall not be applied to the land at rates in excess of the nitrogen requirements of the crops (food or feed crops) and at rates that would cause the excess nitrogen in the sewage sludge to leach to the ground water.

(d) Sewage sludge shall not be applied to land that is 10 meters (30 feet) or less from a surface water.

§ 503.15 Non-agricultural land—national pollutant limits.

The concentration of the pollutants in sewage sludge applied to non-agricultural land shall not exceed the pollutant limits in Table 3.

TABLE 3.—NON-AGRICULTURAL LAND POLLUTANT LIMITS

Pollutant	Maximum Sewage sludge concentration [1] (milligrams per kilogram)
Aldrin/dieldrin	0.33
Arsenic	36
Benzo(a)pyrene	6.9
Cadmium	380
Chlordane	24
Chromium	3100
Copper	3300
DDT/DDE/DDD (total) [2]	0.11
Dimethyl nitrosamine	1.4
Heptachlor	1.5
Hexachlorobenzene	2.8
Hexachlorobutadiene	6.8
Lead	1600
Lindane	92
Mercury	30
Molybdenum	230
Nickel	990
Polychlorinated biphenyls	0.11
Selenium	64
Toxaphene	0.97
Trichloroethylene	180
Zinc	8600

[1] Dry weight basis.
[2] DDT—Bis 2,2-(chlorophenyl)-1,1,1-trichloroethane
DDE—Bis 1,1-(chlorophenyl)-2,2-dichloroethane
DDD—Bis 1,1-(chlorophenyl)-2,2-dichloroethane.

§ 503.16 Non-agricultural land—management practices.

The application of sewage sludge to non-agricultural lands must meet the following requirements:

(a) Food crops and feed crops shall not be grown or harvested during the period when sewage sludge is applied to that land or for a period of 5 years after the final application of the sewage sludge;

(b) Animals shall not be grazed during the period when sewage sludge is applied or for a period of five years after the final application of the sewage sludge;

(c) A vegetative cover shall be established on the land;

(d) When sewage sludge meeting the Class A pathogen reduction requirements specified in § 503.52(a) is applied, public access to the land shall be restricted for the period of time necessary to establish a vegetative cover on the land;

(e) Sewage sludge shall not be applied to the land at rates in excess of the nitrogen requirements of the vegetation (trees, grasses, etc.) and at rates that would cause the excess nitrogen in the sewage sludge to leach to the ground water; and

(f) Sewage sludge shall not be applied to land that is 10 meters (30 feet) or less from a surface water.

§ 503.17 Pathogen and vector attraction reduction requirements.

Sewage sludge applied to either agricultural or non-agricultural land shall comply with the requirements in § 503.52 (a), (b), or (c) and the requirements in § 503.53 (a), (b), (c), (d), (e), or (f).

Subpart C—Distribution and Marketing of Sewage Sludge

§ 503.20 Applicability.

This subpart applies to the distribution and marketing of sewage sludge, to any person who distributes and markets sewage sludge, and to any person who uses sewage sludge that is distributed and marketed. Sewage sludge which is applied to either agricultural or non-argicultural land in compliance with Subpart B is not subject to this subpart.

§ 503.21 Specialized definitions.

(a) Annual product application rate is the maximum amount of the product prepared by a distributor that may be applied to a unit area of land in a 365-consecutive-day period in compliance with the pollutant limits in this subpart.

(b) Annual whole sludge application rate is the maximum amount of sewage sludge (or a product derived from sewage sludge prior to disbursement by the treatment works) that may be applied to a unit area of land in a 365-consecutive-day period in compliance with the pollutant limits in this subpart.

(c) Distribution and marketing is the give-away or sale of sewage sludge or a product derived from sewage sludge, either in containers (e.g., bags) or in bulk form, by owners or operators of treatment works or by a person who receives sewage sludge from treatment works.

(d) Distributor is a person who prepares the product for distribution and marketing and who is responsible for distributing and marketing the product.

(e) Product is the material that is distributed and marketed. The product may be either sewage sludge, processed sewage sludge, or a mixture of sewage sludge and other materials such as woodchips.

§ 503.22 Distribution and marketing—general requirements.

(a) No person subject to this part shall distribute and market sewage sludge except in accordance with this subpart.

(b) When the treatment work is not the distributor of the product, the treatment work shall enter into an agreement with the distibutor to comply with the requirements of this subpart. The agreement must include the following:

(1) Name and address of the distributor;

(2) Concentrations of the pollutants listed in Table 4 of 40 CFR 503.23 that are in the sewage sludge disbursed to the distributor;

(3) Appropriate annual whole sludge application rate of the sewage sludge disbursed by the treatment work;

(4) Appropriate annual product application rate of the product to be distributed and marketed;

(5) Documentation that the sewage sludge disbursed to the distributor is in compliance with the Class A pathogen reduction requirements in 40 CFR 503.52(a) and that it has been monitored for compliance with 40 CFR 503.53 (a), (b), (c), (d), or (e).

(6) Facsimile of the label affixed to the product or the information sheet accompanying the product that contains the information required in 40 CFR 503.24(b).

(c) Sewage sludge shall not be applied at rates that would exceed the nitrogen requirements of the vegetation (food crops, grasses, ornamental plants, etc.) and that would cause the excess nitrogen to leach to the ground water.

(d) Owners or operators of treatment works or distributors of sewage sludge shall comply with the monitoring requirements in § 503.81 and the record keeping and report requirements in § 503.83.

§ 503.23 Distribution and marketing—national pollutant limits.

(a) The concentration of the pollutants in sewage sludge that is distributed and marketed shall not exceed the pollutant limits in Table 4 for the appropriate annual whole sludge application rate prior to being disbursed by the treatment works. The procedure in Appendix B shall be used to determine the annual whole sludge application rate.

(b) The annual product application rate for sewage sludge that is distributed and marketed by distributors shall not exceed the pollutant limits in § 503.23(a).

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TABLE 4

DISTRIBUTION AND MARKETING POLLUTANT LIMITS

Maximum Sewage Sludge Concentration
(milligrams per kilogram - dry weight basis)

Annual Whole Sludge Application Rate (metric tons per hectare)	1	3	5	10	15	20	25	30	35	40	45	50
Pollutant												
Aldrin/dieldrin	16	5.5	3.3	1.6	1.1	0.82	0.66	0.56	0.47	0.41	0.36	0.33
Arsenic	700	230	140	70	47	35	28	23	20	18	16	14
Benzo(a)pyrene	80	26	15	7.7	5.1	3.8	3.1	2.6	2.2	1.9	1.7	1.5
Cadmium	900	310	180	90	61	46	37	31	26	23	20	18
Chlordane	22500	7500	4500	2200	1500	1100	900	750	640	560	500	450
Chromium	26500	8800	5300	2700	1770	1330	1060	880	760	660	590	530
Copper	2300	770	460	230	150	110	92	77	66	57	51	46
DDT/DDE/DDD (total)[1]	46	15	9.2	4.6	3.1	2.3	1.8	1.5	1.3	1.2	1	0.92
Heptachlor	79	26	19	7.9	5.3	3.9	3.2	2.6	2.3	2	1.8	1.6
Hexachlorobenzene	46	15	9.1	4.6	3	2.3	1.8	1.15	1.3	1.14	1.01	0.91
Hexachlorobutadiene	41000	14000	8200	4100	2700	2100	1600	1400	1200	1000	910	820
Lead	6000	2100	1300	600	400	310	250	210	180	160	140	130
Lindane	293500	97800	58700	29350	19570	14680	11740	9780	8390	7340	6500	5870
Mercury	1990	660	400	199	133	99	80	66	57	50	44	40
Nickel	3900	1300	780	390	260	200	160	130	110	98	87	76
Polychlorinated biphenyls	49	49	30	15	10	7	6	5	4	4	3	3
Selenium	8106	2702.1	1600	810	540	410	320	270	230	200	160	160
Toxaphene	117	39	23	12	7.8	5.8	4.7	3.9	3.3	2.9	2.6	2.3
Zinc	8600	2900	1700	860	570	430	340	290	250	220	190	170

1 DDT - 2,2-Bis(chlorophenyl)-1,1,1-trichloroethane
DDE - 1,1-Bis(chlorophenyl)-2,2-dichloroethylene
DDD - 1,1-Bis(chlorophenyl)-2,2-dichloroethane

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§ 503.24 Distribution and marketing—management practices.

(a) When sewage sludge is distributed and marketed, a label shall be affixed to the product or an information sheet shall acompany the product. The label or information sheet shall contain the information required by paragraph (b) of this section.

(b) When sewage sludge is distributed and marketed, the following information shall be provided on a label or information sheet:

(1) Name and address of the distributor of the product;

(2) Statement that the product is derived from sewage sludge;

(3) List of the nitrogen and pollutant concentrations in the product (at a minimum, the list of pollutants is to include the pollutants on Table 4 in § 503.23 that are present in the product);

(4) Statement prohibiting the use of the product on frozen, snow-covered, or flooded land;

(5) Statement prohibiting use, except in accordance with the instructions;

(6) Instructions on the appropriate uses of the product;

(7) Statement prohibiting the use of the product 10 meters (30 feet) or less from a surface water;

(8) Rate at which the product may be applied for stipulated uses (rates may not exceed the nitrogen requirements of the vegetation—food crops, grasses, ornamentals, etc.);

(9) Warning to keep the product out of reach of children;

(10) Statement prohibiting the grazing of animals intended for human consumption on land where the product is applied;

(11) Statement prohibiting the use of crops grown on land where the product is applied as feed for animals intended for human consumption; and

(12) Statement that compliance with the instructions on the label or information sheet will constitute compliance with section 405(e) of the CWA, as amended.

§ 503.25 Pathogen and vector attraction reduction requirements.

Sewage sludge that is distributed and marketed shall be treated to comply with the Class A pathogen reduction requirements in § 503.52(a) and one of the vector attraction reduction requirements in § 503.53 (a) through (e).

Subpart D—Disposal of Sewage Sludge in Monofills

§ 503.30 Applicability.

This subpart applies to the disposal of sewage sludge in monofills accepting only sewage sludge, to sewage sludge monofills, and to any person who disposes of sewage sludge in a monofill.

§ 503.31 Specialized definitions.

(a) Base flood is a flood that has a one-percent or greater chance of recurring in any given year or a flood of a magnitude equalled or exceeded once in 100 years, on the average, over a significantly long period.

(b) Class I ground water is ground water of unusually high value that is highly vulnerable to contamination and is either an irreplaceable source of drinking water to substantial populations or ecologically vital.

(c) Class II ground water is ground water that is not Class I ground water and that is used currently or is available potentially as a source of drinking water and other beneficial uses.

(d) Class III ground water is ground water that:

(1) Is not a source of drinking water and has a total dissolved solids concentration greater than 10,000 milligrams per liter;

(2) Is not a source of drinking water and is contaminated by either naturally occurring conditions or the effects of broad scale human activity to levels that cannot be cleaned up using treatment methods reasonably employed in public water supply systems; or

(3) Is not a source of drinking water because of insufficient yields to meet the minimum needs of an average household.

(e) Closed sewage sludge unit is a sewage sludge unit that no longer receives sewage sludge as of the effective date of this rule and that has received a final cover.

(f) Cover material is soil or other suitable material used to cover sewage sludge in a sewage sludge unit.

(g) Displacement is the relative movement of a fault measured in any direction.

(h) Fault is a fracture along which rocks on one side are displaced with respect to those on the other side.

(i) Final cover is suitable material that permanently covers the sewage sludge unit.

(j) Floodplain is the lowland and relatively flat areas adjoining inland and coastal waters, including floodplain areas of offshore islands that are inundated by a base flood.

(k) Holocene time is the most recent epoch of the Quaternary period, extending from the end of the Pleistocene to the present.

(l) Lateral expansion is a horizontal expansion of a sewage sludge unit boundary.

(m) Monofill is an area of land that contains one or more sewage sludge units.

(n) Runoff is rainwater, leachate, or other liquid that drains overland on any part of a sewage sludge unit.

(o) Saturated zone is that part of the earth's crust in which all voids of porous materials are filled with water.

(p) Seismic impact zone is an area that has had horizontal ground level acceleration equal to or greater than 0.10 gravities.

(q) Sewage sludge unit is an area of land where only sewage sludge is placed and where the sewage sludge is covered with suitable material at the end of each operating day or at more frequent intervals. Land does not include waters of the United States as defined in 40 CFR 230.3(s).

(r) Sewage sludge unit boundary is the outermost perimeter of the sewage sludge unit.

(s) Unsaturated zone is the zone between the land surface and the water table.

(t) Water table is the upper surface of ground water where the pressure in the porous medium above the ground water equals the atmospheric pressure.

(u) Wetland areas 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 typically adapted for life in saturated soil conditions. Wetlands include, but are not limited to, swamps, marshes, bogs, and similar areas.

§ 503.32 Monofills—general requirements.

(a) No person shall place sewage sludge in a monofill unless the requirements in this subpart are met.

(b) In addition to the requirements of this subpart, owners or operators of monofills shall comply with the National Pollutant Discharge Elimination System (NPDES) requirements promulgated pursuant to section 402 of the CWA.

(c) Owners or operators of a monofill shall determine the class of ground water over which a monofill is located.

(d) Monofills shall not cause or contribute to the harm of a threatened or endangered species of plant, fish, or wildlife or result in the destruction or adverse modification of the critical habitat of a threatened or endangered species.

(e) Monofills and sewage sludge units shall not restrict the flow of a base flood; reduce the temporary water storage capacity of a floodplain; or present a hazard to human health, wildlife, or land or water resources because of sewage sludge in the run-off from the base flood.

(f) A monofill located within 3,048 meters (10,000 feet) of an airport runway used by turbine-powered aircraft or within 1,524 meters (5,000 feet) of an airport runway used only by piston engine-powered aircraft shall not pose a hazard to aircraft from birds.

(g) When a monofill is located in a seismic impact zone, the sewage sludge units shall be designed to withstand the maximum recorded horizontal ground level acceleration.

(h) Sewage sludge units shall be located 60 meters or more from a fault or stress fractures that have had displacement in Holocene time.

(i) Sewage sludge units shall be located in areas where adequate support for the structural components of the sewage sludge unit exists.

(j) Sewage sludge units shall be located outside the perimeter of wetland areas.

(k) Owners or operators of a sewage sludge unit shall collect and discharge the volume of run-off from a 24-hour, 25-year storm event, in accordance with an applicable NPDES permit.

(l) Sewage sludge units located within 60 meters of a fault or stress fractures that have had displacement in Holocene time, located in unstable areas, or located in wetland areas shall be closed within 1 year of the effective date of this rule.

(m) Owners or operators of monofills shall develop a written plan that describes the steps necessary to close each sewage sludge unit and the measures required after each closure to protect public health and the environment for each sewage sludge unit. The plan shall be submitted to the permitting authority with a permit application. At a minimum, the plan shall include:

(1) A description of the final cover to be used on each sewage sludge unit that closes;

(2) A description of how the final cover will minimize the effects of any volatilization of the pollutants, minimize settling, subsidence, erosion, or other events, and minimize runoff from, or other damage to, the final cover;

(3) A description of how the final cover will be maintained for a period of 10 years;

(4) A description of the methane gas monitoring that will be conducted for a period of 10 years to ensure continued compliance with the requirements in § 503.34(b); and

(5) A description of how public access restrictions to the sewage sludge unit will be maintained for a period of 10 years.

(n) Owners or operators of treatment works shall comply with the monitoring requirements in § 503.81 and the record keeping and report requirements in § 503.84.

§ 503.33 Monofills—pollutant limits.

(a) *National limits.* The concentration of the pollutants in the sewage sludge placed in monofills located over Class I, Class II, and Class III(1) or Class III(3) ground water as defined in § 503.31 (b), (c), and (d)(1) and (d)(3) shall not exceed the pollutant limits in Table 5 or (b)(1) of this section, except as provided in (b)(3) of this section.

(b) *Case-by-case limits.* (1) Where a sewage sludge unit boundary is located less than 150 meters from the property line of the monofill:

(i) Owners or operators of the monofill shall submit the actual distance of the sewage sludge unit boundary to the property line of the monofill; and

(ii) The permitting authority must calculate numeric limits for the pollutants in Table 5 using an EPA-approved model and the actual distance of the sewage sludge unit to the monofill boundary.

(2) When a monofill is located over Class III(2) ground water as defined in § 503.31(d)(2):

(i) Owners or operators of the monofill must submit the actual concentration for those pollutants that exceed the values in Appendix A; and

(ii) The permitting authority shall calculate the numeric limits using an EPA-approved model and the actual concentration in the ground water of those pollutants that exceeded the values in Appendix A.

(3) When one or more of the pollutant limits in § 503.33(a), § 503.33(b)(1), or § 503.33(b)(2) are exceeded and when the monofill site characteristics are different from the values in Table 6, alternative limits may be developed in accordance with the following procedure:

(i) Owners or operators shall document site-specific values for one or more of the parameters in Table 6; and

(ii) The permitting authority shall calculate numeric limits for all pollutants in Table 5 using an EPA-approved model and the site-specific values provided by the owner or operator.

TABLE 5.—MONOFILL POLLUTANT LIMITS

MAXIMUM SEWAGE SLUDGE CONCENTRATION

[Milligrams per kilogram [1]]

Pollutant	Monofills over class I ground water	Monofills over class II/class III(1) and class III(3) ground water
Arsenic	0.20	24
Benzene	0.28	0.85
Benzo(a)pyrene	89	250
Bis(2-ethylhexyl)phthalate	4.5	1600
Cadmium	0.040	9.6
Chlordane	180	
Copper	8.4	
DDT/DDE/DDD (Total) [2]	0.95	51
Dimethyl nitrosamine	0.0019	0.07
Lead	0.35	530
Lindane	2.3	75
Mercury	0.0070	26
Nickel	7.0	
Polychlorinated biphenyls	49	49
Toxaphene	0.5	1.63
Trichloroethylene	2.4	7.4

[1] Dry weight basis.

[2] DDT—2,2-Bis(chlorophenyl)-1,1,1-trichloroethane
DDE—1,1-Bis(chlorophenyl)-2,2-dichloroethene
DDD—1,1-Bis(chlorophenyl)-2,2-dichloroethane.

TABLE 6.—MONOFILL PARAMETERS

Parameter	Value [1]
Depth to ground water	0 meters for Class I ground water; 1 meter for Class II and Class III ground water
Soil type	Sand
Net ground water recharge rate.	0.5 meters per year
Ground water electromotive potential (Eh).	+500 millivolts
Ground water pH	6.0
Partition coefficient (liters per kilogram):	
Arsenic	5.86
Benzene	0.0074
Benzo(a)pyrene	63.0
Bis(2-ethylhexyl)phthalate	0.7244
Cadmium	14.9
Chlordane	17.0
Copper	41.0
DDT/DDE/DDD (Total) [2]	500.0
Dimethyl nitrosamine	0.000004
Lead	234.0
Lindane	0.108
Mercury	322.0
Nickel	12.2
Polychlorinate biphenyls	32.0
Toxaphene	0.096
Trichlorethylene	0.0198

[1] Use value in this Table or measured site-specific value for parameter

[2] DDT—2,2-Bis(chlorophenyl)-1,1,1-trichloroethane
DDE—1,1-Bis(chlorophenyl)-2,2-dichloroethene
DDD—1,1-Bis(chlorophenyl)-2,2-dichloroethane.

§ 503.34 Monofills—management practices.

(a) The owners or operators of a monofill shall cover sewage sludge units with suitable material at the end of each operating day. Cover material shall be applied at more frequent intervals, if necessary, to control disease vectors, odors, gas venting, and scavenging.

(b) The owners or operators of a monofill shall ensure that:

(1) The concentration of methane gas generated in the sewage sludge units does not exceed 1.25 percent methane in any structure within the monofill;

(2) The concentration of methane gas generated in the sewage sludge units does not exceed 5.0 percent methane at the property line of the monofill;

(3) A routine methane gas monitoring program is implemented in accordance with § 503.84(a); and

(4) All necessary and appropriate actions are taken immediately to protect public safety if the limits specified in paragraph (b) (1) or (2) of the section are detected.

(c) Owners and operators shall restrict public access to monofills to protect human health and the environment and to prevent unauthorized vehicular traffic or dumping in the monofill.

§ 503.35 Pathogen reduction requirements.

Sewage sludge placed in a monofill shall be treated to comply with either the Class A pathogen reduction requirements in § 503.52(a) or the Class B pathogen reduction requirements in § 503.52(b).

Subpart E—Disposal of Sewage Sludge on Surface Disposal Sites

§ 503.40 Applicability.

This subpart applies to the disposal of sewage sludge on surface disposal sites, to surface disposal sites, and to any person who disposes of sewage sludge on a surface disposal site.

§ 503.41 Specialized definitions.

(a) Base flood is a flood that has a one-percent or greater chance of recurring in any given year or a flood of a magnitude equalled or exceeded once in 100 years, on the average, over a significantly long period.

(b) Displacement is the relative movement of a fault measured in any direction.

(c) Fault is a fracture along which rocks on one side are displaced with respect to those on the other side.

(d) Floodplain is the lowland and relatively flat areas adjoining inland and coastal waters, including floodplain areas of offshore islands that are inundated by a base flood.

(e) Holocene time is the most recent epoch of the Quaternary period, extending from the end of the Pleistocene to the present.

(f) Lateral expansion is a horizontal expansion of a surface disposal site.

(g) Runoff is a rainwater, leachate, or other liquid that drains overland on any part of a surface disposal site.

(h) Saturated zone is that part of the earth's crust in which all voids of porous materials are filled with water.

(i) Seismic impact zone is an area that has had horizontal ground level acceleration equal to or greater than 0.10 gravities.

(j) Surface disposal site is an area of land on which only sewage sludge is placed for a period of 1 year or longer. Surface disposal sites do not have a vegetative or other cover. Land on which a surface disposal site is located does not include waters of the United States as defined in 40 CFR 230.3(s).

(k) Unsaturated zone is the zone between the land surface and the water table.

(l) Water table is the upper surface of ground water where the pressure in the porous medium above the ground water equals the atmospheric pressure.

(m) Wetland areas 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 typically adapted for life in saturated soil conditions. Wetlands include, but are not limited to, swamps, marshes, bogs, and similar areas.

§ 503.42 Surface disposal sites—general requirements.

(a) No person subject to this part shall place sewage sludge in a surface disposal site except in accordance with this subpart.

(b) In addition to the requirements of this subpart, owners or operators of surface disposal sites shall comply with the NPDES requirements promulgated pursuant to section 402 of the CWA.

(c) Surface disposal sites shall not cause or contribute to the harm of a threatened or endangered species of plant, fish, or wildlife or result in the destruction or adverse modification of the critical habitat of a threatened or endangered species.

(d) Surface disposal sites shall not restrict the flow of a base flood; reduce the temporary water storage capacity of a floodplain; or present a hazard to human health, wildlife, or land or water resources because of sewage sludge in the runoff from the base flood.

(e) A surface disposal site located within 3,048 meters (10,000 feet) of an airport runway used by turbine-powered aircraft or within 1,524 meters (5,000 feet) of an airport runway used only by piston engine-powered aircraft shall not pose a hazard to aircraft from birds.

(f) When a surface disposal site is located in a seismic impact zone, the surface disposal site shall be designed to withstand the maximum recorded horizontal ground level acceleration.

(g) Surface disposal sites shall be located 60 meters or more from a fault or stress fractures that have had displacement in Holocene time.

(h) Surface disposal sites shall be located in areas where adequate support for the structural components of the surface disposal site exists.

(i) Surface disposal sites shall be located outside the perimeter of wetland areas.

(j) Owners or operators of surface disposal sites shall collect and discharge the volume of runoff from a 24-hour, 25-year storm event, in accordance with an applicable NPDES permit.

(k) Sewage sludge surface disposal sites located within 60 meters of a fault or stress fractures that have had displacement in Holocene time, located in unstable areas, or located in wetland areas shall be closed within 1 year of the effective date of this rule.

(l) Owners or operators of treatment works shall comply with the monitoring requirements in § 503.81 and record keeping and report requirements in § 503.85.

§ 503.43 Surface disposal sites—national pollutant limits.

The concentration of the pollutants in sewage sludge placed on a surface disposal site shall not exceed the pollutant limits in Table 7.

TABLE 7.—SURFACE DISPOSAL SITES POLLUTANT LIMITS

Pollutant	Maximum sewage sludge concentration [1] (milligrams per kilogram)
Arsenic	36
Benzene	15
Benzo(a)pyrene	99
Bis(2-ethylhexyl)phthalate	782
Cadmium	385
Chlordane	180
Copper	3300.3
DDT/DDE/DDD (Total) [2]	0.95
Dimethyl nitrosamine	1.4
Lead	1622
Lindane	2.3
Mercury	17
Nickel	988
Polychlorinated biphenyls	49
Toxaphene	0.5
Trichloroethylene	181

[1] Dry Weight Basis.

[2] DDT—2,2-Bis(chlorophenyl)-1,1,1,-trichloroethane. DDE—1,1-Bis(chlorophenyl)-2,2-dichoeroethene. DDD—1,1,-Bis(chlorophenyl)-2,2-dichloroethane.

§ 503.44 Surface disposal sites—management practices.

(a) The owners and operators of a surface disposal site shall ensure that:

(1) The concentration of methane gas generated in a surface impoundment does not exceed 1.25 percent methane in any structure within the property line of the surface disposal site;

(2) The concentration of methane gas generated in a surface disposal site does not exceed 5.0 percent methane at the property line of the surface disposal site;

(3) A routine methane gas monitoring program is implemented in accordance with § 503.85(a); and

(4) All necessary and appropriate actions are taken immediately to protect public safety if the limits specified in paragraph (a) (1) or (2) of this section are detected.

(b) Food crops and feed crops intended for human or animal consumption shall not be grown on the sewage sludge.

(c) Animals shall not be grazed on the sewage sludge.

(d) Owners and operators shall restrict public access to surface disposal sites to protect human health and the environment and to prevent unauthorized dumping at the site.

§ 503.45 Pathogen and vector attraction reduction requirements.

Sewage sludge placed on a surface disposal site shall be treated to comply with either the Class A pathogen reduction requirement in § 503.52(a) or the Class B pathogen reduction requirements in § 503.52(b) and one of the vector attraction reduction requirements in § 503.53 (a) through (f).

Subpart F—Pathogen and Vector Attraction Reduction Requirements

§ 503.50 Applicability and scope.

(a) *Applicability.* This subpart applies to sewage sludge that is applied to agricultural and non-agricultural land, distributed and marketed, disposed of in a monofill, or disposed of on a surface disposal site.

(b) *Scope.* This subpart establishes the requirements for eliminating or reducing pathogenic organisms in sewage sludge and for eliminating or reducing the characteristics of sludge that attract vectors.

§ 503.51 Specialized definitions.

(a) Aerobic digestion is the oxidation of organic matter in sewage sludge into carbon dioxide by aerobic bacteria.

(b) Anaerobic digestion is the decomposition of organic matter in sewage sludge into methane and carbon dioxide by anaerobic bacteria.

(c) Density of microbial organisms per unit mass of volatile suspended solids is the number of microbial organisms divided by the mass of volatile suspended solids in the sewage sludge.

(d) Feed crops are crops intended for consumption by animals.

(e) Food crops are crops intended for human consumption.

(f) Indicator organisms are fecal coliform and fecal streptococci (enterococci) that are used to indicate the presence of pathogenic organisms in the processed sewage sludge.

(g) Pathogen reduction is the elimination or reduction of pathogenic bacteria (*Salmonella* sp.), viruses, protozoa, and helminth ova in sewage sludge.

(h) Specific oxygen uptake rate (SOUR) is the rate at which bacteria consume oxygen in a liquid sewage sludge that has undergone aerobic digestion (i.e., mass of oxygen consumed per unit time per unit mass of sewage sludge solids).

(i) Vector attraction reduction is the elimination or reduction of the characteristics of sewage sludge that attract rodents, flies, mosquitos, and other organisms (i.e., organic amines and short-chained fatty acids).

(j) Volatile solids is that portion of the total solids in sewage sludge that evaporates when the sewage sludge is combusted at 550 degrees Celsius in the presence of excess air.

(k) Volatile suspended solids is that portion of the total suspended solids in sewage sludge that evaporates when the sewage sludge is combusted at 550 degrees Celsius in the presence of excess air.

§ 503.52 Pathogen reduction requirements.

(a) *Class A pathogen reduction requirements.* Owners or operators of treatment works or distributors of sewage sludge not from treatment works shall monitor their sewage sludge in accordance with the methods in § 503.81(b) (3) through (11) to ensure that pathogenic organisms or indicator organisms do not exceed the limits in paragraph (a) (1) or (2) of this section. Also, owners or operators of treatment works or distributors shall comply with paragraph (a)(3) and, if applicable paragraph (a)(4) of this section.

(1) Pathogenic organisms are equal to or less than:

(i) 3 *Salmonella* sp. per gram of volatile suspended solids;

(ii) 1 plaque forming virus unit per gram of volatile suspended solids;

(iii) 1 protozoan organism per gram of volatile suspended solids; and

(iv) 1 helminth egg per gram of volatile suspended solids.

(2) Sewage sludge is raised to 53 degrees Celsius for 5 days, to 55 degrees Celsius for 3 days, or to 70 degrees Celsius for one-half hour and the densities of indicator organisms are equal to or less than:

(i) 2 $\log_{10}$ fecal coliform per gram of volatile suspended solids; and

(ii) 2 log_{10} fecal streptococci (enterococci) per gram of volatile suspended solids.

(3) Owners or operators of treatment works or distributors shall process the sewage sludge to achieve the limits in paragraph (a) (1) or (2) of this section prior to or concurrent with § 503.53 (a) through (e).

(4) If the method selected for vector attraction reduction is injection below the soil surface as provided in § 503.53(f), treatment works or distributors shall monitor the sewage sludge to ensure that the densities of fecal coliform and fecal streptococci (enterococci) each do not exceed 3 log_{10} per gram of volatile suspended solids prior to injection.

(b) *Class B pathogen reduction requirements.* Owners or operators of treatment works or distributors of sewage sluge not from treatment works shall monitor their sewage sludge in accordance with the methods in § 503.81(b) (3) through (11) to ensure that pathogenic organisms or indicator organisms do not exceed the limits in paragraph (b) (1) or (2) of this section. Also, owners or operators of treatment works or distributors shall comply with paragraphs (b) (3) and (4) of this section.

(1) The density of pathogenic organisms in the influent to the treatment work is reduced in the final processed sludge by:

(i) 2 log_{10} for *Salmonelli* sp. per gram of volatile suspended solids; and

(ii) 2 log_{10} for viruses per gram of volatile suspended solids.

(2) When the influent to the treatment work or sewage sludge not from a treatment work is processed by a physical or biological method and when the sewage sludge from those methods is treated in a physical, biological, or chemical addition method, or is stored for at least 1 day, the densities of the indicator organisms are equal to or less than:

(i) 6 log_{10} fecal coliform per gram of volatile suspended solids; and

(ii) 6 log_{10} fecal strepotococci (enterococci) per gram of volatile suspended solids.

(3) When sewage sludge is applied to the land, owners or operators of treatment works or distributors shall ensure that:

(i) Food crops with harvested parts that touch the sludge-soil mixture and that are totally above ground shall not be grown for a period of 18 consecutive months after application of the sewage sludge to the land;

(ii) Food crops with harvested parts that are below the surface of the ground shall not be grown for a period of 5 consecutive years after application of the sewage sludge, unless no viable helminth ova are present in the soil; if there are no ova present, food crops with harvested parts that are below the surface of the ground may be grown 18 months after application of the sewage sludge;

(iii) Feed crops shall not be harvested for a period of 30 consecutive days after the sewage sludge is applied; and

(iv) Animals shall not be allowed to graze for a period of 30 consecutive days after the sewage sludge is applied.

(4) Owners or operators of treatment works or distributors shall ensure that public access to agricultural and non-agricultural lands is restricted for a period of 12 consecutive months after the application of the sewage sludge.

(c) *Class C pathogen reduction requirements.* Owners or operators of treatment works or distributors of sewage sludge not from treatment works shall monitor their sewage sludge in accordance with the methods in § 503.81(b)(3) through (11) to ensure that pathogenic organisms or indicator organisms do not exceed the limits in paragraph (c) (1) or (2) of this section. Also, owners or operators of treatment works or distributors shall comply with paragraphs (c) (3) and (4) of this section.

(1) The density of pathogenic organisms in the influent to the treatment work is reduced in the final processed sludge by:

(i) 1.5 log_{10} for *Salmonelli* sp. per gram of volatile suspended solids; and

(ii) 1.5 log_{10} for viruses per gram of volatile suspended solids.

(2) When the influent to the treatment work or sewage sludge not from a treatment work is processed by a physical or biological method and when the sewage sludge from those methods is further processed by a physical or biological method, is stored in a lagoon, is air dried, or is otherwise stored for at least 1 day, the densities of the indicator organisms are equal to or less than:

(i) 6.3 log_{10} fecal coliform per gram of volatile suspended solids; and

(ii) 6.7 log_{10} fecal streptococci (enterococci) per gram of volatile suspended solids.

(3) When sewage sludge is applied to the land, owners or operators of treatment works or distributors shall ensure that:

(i) Food crops with harvested parts that touch the sludge-soil mixture and that are totally above the ground shall not be grown for a period of 18 consecutive months after application of the sewage sludge;

(ii) Food crops with harvested parts that are below the surface of the ground shall not be grown for a period of 5 consecutive years after application of the sewage sludge, unless no viable helminth ova are present in the soil; if there are no ova present, food crops with harvested parts that are below the surface of the ground may be grown 18 months after application of the sewage sludge;

(iii) Feed crops shall not be harvested for a period of 60 consecutive days after the sewage sludge is applied; and

(iv) Animals shall not be allowed to graze for a period of 60 consecutive days after the sewage sludge is applied.

(4) Owners or operators of treatment works or distributors shall ensure that access to agricultural and non-agricultural lands is restricted for a period of 12 consecutive months after the application of the sewage sludge.

§ 503.53 Vector attraction reduction requirements.

Any of the approaches in paragraphs (a) through (f) of this section may be used in meeting the vector attraction reduction requirements when sewage sludge is applied to agricultural and non-agricultural land or disposed of on a surface disposal site. Owners or operators of treatment works that distribute and market their sewage sludge may not use the approach in paragraph (f) of this section.

(a) The mass of volatile solids in sewage sludge that is treated by an aerobic or anaerobic digestion process is reduced by 38 percent.

(b) The mass of volatile solids in sewage sludge that is treated by an anaerobic digestion process is reduced by less than 15 percent when the sewage sludge is processed for 40 additional days at 30 or more degrees Celsuis by anaerobic digestion.

(c) For sewage sludge that is processed by aerobic digestion, the specific oxygen uptake rate (SOUR) of the sewage sludge prior to final disposal is 1 milligram of oxygen per hour, per gram or less of sewage sludge solids.

(d) The pH of the sewage sludge is raised to 12 or above by alkali addition and, without the addition of more alkali, remains at 12 or above for 2 consecutive hours and then remains at 11.5 or above for an additional period of 22 hours.

(e) The percent solids of the sewage sluge, based on the moisture and solids content of the sewage sludge prior to mixing with other materials, is 75 percent or greater.

(f) The sewage sludge is injected below the surface of the soil with no evidence of the sewage sludge on the land surface within 1 hour after injection of the sewage sludge.

Subpart G—Incineration of Sewage Sludge

§ 503.60 Applicability.

This subpart applies to the incineration of sewage sludge in an incinerator that only fires sewage sludge, to sewage sludge incinerators, and to any person who disposes of sewage sludge in a sewage sludge incinerator.

§ 503.61 Specialized definitions.

(a) Air pollution control system is one or more processes used to collect emissions from a sewage sludge incinerator.

(b) Control efficiency is the mass of a metallic pollutant in the sewage sludge fed to an incinerator minus the mass of that pollutant in the emission from the incinerator stack divided by the mass of the pollutant in the sewage sludge fed to the incinerator.

(c) Dispersion factor is a numerical value that correlates the maximum allowable emission rate for a pollutant from a sewage sludge incinerator stack to the maximum allowable increase in the ground level ambient air concentration for that pollutant at a specified distance from the incinerator stack.

(d) Incineration is the firing of sewage sludge in an enclosed device using controlled flame combustion. An enclosed device includes, but is not limited to, multiple hearth incinerators, fluidized bed incinerators, electric incinerators, or rotary kiln incinerators.

(e) Maximum combustion temperature is the maximum temperature in the combustion zone of a sewage sludge incinerator.

(f) Risk specific concentration is the increase in the concentration of a pollutant that sewage sludge incinerators may contribute to the average annual ground level ambient air concentration for that pollutant.

(g) Sewage sludge feed rate is the average amount of sewage sludge incinerated per day for all sewage sludge incinerators within the property line of a facility or the incinerator design capacity for the total amount of sewage sludge that can be incinerated per day for all sewage sludge incinerators within the property line of the facility.

(h) Stack height is the difference between the elevation of the top of a sewage sludge incinerator stack and the elevation of the ground surface at the base, when this difference is equal to or less than 65 meters. For incinerator stacks higher than 65 meters, the creditable stack height above 65 meters is determined in accordance with 40 CFR 51.1(l)(ii).

(i) Total hydrocarbons is the sum of all emitted organic compounds that have one or more carbon-to-carbon bonds, one or more carbon-to-hydrogen bonds, and that also may have one or more carbon-to-chlorine, carbon-to-nitrogen, or carbon-to-oxygen bonds, etc.

§ 503.62 Incineration—general requirements.

(a) No person shall fire sewage sludge in a sewage sludge incinerator unless the sewage sludge and the sewage sludge incinerator meet the requirements in this subpart.

(b) In addition to the requirements in this subpart, owners or operators of sewage sludge incinerators shall comply with the requirements promulgated under the authority of the Clean Air Act in 40 CFR 61.30 through 61.34, 40 CFR 61.50 through 61.55, and 40 CFR 60.150 through 60.154.

(c) Ash from the incineration of sewage sludge shall be disposed of in accordance with the requirements of 40 CFR Parts 257, 258, or 261 through 268, as appropriate.

(d) Sewage sludge feed rates for all sewage sludge incinerators within the property line of treatment works shall be used to calculate the pollutant limits in § 503.63 (b) through (e).

(e) An instrument that continuously measures the sewage sludge feed rate shall be installed, calibrated, operated, and maintained for each sewage sludge incinerator. The instrument shall have an accuracy of plus or minus five percent over its operating range.

(f) Access to the sewage sludge that is fed to an incinerator shall be provided so that representative grab samples of the sewage sludge can be obtained.

(g) An instrument that monitors and continuously records the oxygen content of the combustion chamber gas prior to the point at which any air dilutes the combustion chamber gas shall be installed, calibrated, operated, and maintained. The oxygen measuring instrument shall have an accuracy of plus or minus five percent over its operating range and shall be calibrated at least once every 24-hour operating period.

(h) Instruments that monitor and continuously record temperatures shall be installed, calibrated, operated, and maintained. The number and placement of the instruments shall be as follows:

(1) For a multiple hearth incinerator, one instrument in every hearth and two instruments in the combustion hearth;

(2) For a fluidized bed incinerator, one instrument in the bed and one instrument in the outlet duct of the fluidized bed;

(3) For an electric incinerator, one instrument in the drying zone, one instrument in the cooling zone, and two instruments in the combuston zone; and

(4) For a rotary kiln incinerator, one instrument in the drying zone, one instrument in the cooling zone, and two instruments in the combustion zone.

(i) An instrument that monitors and continuously records the total hydrocarbon concentration, in parts per million, in the sewage sludge incinerator exit gas shall be installed, calibrated, operated, and maintained. The total hydrocarbon measuring device shall employ a flame ionization detector and a heated sampling line maintained at a temperatoure of 150 degrees Celsius at all times.

(j) Owners or operators of treatment works shall comply with the monitoring requirements in § 503.81 and recordkeeping and report requirements in § 503.86.

§ 503.63 Incineration—pollutant limits.

(a) Sewage sludge may be fired in an incinerator only if the sewage sludge does not exceed the pollutant limit for beryllium in § 503.63(b); the pollutant limit for mercury in § 503.63(c); the pollutant limit for lead in § 503.63(d); the pollutant limits for arsenic, cadmium, chromium, and nickel in § 503.63(e); and the pollutant limit for total hydrocarbons in § 503.63(f).

(b) Beryllium.

The maximum allowable concentration of beryllium in sewage sludge which may be incinerated shall not exceed the concentration in paragraph (b)(1) of this section, except as provided in paragraph (b)(2) of this section.

(1) National limit—beryllium.

The maximum allowable concentration of beryllium shall be calculated using equation (1).

$$C = \frac{10}{(1-CE) \times SF} \qquad (1)$$

Where:

C=Maximum allowable beryllium concentration in sewage sludge, in milligrams per kilogram (dry weight basis).

CE=Sewage sludge incinerator control efficiency (from Table 10).

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

(2) Case-by-case limit—beryllium.

If the concentration of beryllium in the sewage sludge that is to be incinerated exceeds the concentration in equation (1), owners or operators may perform a test of the incinerator(s) in accordance with requirements specified by EPA to determine the actual control efficiency of the sewage sludge incinerator(s) in preventing the release of beryllium to the atmosphere. The control efficiency obtained from the performance test shall be used in equation (1) to calculate a maximum allowable concentration of beryllium in sewage sludge which may be fed into the incinerator.

(c) Mercury.

The maximum allowable concentration of mercury in sewage sludge which may be incinerated shall not exceed the concentration in paragraph (c)(1) of this section, except as provided in paragraph (c)(2) of this section.

(1) National limit—mercury.

The maximum allowable concentration of mercury shall be calculated using equation (2).

$$C = \frac{3200}{(1-CE) \times SF} \qquad (2)$$

Where:

C = Maximum allowable concentration of mercury in sewage sludge, in milligrams per kilogram (dry weight basis).

CE = Sewage sludge incinerator control efficiency (from Table 10).

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

If the concentration of mercury in the sewage sludge that is to be incinerated exceeds the concentration in equation (2), owners or operators may perform a test of the incinerator(s) in accordance with requirements specified by EPA to determine the actual control efficiency of the sewage sludge incinerator(s) in preventing the release of mercury to the atmosphere. The control efficiency obtained from the performance test shall be used in equation (2) to calculate a maximum allowable concentration of mercury in the sewage sludge which may be fed into the incinerator.

(d) Lead.

The maximum allowable concentration of lead in sewage sludge which may be incinerated shall not exceed the concentration in paragraph (d)(1) of this section, except as provided in paragraph (d)(2)(i) or (2)(ii) of this section.

(1) National limit—lead.

The maximum allowable concentration of lead incinerated shall be calculated using equation (3).

$$C = \frac{.25\ (NAAQS) \times 86{,}400}{DF \times (1-CE) \times SF} \qquad (3)$$

Where:

C = Maximum allowable concentration of lead in sewage sludge, in milligrams per kilogram (dry weight basis).

NAAQS = National Ambient Air Quality Standard for lead (1.5 micrograms per cubic meter maximum arithematic mean averaged over a calendar quarter).

86,400 = Number of seconds in a day.

DF = Dispersion factor, in micrograms per cubic meter, per gram, per second (from Table 9).

CE = Sewage sludge incinerator control efficiency (from Table 10).

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

(i) The dispersion factor (DF) in equation (3) shall be obtained from Table 9 if the sewage sludge incinerator stack height is 65 meters or less.

(ii) When the sewage sludge incinerator stack height exceeds 65 meters, the creditable stack height shall be determined in accordance with 40 CFR 51.1(l)(ii) and shall be used in an EPA-approved air dispersion model to determine the appropriate dispersion factor for equation (3).

(2) Case-by-case limit—lead.

(i) If the concentration of lead in the sewage sludge that is to be incinerated exceeds the concentration in equation (3) because of the dispersion factor in Table 9, owners or operators may determine an alternative dispersion factor using an EPA-approved air dispersion model. The dispersion factor obtained from air dispersion modeling shall be used in equation (3) to calculate a maximum allowable concentration of lead in sewage sludge which may be fed into the incinerator.

(ii) If the concentration of lead in the sewage sludge that is to be incinerated exceeds the concentration in equation (3) because of the control efficiency in Table 10, owners or operators may perform a test of the incinerator(s) in accordance with requirements specified by EPA to determine the actual control efficiency of the incinerator(s) in preventing the release of lead to the atmosphere. The control efficiency obtained from the performance test shall be used in equation (3) to calculate a maximum allowable concentration of lead in the sewage sludge which may be fed into the incinerator.

(e) Arsenic, cadmium, chromium, and nickel.

The maximum allowable concentration of arsenic, cadmium, chromium, or nickel in sewage sludge which may be incinerated shall not exceed the concentration in paragraph (e)(l) of this section, except as provided in paragraph (e)(2)(i) or (ii) of this section.

(1) National limit—arsenic, cadmium, chromium, and nickel.

The maximum allowable concentration of arsenic, cadmium, chromium, or nickel shall be calculated using equation (4).

$$C = \frac{RSC \times 86{,}400}{DF \times (1-CE) \times SF} \qquad (4)$$

Where:

C = Maximum allowable concentration of arsenic, cadmium, chromium, or nickel in sewage sludge, in milligrams per kilogram (dry weight basis).

CE = Sewage sludge incinerator control efficiency (from Table 10).

DF = Dispersion factor, in micrograms per cubic meter, per gram, per second (from Table 9).

RSC = Risk specific concentration, in micrograms per cubic meter (from Table 8).

86,400 = Number of seconds in a day.

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

(i) The dispersion factor (DF) in equation (4) shall be obtained from Table 9 if the sewage sludge incinerator stack height is 65 meters or less.

(ii) When the sewage sludge incinerator stack height exceeds 65 meters, the creditable stack height shall be determined in accordance with 40 CFR 51.1(l)(ii) and shall be used in an EPA-approved air dispersion model to determine the appropriate dispersion factor for equation (4).

(2) Case-by-case limit—arsenic, cadmium, chromium, and nickel.

(i) If the concentration of arsenic, cadmium, chromium, or nickel in the sewage sludge that is to be incinerated exceeds the concentration in equation (4) because of the dispersion factor in Table 9, owners or operators may determine an alternative dispersion factor using an EPA-approved air dispersion model. The dispersion factor obtained from air dispersion modeling shall be used in equation (4) to calculate a maximum allowable concentration of arsenic, cadmium, chromium, or nickel in sewage sludge which may be fed into the incinerator.

(ii) If the concentration of arsenic, cadmium, chromium, or nickel in the sewage sludge that is to be incinerated exceeds the concentration in equation (4) because of the control efficiency in Table 10, owners or operators may perform a test of the incinerator(s) in accordance with requirements specified by EPA to determine the actual control efficiency of the sewage sludge incinerator(s) in preventing the release of arsenic, cadmium, chromium, or nickel to the atmosphere. The control efficiency obtained from the performance test shall be used in equation (4) to calculate a maximum allowable concentration of arsenic, cadmium, chromium, or nickel in the sewage sludge which may be fed into the incinerator.

(f) Total hydrocarbons.

The maximum allowable concentration of total hydrocarbons that may be in the emissions from sewage sludge incinerators shall not exceed the concentration in paragraph (f)(1) of this section, except as provided in paragraph (f)(2) of this section.

(1) National limit—total hydrocarbons.

The maximum allowable concentration of total hydrocarbons shall be calculated using equation (5).

$$THC = \frac{RSC \times 3{,}240{,}000{,}000}{DF \times GF} \quad (5)$$

Where:

THC=Maximum allowable concentration of total hydrocarbons in the sewage sludge incinerator's emissions, in parts per million, on a volumetric basis, corrected for seven percent oxygen (dry basis).

RSC=Risk specific concentration, in micrograms per cubic meter (from Table 8).

3,240,000,000=Conversion factors.

DF=Dispersion factor, in micrograms per cubic meter, per gram, per second (from Table 9).

GF=Maximum combustion gas flow rate from the sewage sludge incinerator, in gram moles per day.

(i) The dispersion factor (DF) in equation (5) shall be obtained from Table 9 if the sewage sludge incinerator stack height is 65 meters or less.

(ii) When the sewage sludge incinerator stack height exceeds 65 meters, the creditable stack height shall be determined in accordance with 40 CFR 51.1(l)(ii) and shall be used in an EPA-approved air dispersion model to determine the appropriate dispersion factor for equation (5).

(iii) The maximum combustion gas flow rate (GF) in equation (5) shall be determined using the procedure in Appendix D of this part.

(iv) The concentration of total hydrocarbons measured in the emissions shall be corrected to 50 percent excess air (seven percent oxygen), zero percent moisture as shown in equation (6).

Correction factor dimensionless)=14 (6) (21−Y)

Where:

Y=Oxygen concentration in the sewage sludge incinerator exit gas (percent).

(v) The corrected concentration of total hydrocarbons is the total hydrocarbon concentration that must meet the concentration calculated with equation (5), except as provided in paragraph (f)(2) of this section.

(2) Case-by-case limit—total hydrocarbons.

If the concentration of total hydrocarbons from incinerator emissions—measured with the device specified in § 503.62(i) and corrected to 50 percent excess air (seven percent oxygen), as provided in equation (6)—exceeds the limit in equation (5) because of the dispersion factor in Table 9, owners or operators may determine an alternative dispersion factor using an EPA-approved air dispersion model. The dispersion factor obtained from the dispersion modeling shall be used in equation (5) to calculate a maximum allowable concentration of total hydrocarbons in sewage sludge which may be fed into the incinerator.

TABLE 8.—RISK SPECIFIC CONCENTRATION

Pollutant	RSC (Micrograms per cubic meter)
Arsenic	0.0023
Cadmium	0.0057
Chromium	0.085
Nickel	0.033
Total Hydrocarbons	2.69

TABLE 9.—DISPERSION FACTORS

Stack height (meters)	Dispersion factor (micrograms per cubic meter per gram per second)
5	58.24
6	57.67
7	57.12
8	56.58
9	56.04
10	55.80
11	54.96
12	50.98
13	47.00
14	42.41
15	37.83
16	33.24
17	28.65
18	25.88
19	23.10
20	20.33
21	17.55
22	14.78
23	12.00
24	11.73
25	11.46
26	11.19
27	10.93
28	10.66
29	10.39
30	10.12

TABLE 9.—DISPERSION FACTORS—Continued

Stack height (meters)	Dispersion factor (micrograms per cubic meter per gram per second)
31	9.85
32	9.59
33	9.32
34	9.04
35	8.78
36	8.51
37	8.24
38	7.98
39	7.71
40	7.52
41	7.37
42	7.23
43	7.09
44	6.95
45	6.81
46	6.67
47	6.53
48	6.39
49	6.25
50	6.11
51	5.97
52	5.83
53	5.69
54	5.54
55	5.40
56	5.26
57	5.12
58	4.98
59	4.84
60	4.70
61	4.56
62	4.42
63	4.28
64	4.14
65	3.99

TABLE 10.—INCINERATOR CONTROL EFFICIENCIES

Pollutant	Control Efficiencies
Arsenic	0.96
Beryllium	0.99
Cadmium	0.65
Chromium	0.96
Lead	0.67
Mercury	0.00
Nickel	0.95

§ 503.64 Incineration—management practices.

(a) Except as provided in paragraph (b) of this section, sewage sludge incinerators must be operated as follows:

(1) The maximum combustion temperature in the sewage sludge incinerator shall be no greater than 898 degrees Celsius (1650 degrees Fahrenheit);

(2) The maximum oxygen content of the exit gas from a sewage sludge incinerator stack shall be 12 percent (dry basis) for a multiple hearth sewage

sludge incinerator, seven percent (dry basis) for a fluidized bed sewage sludge incinerator, nine percent (dry basis) for an electric sewage sludge incinerator, and 12 percent (dry basis) for a rotary kiln sewage sludge incinerator; and

(3) The air pollution control system, including instrumentation, used to collect emissions from the sewage sludge incinerator stack shall be appropriate for the type of incinerator used and shall be operated and maintained to meet all applicable requirements.

(b) When a performance test of an incinerator is used to obtain a control efficiency for the pollutants in § 503.63(b) through (e), the incinerator must be operated as follows:

(1) The maxium combustion temperature and maximum oxygen content of the stack exit gas for the sewage sludge incinerator shall be based on the results of the performance test; and

(2) The air pollution control system used to collect emissions from the sewage sludge incinerator stack, including instrumentation, shall be appropriate for the type of incinerator used and shall be operated and maintained to meet all applicable requirements.

Subpart H—Removal Credits

§ 503.70 Applicability and description of a removal credit.

(a) *Applicability.* This subpart applies to those pollutants in sewage sludge for which pollutant limits are established in this part, to additional pollutants that do not pose an unreasonable risk to human health or the environment when sewage sludge is used or disposed of by a particular method, and to pollutants in sewage sludge that is disposed of in accordance with 40 CFR Part 258.

(b) *Description of a removal credit.* Regulations at 40 CFR Part 403 provide that, subject to the conditions of Part 403, any POTW receiving wastes from an industrial user to which a categorical pretreatment standard applies, at its discretion, upon authorization from the approval authority, may grant credits to industrial users that reflect removal by the POTW of pollutants specified in the categorical pretreatment standards.

§ 503.71 Specialized definition.

Categorical pretreatment standard is a numerical effluent limit promulgated by EPA for a pollutant discharged into a POTW with which all processes in an industrial category must comply.

§ 503.72 Pollutants for which removal credits may be authorized.

Subject to the conditions of 40 CFR Part 403, the owners or operators of a POTW may grant removal credits under any of the following conditions:

(a) For any pollutant listed on Table 11 that is regulated in the use or disposal method employed by the POTW, if the POTW complies with the requirements of this part;

(b) For any pollutant listed on Table 12 in the use or disposal method employed by the POTW if the POTW's sewage sludge does not exceed the levels shown on Table 13 and if the POTW complies with the requirements of this part; or

(c) For any pollutant present in the sewage sludge of the POTW, if the owner or operator disposes of the sludge in accordance with 40 CFR Part 258.

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TABLE 11

REGULATED POLLUTANTS ELIGIBLE FOR REMOVAL CREDITS

Pollutants	LA	D&M	MF	SD	I
Acrylonitrile					X
Aldrin	X	X			X
Arsenic	X	X	X	X	X
Benzene			X	X	X
Benzidine					X
Benzo(a)pyrene	X	X	X	X	X
Beryllium					X
Bis(2-chloroethyl)ether					X
Bis(2-xethylhexyl)phthalate			X	X	X
Bromodichloromethane					X
Bromoethane					X
Cadium	X	X	X	X	X
Carbon tetrachloride					X
Chlordane	X	X	X	X	X
Chloroform					X
Chromium	X	X			X
Copper	X	X	X	X	
DDD,DDE,DDT	X	X	X	X	X
Dibromochloromethane					X
Dibutyl phthalate					X
2,4-dichlorophenol					X
1,3-dichloropropene					X
Diethyl phthalate					X
2,4-dinitrophenol					X
1,2-diphenylhydrazine					X
Dieldrin	X	X			
Dimethyl nitrosamine	X		X	X	
Endosulfan					X
Endrin					X
Ethylbenzene					X
Heptachlor	X	X			X
Heptachlor epoxide					X
Hexachlorobenzene	X	X			
Hexachlorobutadiene	X	X			
alpha-hexachlorocyclohexane					X
beta-hexachlorocyclohexane					X
Hexachloropentadiene					X
Hexachloroethane					X
Hydrogen cyanide					X
Isophorone					X
Lead	X	X	X	X	X
Lindane	X	X	X	X	X

(continued)	LA	D&M	MF	SD	I
Mercury	X	X	X	X	X
Molybdenum	X				
Nitrobenzene					X
N-Nitrosodimethylamine					X
N-Nitrosodi-n-propylamine					X
Nickel	X	X	X	X	X
Pentachlorophenol					X
Phenol					X
Polychlorinated biphenyls	X	X	X	X	X
Selenium	X	X			
2,3,7,8-tetrachlorodibenzo-p-dioxin					X
1,1,2,2,-tetrachloroethane					X
Tetrachloroethylene					X
Toulene					X
Toxaphene	X	X	X	X	X
Trichloroethylene	X		X	X	X
1,2,4-trichlorobezene					X
1,1,1-trichloroethane					X
1,1,2-trichloroethane					X
2,4,6-trichlorophenol					X
Zinc	X	X	X	X	X

KEY: LA refers to land application
D&M refers to distribution and marketing
MF refers to sludge-only landfills
SD refers to surface disposal unit
I refers to incineration

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TABLE 12.—ADDITIONAL POLLUTANTS ELIGIBLE FOR REMOVAL CREDITS

	mg/kg
Land Application of Sewage Sludge:	
Cyanide	2,686.6
Flouride	738.7
Iron	78,700
Pentachlorophenol	30.43
Distribution and Marketing of Sewage Sludge:	
Cyanide	2,686.6
Dimethyl nitrosamine	2.55
Fluoride	738.7
Iron	78,700
Pentachlorophenol	30.43
Trichloroethylene	13.07
Disposal of Sewage Sludge in Monofills:	
Chlordane	12
Chromium	1,499.7
Copper [1]	1,427
Cyanide	2,686.6
2,4 Dichlorophenoxyacetic acid	7.16
Malathion	0.63
Molybdenum	40
Nickel	1,662.7
Phenol	82.06
Selenium	4.85
Zinc	4,580
Disposal of Sewage Sludge on Surface Disposal Sites:	
Chromium	1,499.7
Cyanide	2,686.6
2,4 Dichlorophenoxyacetic acid	7.16
Malathion	0.63
Molybdenum	40
Phenol	82.06
Selenium	4.85
Zinc	4,580
Incineration of Sewage Sludge:	
Copper	1,427
Selenium	4.85
Zinc	4,580

[1] A removal credit may be granted for this pollutant when the monofill is located over ground water classified as Class II, Class III(1), and Class III(3), as defined in § 503.31 (c) and (d).

Subpart I—Monitoring, Record Keeping, and Reports

§ 503.80 Purpose.

This subpart contains the minimum frequencies that owners or operators of treatment works must monitor their sewage sludge; the minimum records that owners or operators of treatment works must keep; the period of time the records must be kept; and the minimum information that owners or operators of treatment works must report to the permitting authority. Nothing in this subpart prevents the establishment of more stringent monitoring, record keeping, and report requirements for any practice covered by this part.

§ 503.81 General.

Owners or operators of treatment works or distributors of sewage sludge shall collect sewage sludge samples and analyze these samples in accordance with the procedures, methods, and frequency specified in paragraphs (a), (b), and (c) of this section. The pollutants and pathogenic organisms or indicator organisms for which owners or operators of treatment works shall analyze their sewage sludge depend on the use or disposal method employed by the treatment work or distributor and are specified in § 503.93 through § 503.97 of this part.

(a) Sampling protocol.

"Sampling Procedures and Protocols for the National Sewage Sludge Survey," Office of Water Regulations and Standards (March 1988).

(b) Analytical methods.

(1) Organic pollutants.

Methods 1624 and 1625 in "Analytical Methods for the National Sewage Sludge Survey," Office of Water Sample Control Center (March 1988) or Methods 624 and 625 in 40 CFR Part 136.

(2) Inorganic pollutants.

"Analytical Methods for the National Sewage Sludge Survey," Office of Water Sample Control Center (March 1988).

(3) Pathogenic bacteria, *Salmonella* sp.

(i) Part 912 C.1, "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985); or

(ii) Kenner, B.A. and H.A. Clark, "Detection and enumeration of *Salmonella* and *Pseudomonas aeruginosa*," "J. Water Pollution Control Federation," 46(9):2163–2171.

(4) Viruses.

"The Manual of Methods for Virology," EPA/600/4–84/013 (February 1984), as revised.

(5) Protozoa.

(i) Part 917, "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985); or

(ii) Fox, J.C., P.R. Fitzgerald, and C. Lue-Hing, "Sewage Organisms: A Color Atlas," Lewis Publishers, Chelsea, Michigan (1981).

(6) Helminth ova.

(i) Part 917, "Standard Methods for the Examination of Water and Wastewater," 16th edition (1985); or

(ii) Fox, J.C., P.R. Fitzgerald, and C. Lue-Hing, "Sewage Organisms: A Color Atlas," Lewis Publishers, Chelsea Michigan (1981).

(7) Fecal coliform.

Part 908 or Part 909, "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985).

(8) Fecal streptococci/enterococci.

(i) Part 910 A, "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985); or

(ii) Slantely, L.W. and C.H. Bartley, "Numbers of enterococci in water, sewage, and feces determined by the membrane filter technique with an improved medium," "J. Bacteriology," 74:591–595 (1957).

(9) Volatile solids.

Part 209 C, "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985).

(10) Volatile suspended solids.

Part 209 G, "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985).

(11) Percent volatile solids reduction.

The percent volatile solids reduction shall be calculated using the following equation:

$$\text{Percent Volatile Solids Reduction} = \frac{(Mi - Mg) \times 100}{Mi}$$

Where:
Mi = The mass of volatile solids in sewage sludge prior to processing.
Mg = The mass of volatile solids in sewage sludge after processing.

(12) Specific oxygen uptake rate (SOUR).

Part 213 A, "Standard Methods for the Examination of Water and Wastewater," 16th Edition (1985).

(c) Frequency of monitoring and reporting.

Unless otherwise specified, owners or operators of treatment works shall monitor and report the parameters specified in this subpart in accordance with the following:

Treatment works design capacity (million gallons per day)	Frequency of monitoring
Less than 1.0	Once per year.
1.0 to 10.0	Once per quarter.
Greater than 10.0	Once per month.

§ 503.82 Land application of sewage sludge.

(a) Monitoring—(1) Agricultural land.

From a representative sample of sewage sludge, owners or operators of treatment works or distributors of sewage sludge, in accordance with the applicable frequency specified in § 503.81(c), shall:

(i) Determine the concentrations of nitrogen and the pollutants listed on Tables 1 and 2 in § 503.13. Also, owners or operators shall monitor for the pollutants listed on Table 12 in § 503.72 if the POTW grants removal credits for these pollutants.

(ii) Determine compliance with Class A, Class B, or Class C pathogen-reduction requirements in § 503.52.

(iii) Determine compliance with the vector attraction reduction requirements in § 503.53.

(iv) When owners or operators of treatment works inject the sewage sludge below the surface of agricultural land to comply with the vector attraction reduction requirements in § 503.53(f), the sewage sludge does not have to be monitored for volatile solids, SOUR, pH, or moisture content.

(2) *Non-agricultural land.* From a representative sample of sewage sludge, owners or operators of treatment works or distributors of sewage sludge, in accordance with the applicable frequency specified in § 503.81(c), shall:

(i) Determine the concentrations of nitrogen and the pollutants listed on Table 3 in § 503.15. Also, owners or operators shall monitor for the pollutants listed on Table 12 in § 503.72 if the POTW grants removal credits for these pollutants.

(ii) Determine compliance with Class A, Class B, or Class C pathogen reduction requirements in § 503.52.

(iii) Determine compliance with the vector attraction reduction requirements in § 503.53.

(iv) When owners or operators of treatment works inject the sewage sludge below the surface of non-agricultural land to comply with the vector attraction reduction requirements in § 503.53(f), the sewage sludge does not have to be monitored for volatile solids, SOUR, pH, or moisture content.

(b) *Record keeping*—(1) *Agricultural land.* Owners or operators of treatment works or distributors of sewage sludge shall retain for the life of the treatment works the following:

(i) The name and address of the applier of the sewage sludge;

(ii) The location and legal description of the field, including the area of each field where the sewage sludge is applied;

(iii) The concentrations of nitrogen and the pollutants listed on Tables 1 and 2 in § 503.13;

(iv) The amount of sewage sludge applied to each site;

(v) The amount of each organic pollutant listed on Table 1 in § 503.13 applied to each site;

(vi) The amount of each inorganic pollutant listed on Table 2 in § 503.13 applied to each site;

(vii) The results of monitoring the sewage sludge to determine compliance with the pathogen reduction requirements in § 503.52;

(viii) The results of monitoring the sewage sludge to determine compliance with the vector attraction reduction requirements in § 503.53;

(ix) A record that indicates whether sewage sludge was injected below the soil surface to comply with the vector attraction reduction requirement in § 503.53(f);

(x) The contracts between the treatment work and the distributors and appliers of the sewage sludge;

(xi) Certification that the applier was informed about the access and use restrictions;

(xii) Certification that the land application does not cause or contribute to the harm of a threatened or endangered species or result in the destruction or adverse modification of the critical habitat of a threatened or endangered species; does not restrict the flow of the base flood; does not reduce the temporary water storage capacity of a floodplain; and does not present harm to human health, wildlife, or land or water resources; and

(xiii) Certification, for each application site, that the distance between the sewage sludge boundary and any surface water is at least 10 meters.

(2) *Non-agricultural land.* Owners or operators of treatment works or distributors of sewage sludge shall keep, for 5 years, the following:

(i) The name and address of the applier of the sewage sludge;

(ii) The concentrations of nitrogen and the pollutants listed on Table 3 in § 503.15;

(iii) The results of monitoring the sewage sludge to determine compliance with the pathogen reduction requirements in § 503.52;

(iv) The results of monitoring the sewage sludge to determine compliance with the vector attraction reduction requirements § 503.53;

(v) A record that indicates whether sewage sludge was injected below the soil surface to comply with the vector attraction reduction requirement in § 503.53(f);

(vi) The contracts between the treatment works and the distributors and appliers of the sewage sludge;

(vii) Certification that the applier was informed about the access and use restrictions;

(viii) Certification that the land application does cause or contribute to the harm of a threatened or endangered species or result in the destruction or adverse modification of the critical habitat of a threatened or endangered species; does not restrict the flow of the base flood; does not reduce the temporary water storage capacity of a floodplain; and does not present harm to human health, wildlife, or land or water resources; and

(ix) Certification, for each application site, that the distance between the sewage sludge boundary and any surface water is at least 10 meters.

(c) *Reports.*—(1) *Agricultural land.* In accordance with the applicable frequency specified in § 503.81(c), owners or operators of treatment works or distributors of sewage sludge shall provide the permitting authority with:

(i) The information required by § 503.82(b)(1).

(ii) After the initial submission, the owners or operators of a treatment work or distributors of sewage sludge shall re-submit the information in § 503.82(b)(1) (x) through (xiii) only when there are changes.

(2) *Non-agricultural land.* In accordance with the applicable frequency specified in § 503.81(c), owners or operators of treatment works or distributors of sewage sludge shall provide the permitting authority with:

(i) The information required by § 503.82(b)(2).

(ii) After the initial submission, the owners or operators of a treatment work or distributors of sewage sludge shall re-submit the information in § 503.82(b)(2) (vi) through (ix) only when there are changes.

§ 503.83 Distribution and marketing of sewage sludge.

(a) *Monitoring.* (1) Owners or operators of treatment works shall determine the concentrations of nitrogen and the pollutants listed on Table 4 in § 503.23 from a representative sample of sewage sludge prior to its disbursement or in accordance with the applicable frequency specified in § 503.81(c), whichever is the more frequent period of time. Also, owners or operators shall determine the concentrations of the pollutants listed on Table 12 in § 503.72 if the POTW grants removal credits for these pollutants.

(2) When a treatment work is not the distributor, the distributor of the product shall determine the concentrations of nitrogen and the pollutants on Table 4 in

§ 503.23 from a representative sample of the product prior to its disbursement.

(3) Owners or operators of treatment works shall determine compliance with the Class A pathogen reduction requirements in §503.52(a) from a representative sample of the sewage sludge that is disbursed.

(4) Owners or operators of treatment works shall determine compliance with the vector attraction reduction requirement selected in § 503.53 (a) through (e) from a representative sample of the sewage sludge that is disbursed.

(b) *Record keeping.* Owners or operators of treatment works shall keep, for 5 years, the following:

(1) The name and address of the distributor of the sewage sludge;

(2) The concentrations of nitrogen and the pollutants that are listed on Table 4 in § 503.23 prior to disbursement by the treatment work;

(3) The concentrations of nitrogen and the pollutants in the product that are listed on Table 4 in § 503.23;

(4) The appropriate annual whole sludge application rate prior to disbursement by the treatment work;

(5) The annual product application rate;

(6) The contracts between the distributor of the product and the treatment work, when applicable;

(7) The results of monitoring the sewage sludge prior to disbursement by the treatment work to determine compliance with the pathogen reduction requirements;

(8) The results of monitoring the sewage sludge prior to disbursement by the treatment work to determine complicance with the vector attraction reduction requirements; and

(9) A copy of the label affixed to the product or the informational sheet accompanying the product.

(c) *Reports.* In accordance with the applicable frequency specified in § 503.81(c), owners or operators of treatment works shall provide the permitting authority with:

(1) The information required by § 503.83(b).

(2) After the initial submission, the owners or operators of a treatment work shall re-submit the information in § 503.83(b) only if there are changes.

§ 503.84 Disposal of sewage sludge in monofills.

(a) *Monitoring.* (1) From a representative sample of sewage sludge, owners or operators of treatment works shall determine the concentrations of the pollutants listed on Table 5 in § 503.33 in accordance with the applicable frequency specified in § 503.81(c). Also, owners or operators shall monitor for the pollutants listed on Table 12 in § 503.72 if the POTW grants removal credits for these pollutants.

(2) From a representative sample of sewage sludge, owners or operators of treatment works shall determine compliance with either Class A or Class B pathogen reduction requirements in § 503.52(a) or (b) in accordance with the applicable frequency specified in § 503.81(c).

(3) Owners or operators of monofills shall continuously monitor the air for methane gas in any structure within a monofill and at the property line of the monofill.

(4) Owners or operators of monofills shall monitor the run-off from the monofill that is collected to determine the volume of the run-off discharged and the concentration of pollutants in the discharge.

(b) *Record keeping.* Owners or operators of treatment works or of the monofill, as appropriate, shall keep, for 10 years, the following:

(1) The concentrations of the pollutants listed on Table 5 in § 503.33;

(2) The results of monitoring the sewage sludge to determine compliance with the pathogen reduction requirements in § 503.52 (a) or (b);

(3) A record of the methane gas concentration in any structure within the monofill and at the property line of the monofill;

(4) The volume of run-off collected and discharged and the concentration of the pollutants in the discharge;

(5) Certification that the monofill does not cause or contribute to the harm of a threatened or endangered species or result in the destruction or adverse modification of the critical habitat of a threatened or endangered species; does not restrict the flow of a base flood; does not reduce the temporary water storage capacity of a floodplain; and does not present a hazard to human health, wildlife, or land or water resources;

(6) Certification that the monofill is not a hazard to aircraft from birds if the monofill is located within 3,048 meters (10,000 feet) of aircraft runways used by turbine-powered aircraft or within 1,524 meters (5,000 feet) of an airport runway used only by piston engine-powered aircraft;

(7) Certification that the monofill is designed to withstand stress created by the maximum horizontal ground level acceleration if the monofill is located in a seismic zone;

(8) Certification that each sewage sludge unit is located 60 meters or more from a fault or stress fractures that have had displacement in Holocene time;

(9) Certification that each sewage sludge unit is located in an area that has adequate support for the structural components of the unit; and

(10) Certification that each sewage sludge unit is located outside wetland areas.

(c) *Reports.* In accordance with the applicable frequency specified in § 503.81(c), owners or operators of treatment works or of the monofills, as appropriate, shall provide the permitting authority with:

(1) The information required in § 503.84(b).

(2) After the initial submission, the owners or operators of a treatment work or monofill, as appropriate, shall re-submit the information in § 503.84(b) (5) through (10) only when there are changes.

§ 503.85 Disposal of sewage sludge on surface disposal sites.

(a) *Monitoring.* (1) From a representative sample of sewage sludge, owners or operators of treatment works shall determine the concentrations of the pollutants listed on Table 7 in § 503.43 in accordance with the applicable frequency specified in § 503.81(c). Also, owners or operators shall monitor for the pollutants listed on table 12 in § 503.72 if the POTW grants removal credits for these pollutants.

(2) From a representative sample of sewage sludge, owners or operators of treatment works shall determine compliance with either Class A or Class B pathogen reduction requirements in § 503.52 (a) or (b) in accordance with the applicable frequency specified in § 503.81(c).

(3) From a representative sample of sewage sludge, owners or operators of treatment works shall determine compliance with the vector attraction reduction requirements in § 503.53 in accordance with the applicable frequency specified in § 503.81(c).

(4) When owners or operators of treatment works inject the sewage sludge below the soil surface to reduce the vector attraction, the sewage sludge does not have to be monitored for volatile solids, SOUR, pH, or moisture content.

(5) Owners or operators of surface disposal sites shall continuously monitor the air for methane gas in any structure on the disposal site and at the property line of the site.

(6) Owners or operators of surface disposal sites shall monitor the runoff from the surface disposal site that is collected to determine the volume of the runoff discharged and the concentration of pollutants in the discharge.

(b) *Record keeping.* Owners or operators of treatment works or of the surface disposal sites, as appropriate, shall keep, for 5 years, the following:

(1) The concentrations of the pollutants listed on Table 7 in § 503.43;

(2) The results of monitoring the sewage sludge to determine compliance with the pathogen reduction requirements in § 503.52 (a) or (b).

(3) The results of monitoring the sewage sludge to determine compliance with the vector attraction reduction requirements of § 503.53;

(4) A record of the methane gas concentration in any structure within the surface disposal site and at the property line of the surface disposal site;

(5) The volume of run-off collected and discharged and the concentration of the pollutants in the discharge;

(6) Certification that the surface disposal site does not cause or contribute to the harm of a threatened or endangered species or result in the destruction or adverse modification of the critical habitat of a threatened or endangered species; does not restrict the flow of a base flood; does not reduce the temporary water storage capacity of a floodplain; and does not present a harzard to human health, wildlife, or land or water resources;

(7) Certification that the surface disposal site is not a hazard to aircraft from birds if the surface disposal site is located within 3,048 meters (10,000 feet) of aircraft runways used by turbine-powered aircraft or within 1,524 meters (5,000 feet) of an airport runway used only by piston engine-powered aircraft;

(8) Certification that the surface disposal site is designed to withstand stress created by the maximum ground level acceleration if the surface disposal site is located in a seismic zone;

(9) Certification that each surface disposal site is located 60 meters or more from a fault or stress fractures that have had displacement in Holocene time;

(10) Certification that each surface disposal site is located in an area that has adequate support for the structural components of the site; and

(11) Certification that each new surface disposal site is located outside wetland areas.

(c) *Reports.* In accordance with the applicable frequency specified in § 503.81(c), owners or operators of treatment works or of the surface disposal site, as appropriate, shall provide the permitting authority with:

(1) The information required in § 503.85(b).

(2) After the initial submission, owners or operators of a treatment work or surface disposal site, as appropriate, shall re-submit the information in § 503.85(b) (6) through (11) only when there are changes.

§ 503.86 Incineration of sewage sludge.

(a) *Monitoring.* (1) From a representative sample of sewage sludge, owners or operators of treatment works that incinerate their sewage sludge shall determine the concentrations of arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel in accordance with the applicable frequency specified in § 503.81(c). Also, owners or operators shall monitor for the pollutants listed on Table 12 in § 503.72 if the POTW grants removal credits for these pollutants.

(2) Owners or operators of sewage sludge incinerators shall continuously monitor:

(i) The total hydrocarbon concentration in the incinerator stack;

(ii) The rate at which sewage sludge is fed to an incinerator;

(iii) The combustion temperature in the incinerator;

(iv) The oxygen content of the exit gas; and

(v) The pressure drop across the air pollution control system, if applicable.

(b) *Record keeping.* Owners or operators of treatment works or of the sewage sludge incinerator, as appropriate, shall keep, for 5 years, the following:

(1) The concentrations of arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel in the sewage sludge;

(2) A record of the parameters in § 503.86(a)(2) that are continuously monitored;

(3) Calibration and maintenance records and original instrument chart recordings for continuous-monitoring instruments;

(4) Results of any site-specific air modeling; and

(5) Results of any incinerator performance tests.

(c) *Reports.* In accordance with the applicable frequency specified in § 503.81(c), owners or operators of treatment works or of the incinerator, as appropriate, shall provide the permitting authority with the following:

(1) The information required in § 503.86(b);

(2) The periods when the combustion temperature in the incinerator was above the maximum allowable temperature, as specified in § 503.64 (a)(1) or (b)(1), for 15 minutes or longer;

(3) The periods when the oxygen content of the exit gas from the incinerator stack was above the maximum allowable, as specified in § 503.64 (a)(2) or (b)(1), for 15 minutes or longer;

(4) The periods when the pressure drop across the air pollution control device remained outside the range of allowable drop, as specified in § 503.64 (a)(3) or (b)(2), if applicable, for longer than 1 hour;

(5) The recordings for the concentration of total hydrocarbons in the incinerator stack, required in § 503.86(a) (i); and

(6) The recordings for the sewage sludge feed rate, required in § 503.86(a)(2)(ii).

APPENDIX A.—GROUND WATER POLLUTANT CRITERIA

Pollutant	Concentration (micrograms per liter) [1]
Arsenic	50.0
Benzene	5.0
Bezo(a)pyrene	0.3
Bis(2-ethylhexyl)phthalate	248.0
Cadmium	10.0
Chlordane	2.1
Copper	1300.0
DDT/DDE/DDD (total) [2]	10.2
Dimethylnitrosamine	0.1
Lead	50.0
Lindane	4.0
Mercury	2.0
Nickel	1750.0
Polychlorinated biphenyls	0.45
Toxaphene	5.0
Trichloroethylene	5.0

[1] Pollutant concentration values referenced in 503.33(a).

[2] DDT—2,2-Bis(chlorophenyl)-1,1,1-trichloromethane
DDE—1,1-Bis(chlorophenyl)-2,2-dichloroethene
DDD—1,1-Bis(chlorophenyl)-2,2-dichloroethane

APPENDIX B—Procedure To Determine Annual Whole Sludge Application Rate

Land Application

Section 503.13(b) requires that sewage sludge be applied to agricultural land at an annual whole sludge application rate (AWSAR) that does not exceed the annual pollutant loading rates (APLR) in Table 1. This appendix contains a procedure to be used in determining the AWSAR that will not cause the APLRs to be exceeded.

The relationship between APLR and AWSAR is shown in equation (1).

$$APLR = C \times 0.001 \times AWSAR \qquad (1)$$

Where:

APLR = Annual pollutant loading rate, in kilograms per hectare, per 365-consecutive-day period.

C = Pollutant concentration in sewage sludge, in milligrams per kilogram (dry weight basis).

AWSAR = Annual whole sludge application rate, in metric tons per hectare, per 365-consecutive-day period (dry weight basis).

To determine the pollutant concentration in the sewage sludge, equation (1) is rearranged into equation (2):

$$C = \frac{APLR}{.001 \times AWSAR} \quad (2)$$

The APLR rates are given in Table 1 in § 503.13. The APLR remains constant for all AWSAR and all sludge pollutant concentrations. When the pollutant concentrations vary, AWSARs vary. As the AWSAR increases, the pollutant concentration decreases and vice versa.

Table B–1 contains the pollutant concentrations based on the APLRs in Table 1 for various AWSARs. Table B–1 is used to illustrate the procedure to determine the appropriate AWSAR for a sewage sludge.

Procedure:

1. Locate the sludge pollutant concentrations in Table B–1. The circled values in Table B–1 represent the actual pollutant concentrations for this example. When an actual pollutant concentration is between the values in Table B–1, circle the concentration for the lower AWSAR. For example, if the actual concentration for lindane is 125 mg/kg, circle the value for the 35 MT/ha AWSAR (i.e., 130).

2. Determine the limiting AWSAR for the sewage sludge. The limiting AWSAR is the lowest AWSAR considering all of the circled concentration values. In this example, the limiting AWSAR is 10 MT/ha/365-consecutive-day period.

3. Sewage sludge with the actual pollutant concentrations used in this example (i.e., the circled values in Table B–1) can be applied to agricultural land at an annual whole sludge application rate of 10 MT/ha or less. If the sewage sludge is applied to agricultural land at an annual whole sludge application rate greater than 10 MT/ha, the annual pollutant loading rate for hexachlorobutadiene would be exceeded.

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TABLE 8-1

Maximum Sewage Sludge Concentration
(mg/kg - dry weight basis)

Annual Whole Sludge Application Rate (metric tons per hectare)	1	3	5	10	15	20	25	30	35	40	45	50
Pollutant												
Aldrin/dieldrin	16	5.5	3.3	1.6	1.1	0.82	0.66	0.55	0.47	0.41	0.36	0.33
Benzo(a)pyrene	130	45	27	13	8.9	6.7	5.4	4.5	3.8	3.4	3	3
Chlordane	1200	400	240	120	80	60	48	40	34	30	27	24
DDT/DDE/DDD (total)*	5.5	1.8	1.1	0.55	0.36	0.27	0.22	0.18	0.16	0.14	0.12	0.11
Dimethyl nitrosamine	39	13	7.8	3.9	2.6	1.9	1.6	1.3	1.1	0.97	0.87	0.78
Heptachlor	73	24	15	7.3	4.9	3.7	2.9	2.4	2.1	1.8	1.6	1.5
Hexachlorobenzene	39	13	7.8	3.9	2.6	1.9	1.6	1.3	1.1	0.97	0.87	0.78
Hexachlorobutadiene	340	110	68	34	23	17	14	11	9.7	8.5	7.5	6.8
Lindane	4600	1500	920	460	310	230	180	150	130	120	102	92
Polychlorinated biphenyls	5.64	1.88	1.13	0.56	0.38	0.28	0.23	0.19	0.16	0.14	0.13	0.11
Toxaphene	48	16	9.7	4.8	3.2	2.4	1.9	1.6	1.4	1.2	1.08	0.97
Trichloroethylene	13	4.2	2.5	1.3	0.85	0.64	0.51	0.42	0.36	0.32	0.28	0.25

* DDT - 2,2-Bis(chlorophenyl)-1,1,1-trichloroethane

DDE - 1,1-Bis(chlorophenyl)-2,2-dichloroethylene

DDD - 1,1-Bis(chlorophenyl)-2,2-dichloroethane

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Distribution and Marketing

Section 503.23 requires sewage sludge that is distributed and marketed to meet the pollutant limits in Table 4 for an applicable AWSAR. This appendix contains a procedure that can be used to determine the applicable AWSAR for distribution and marketing.

Equations (1) and (2) in the land application section of this appendix show the relationship between annual pollutant loading rate, annual whole sludge application rate, and pollutant concentration in sewage sludge. Equation (2) is used to calculate the pollutant concentrations in Table B-2 for various AWSARs. The procedure to determine the appropriate AWSAR for a sewage sludge that is distributed and marketed is presented below.

Procedure:

1. Determine the actual concentration of the pollutants listed in Table B-2 in the sewage sludge. The circled values in Table B-2 represent the actual pollutant concentrations for this example. When an actual pollutant concentration is between the values in Table B-2, circle the concentration for the lower AWSAR (see Step 1 of the procedure in this appendix for land application).

2. Determine the applicable AWSAR for the sewage sludge. The applicable AWSAR is the lowest AWSAR considering all of the circled concentration values. In this example, the applicable AWSAR is 15 MT/ha/365-consecutive-day period.

3. The pollutant limits that the sewage sludge has to meet prior to disbursement by the treatment works are those for an AWSAR of 15 MT/ha. If a higher AWSAR is used, the annual pollutant loading rate for lindane would be exceeded.

4. The label or information sheet accompanying the product, required by § 503.24(a), would indicate that the annual product application rate should not exceed 15 MT/ha (i.e., 307 pounds per 1000 square feet per year) if the product is sewage sludge only. If the product is a mixture of sewage sludge and other material such as wood chips, the annual product application rate for the mixture may be higher than 15 MT/ha/365-consecutive-day period, depending on the actual pollutant concentrations in the mixture.

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Table B-2

Maximum Sewage Sludge Concentration
(mg/kg - dry weight basis)

Annual Whole Sludge Application Rate (metric tons per hectare)	1	3	5	10	15	20	25	30	35	40	45	50
Pollutant												
Aldrin/dieldrin	16	5.5	3.3	1.6	1.1	0.82	0.66	0.55	0.47	0.41	0.36	0.33
Arsenic	700	230	140	70	47	35	28	23	20	18	16	14
Benzo(a)pyrene	80	26	15	7.7	5.1	3.8	3.1	2.6	2.2	1.9	1.7	1.5
Cadmium	900	310	180	90	61	46	37	31	26	23	20	18
Chlordane	22500	7500	4500	2200	1500	1100	900	750	640	560	500	450
Chromium	26500	8800	5300	2700	1770	1330	1060	880	760	660	590	530
Copper	2300	770	460	230	150	110	92	77	66	58	51	46
DDT/DDE/DDD (total)	46	15	9.2	4.6	3.1	2.3	1.8	1.5	1.3	1.2	1	0.92
Heptachlor	79	26	16	7.9	5.3	3.9	3.2	2.6	2.3	2	1.8	1.6
Hexachlorobenzene	46	15	9.1	4.6	3	2.3	1.8	1.5	1.3	1.14	1.01	0.91
Hexachlorobutadiene	41000	14000	8200	4100	2700	2100	1600	1400	1200	1000	910	820
Lead	6000	2100	1300	600	400	310	250	210	180	160	140	130
Lindane	293500	97800	58700	29350	19570	14680	11740	9780	8390	7340	6500	5870
Mercury	1990	660	400	199	133	99	80	66	57	50	44	40
Nickel	3900	1300	780	390	260	200	160	130	110	98	87	78
Polychlorinated biphenyls	49	49	30	15	10	7	6	5	4	4	3	3
Selenium	8106	2702.1	1600	810	540	410	320	270	230	200	160	160
Toxaphene	117	39	23	12	7.8	5.8	4.7	3.9	3.3	2.9	2.6	2.3
Zinc	8600	2900	1700	860	570	430	340	290	250	220	190	170

* DDT - 1,1-(4-Chlorophenyl)-2,2,2-trichloroethane
DDE - 1,1-(4-Chlorophenyl)-2,2-dichloroethylene
DDD - 1,1-(4-Chlorophenyl)-2,2-dichloroethane

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APPENDIX C—Procedure To Determine the Number of Applications (Years) That Sewage Sludge May Be Applied to Agricultural Land

Section 503.13(c) requires that sewage sludge not be applied to agricultural land in amounts that do not exceed the cumulative pollutant loading rates in Table 2. This appendix contains a procedure to be used in determining the number of sewage sludge applications that can be made without exceeding those rates. The number of applications is dependent on the pollutant concentrations in the sewage sludge and the annual whole sludge application rate (AWSAR).

Procedure:

1. Determine the concentration of arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc in the sewage sludge. For the purpose of this example, assume the following pollutant concentrations (dry weight basis):

arsenic=37 mg/kg
cadmium=30 mg/kg
chromium=2500 mg/kg
copper=1000 mg/kg
lead=1000 mg/kg
mercury=17 mg/kg
molybdenum=75 mg/kg
nickel=400 mg/kg
selenium=14 mg/kg
zinc=4000 mg/kg

2. Determine the AWSAR for the sewage sludge. The AWSAR is the AWSAR from the land application procedure in Appendix B that does not cause the annual pollutant loading rates in Table 1 to be exceeded. For this example, the AWSAR is 10 MT/ha/365-consecutive-day period.

3. Calculate an annual pollutant loading rate (APLR), for each inorganic pollutant using equation (1).

$$APLR = C \times 0.001 \times AWSAR \qquad (1)$$

Where:

APLR=Annual pollutant loading rate, in kilograms per hectare, per 365-consecutive-day period.
C=Pollutant concentration in sewage sludge in milligrams per kilograms (dry weight basis).
AWSAR=Annual whole sludge application rate, in metric tons per hectare, per 365-consecutive-day period (dry weight basis).

For this example, the APLRs are:

Pollutant	Concentration (mg/kg)	APLR (kg/ha)
Arsenic	37	0.37
Cadmium	30	0.30
Chromium	2500	25.0
Copper	1000	10.0
Lead	1000	10.0
Mercury	17	0.17
Molybdenum	75	0.75
Nickel	400	4.0
Selenium	14	0.14
Zinc	4000	40.0

4. Calculate the years a pollutant can be applied to the land by dividing the cumulative pollutant loading rates from Table 2 in § 503.13 by the APLRs from Step 3 of this procedure.

Pollutant	CPLR (kg/ha)	APLR (kg/ha/yr)	Years (CPLR/APLR)
Arsenic	14.0	0.37	37.8
Cadmium	18.0	0.30	60.0
Chromium	530.0	25.0	21.2
Copper	46.0	10.0	4.6
Lead	125.0	10.0	12.5
Mercury	15.0	0.17	88.2
Molybdenum	5.0	0.75	6.7
Nickel	78.0	4.0	19.5
Selenium	32.0	0.14	299.0
Zinc	170.0	40.0	4.3

5. Select the lowest number of years calculated in Step 4. For this example, the lowest number of years is 4.3.

6. Sewage sludge with the pollutant concentrations given in Step 1 could be applied to agricultural land at an AWSAR of 10 MT/ha/365-consecutive-day period for a maximum of 4.3 years. After 4.3 years, the amount of zinc applied to the land exceeds the cumulative amount that can be applied to the land.

Appendix D—Procedure To Calculate Maximum Combustion Gas Flow Rate

Equation (5) in § 503.63(f) is used to calculate the pollutant limit for total hydrocarbons for a sewage sludge incinerator. This appendix contains the procedure used to determine the maximum combustion gas flow rate (GF) used in that equation.

Procedure:

1. Calculate the maximum combustion gas flow rate for the sewage sludge incinerator attributable to the combustible portion of the sewage sludge using equation (1):

$$SGF = SF \times VF \times VEHC \times 70{,}100 \qquad (1)$$

Where:

SGF=Maximum combustion gas flow rate attributable to the combustible portion of the sewage sludge, in gram moles per day.
SF=Annual average daily sewage sludge feed rate, in metric tons per day (dry weight basis).
VF=Annual average volatile solids fraction of the sewage sludge solids (dimensionless, less than 1.0).
VEHC=Annual average heat value of the volatile solids in sewage sludge, in kilocalories per gram of volatile solids in sewage sludge.

2. Calculate the gas flow rates from the combustion of all auxiliary fuels in the sewage sludge incinerator using equation (2).

$$FGF = FR \times FC \qquad (2)$$

Where:

FGF=Fuel combustion gas flow rate, in gram moles per day.
FR=Annual average daily fuel usage rate, in either pounds per day or cubic feet per day.
FC=Fuel constant: natural gas—17.69, #2 fuel oil—324.8, #6 fuel oil—309.7

3. The maximum combustion gas flow rate (GF) used in equation (5) in § 503.63(f) is the sum of the maximum combustion flow rate attributable to the combustible portion of the sewage sludge (SGF) and the fuel combustion gas flow-rate (FGF).

$$GF = SGF + FGF \qquad (3)$$

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