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Understanding Lagoon Requirements Under 40 C.F.R. Part 503: Best Management Practices for Use or Disposal of Sewage Sludge

Part 1 – Land Application of Sewage Sludge Removed from Lagoons

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Contents

Definitions

Agricultural Land: Land on which a food crop, a feed crop, or a fiber crop is grown. This includes range land and land used as pasture.

Agronomic Rate: The whole sludge application rate (dry weight basis) designed: (1) to provide the amount of nitrogen needed by the food crop, feed crop, fiber crop, cover crop, or vegetation grown on the land; and (2) to minimize the amount of nitrogen in the sewage sludge that passes below the root zone of the crop or vegetation grown on the land to the groundwater.

Biosolids: Sewage sludge treated to meet the requirements in 40 C.F.R. Part 503, *Standards for the Use or Disposal of Sewage Sludge* and intended to be applied to land as a soil amendment or fertilizer.

Bulk Sewage Sludge: Sewage sludge that is not sold or given away in a bag or other container for application to the land.

Domestic Septage: Liquid or solid material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar treatment works that receives only domestic sewage. Domestic septage does not include liquid or solid material removed from a septic tank, cesspool, or similar treatment works that receives either commercial wastewater or industrial wastewater and does not include grease removed from a grease trap at a restaurant.

Domestic Sewage: Waste and wastewater from humans or household operations that is discharged to or otherwise enters a treatment works.

Lagoon: Waste stabilization pond or basin designed and built to reduce organic content, suspended solids, and pathogens in wastewater and sewage sludge. May be a system of several connected ponds/basins.

Land Application: The spraying or spreading of sewage sludge onto the land surface; the injection of sewage sludge below the land surface; or the incorporation of sewage sludge into the soil so that the sewage sludge can either condition the soil or fertilize crops or vegetation grown in the soil.

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

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

Other Container: Either an open or closed receptacle. This includes, but is not limited to, a bucket, a box, a carton, and a vehicle or trailer with a load capacity of one metric ton or less.

Plant Available Nitrogen: Forms of nitrogen that are available to plants during the growing season, specifically ammonium and nitrate.

Preparer: The person or entity who generates sewage sludge during the treatment of domestic sewage in a treatment works or the person who derives a material from sewage sludge. Any time the quality of sewage sludge is changed, a material is considered derived from sewage sludge and the person or entity changing the quality becomes a preparer.

Public Contact Site: Land with a high potential for contact by the public. This includes, but is not limited to, public parks, ball fields, cemeteries, plant nurseries, turf farms, and golf courses.

Reclamation Site: A drastically disturbed land that is reclaimed using sewage sludge. This includes, but is not limited to, strip mines and construction sites.

Self-Implementing: The requirements must be met even in the absence of a permit.

Sewage Sludge: The solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator, or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

Store Or Storage: The placement of sewage sludge on land on which the sewage sludge remains for two years or less. This does not include the placement of sewage sludge on land for treatment.

Surface Disposal: The placement on an active sewage sludge unit for final disposal, not for treatment, storage, or to condition the soil or fertilize crops grown in the soil.

Treat Or Treatment of Sewage Sludge: The preparation of sewage sludge for final use or disposal. This includes, but is not limited to, thickening, stabilization, and dewatering of sewage sludge. This does not include storage of sewage sludge.

Acronyms and Abbreviations

BIL	Bipartisan Infrastructure Law
BMP	Best Management Practice
CEC	Contaminants of Emerging Concern
CDX	Central Data Exchange
C.F.R.	Code of Federal Regulations
CFU	Colony Forming Unit
CPLR	Cumulative Pollutant Loading Rate
CWA	Clean Water Act
CWSRF	Clean Water State Revolving Fund
DMT	Dry Metric Ton
ECOS	Environmental Conservation Online System
EPA	Environmental Protection Agency
MPN	Most Probable Number
NEIWPCC	New England Interstate Water Pollution Control Commission
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and maintenance
PAN	Plant Available Nitrogen
PCB	Polychlorinated Biphenyl
POTW	Publicly Owned Treatment Works
PSRP	Processes to Significantly Reduce Pathogens
SOUR	Specific Oxygen Uptake Rate
SSI	Sewage Sludge Incinerator
USFWS	U.S. Fish and Wildlife Services
VAR	Vector Attraction Reduction
WOTUS	Waters of the United States
WWTP	Wastewater Treatment Plant

Notice

This document has been reviewed in accordance with the U.S. Environmental Protection Agency (EPA) policy and approved for publication. The report was prepared with the support of Tetra Tech, Inc. under the direction and review of the Office of Water - Office of Science and Technology.

This document is not a regulation, nor does it change or substitute for any statutory provisions or regulations. Thus, it imposes no legally binding requirements on the EPA, states, territories, Tribes, or the regulated community. While the EPA has made every effort to ensure the accuracy of the content of this document, obligations of the regulated community continue to be determined by statutes, regulations, or other legally binding requirements. In the event of a conflict between the discussion in this document and any statute or regulation, this document would not be controlling. Mention of trade names or commercial products does not constitute endorsement or recommendation for their use.

This document is not a substitute for the regulation 40 C.F.R. Part 503, *Standards for the Use or Disposal of Sewage Sludge* and does not supersede the requirements in the regulation. Should 40 C.F.R. Part 503 be amended to include additional or more stringent requirements, those requirements must be complied with regardless of whether they are included in this document or not.

This document presents best management practices, not regulatory requirements. If a state contains requirements that contradict the recommendations in this document, the state requirement should be complied with.

The terms “biosolids” and “sewage sludge” are often used interchangeably by the public; however, the EPA typically uses the term ‘biosolids’ to mean sewage sludge that has been treated to meet the requirements in Part 503 and is intended to be applied to land as a soil amendment or fertilizer.

This document can be downloaded from the EPA's Biosolids Webpage.

1. Introduction

1.1 Purpose

The Clean Water Act (CWA), Section 405 required the U.S. Environmental Protection Agency (EPA) to develop a regulation to protect public health and the environment from any reasonably anticipated adverse effects of pollutants that might be present in sewage sludge. This regulation, 40 C.F.R. Part 503, *Standards for the Use or Disposal of Sewage Sludge*, was published on February 19, 1993 (58 FR 9248). 40 C.F.R. Part 503 (or "Part 503") contains requirements for sewage sludge when it is applied to land, incinerated in a sewage sludge incinerator (SSI), or placed on a surface disposal site.

While Part 503 contains requirements when land applying sewage sludge, questions may arise in some cases as to how to best meet those requirements for sewage sludge removed from lagoons. The purpose of this document, *Part 1 – Land Application of Sewage Sludge Removed from Lagoons*, is to explain the management of sewage sludge removal from wastewater treatment lagoons for land application. This document provides a summary of Part 503 requirements and provides best management practices (BMPs) for the land application of sewage sludge removed from a lagoon.

By organizing the sewage sludge removal process properly, the project can be done more efficiently and with the assurance that the Part 503 requirements are met. The process consists of planning a sewage sludge removal project (Section 2. Get Ready – Planning), data and information gathering (Section 3. Get Set – Assessment & Analysis), and land application with good management (Section 4. Go – Land Application).

Land application does not refer to the placement of sewage sludge onto land for the purposes of disposal. For more information on disposal of sewage sludge via placement onto land see the definition of Surface Disposal. BMPs for surface disposal of lagoon sewage sludge will be published in *Part 2 – Surface Disposal of Lagoon Sewage Sludge*.

Neither this document nor Part 503 contain requirements for the operation or maintenance of a wastewater lagoon. More information on lagoon operation and maintenance is available on EPA's website Small and Rural Wastewater Systems – Lagoon Wastewater Treatment Systems and *Compliance Tips for Small Wastewater Treatment Lagoons with Clean Water Act Discharge Permits*.

1.2 Background

Lagoon wastewater treatment systems are basins or ponds built to break down wastewater and sewage sludge using biological processes. Sewage sludge concentrates at the bottom of lagoons and contains bacteria and other microorganisms present from the wastewater collection process. Many of these microorganisms remain biologically active and can further digest the organic solids present in these lagoons. Lagoons can provide cost-effective, low maintenance, energy-efficient wastewater treatment. Lagoon wastewater treatment systems are often utilized by small, rural, and Tribal communities and when connection to a municipal sewage collection system is not available or lacks capacity.

Sludge accumulates in lagoons over time. Excess accumulated sludge requires periodic removal to maintain full functioning capacity of the wastewater treatment process within the lagoon. When there is excess sludge in a lagoon, there is less volume for wastewater, which reduces retention time and the overall effectiveness of the lagoon. Excessive sludge buildup can also result in channels through the

lagoon causing short circuiting. Short circuiting occurs when wastewater passes through a lagoon system too quickly without adequate treatment, prompting a need to remove sludge from the lagoon.

Lagoon systems can struggle to meet water quality requirements for effluent. Control of nutrients and ammonia are two examples of issues faced by these lagoon systems. Sewage sludge removal has been shown to improve permit compliance of biological oxygen demand (BOD), total suspended solids (TSS), and ammonia.

In 2022, the EPA released *Lagoon Wastewater Treatment Action Plan: Supporting Small Rural and Tribal Communities 2022-2026*. The Lagoon Action Plan identifies key actions the EPA will implement through 2026 to assist small communities with lagoon wastewater treatment systems. This document, *Understanding Lagoon Requirements Under 40 C.F.R. Part 503: Best Management Practices for Use or Disposal of Sewage Sludge* is listed in the Lagoon Action Plan as Action Item 2.8.

When sewage sludge is removed from a lagoon it can either be disposed of or beneficially used through land application. Land application is the application of sewage sludge to land to either condition the soil or to fertilize crops or other vegetation grown in the soil. Land application of sewage sludge can have numerous benefits including nutrient addition, improved soil health, carbon sequestration, and water retention among additional economic and waste management benefits (e.g., conservation of landfill space; reduced demand on non-renewable resources like phosphorus; and a reduced demand for synthetic fertilizers). Sewage sludge is often applied to agricultural lands, forests, public contact sites (e.g., public parks, golf courses, etc.), reclamation sites (e.g., mines, construction sites, etc.), lawns, and home gardens.

Sewage sludge can either be applied to land in bulk or sold or given away in bags or other containers. Part 503 contains requirements specific to the application site (e.g., agricultural lands, forests, public contact sites, and reclamation sites vs. lawns and home gardens) and the distribution type (e.g., bulk vs. bagged). Part 503 divides treated sewage sludge into two groups based on the level of pathogen treatment: Class A and Class B. Class B treatment processes significantly reduce, but do not eliminate, pathogens in sewage sludge. Class B pathogen requirements are further divided based on whether the sewage sludge is applied to land with high potential for human exposure versus low potential for human exposure. The Part 503 requirements for Class A are designed to further reduce the risk from pathogens present in treated sewage sludge.

1.3 Permitting Authorities

The National Pollutant Discharge Elimination System (NPDES) program oversees and regulates the discharge of pollutants into waters of the United States (WOTUS). More information about Waters of the United States is available on EPA's website Waters of the United States. A NPDES permit translates general requirements of the CWA into specific provisions for an entity discharging pollutants into water to protect human health and the environment. Components of the NPDES program include the sewage sludge program (also commonly referred to as the biosolids program), state NPDES permits, regulation of federal facilities, the pretreatment program, and the general permits program. States may receive authorization from the EPA to run one or more of the NPDES program components. As of December 2023, nine states (Arizona, Idaho, Michigan, Ohio, Oklahoma, South Dakota, Texas, Utah, and Wisconsin) are authorized to implement the sewage sludge program as part of their NPDES program. In all other states, the EPA remains the NPDES permitting authority for sewage sludge use and disposal. However, in many cases, the EPA works with the states to include the requirements of Part 503 in NPDES permits.

So, while the EPA remains the permitting authority in 41 states, state agencies are often the ones issuing permits. Therefore, in many cases, the EPA recommends contacting state biosolids coordinators for questions related to land application of sewage sludge. A list of biosolids coordinators is available on the EPA's website EPA Regional and State Contacts for Biosolids.

This document presents Part 503 requirements and BMPs for meeting those requirements. In addition to the requirements in Part 503, states, territories, and Tribes may have additional or more stringent requirements for land application of sewage sludge removed from lagoons. It should be noted that the BMPs presented in this document are not required and, in the case where a state requirement does not align with the BMPs provided in this document, the state, territory, or Tribal requirement should be complied with. For example, this document presents several options for meeting the vector attraction reduction (VAR) requirements in Part 503 including incorporation and injection. Some locations may have no-till requirements and therefore incorporation or injection may not be allowable options for meeting the Part 503 VAR requirements. In this case, the state requirements should be followed, and an alternate VAR option should be utilized.

1.4 Assumptions

This document describes the Part 503 requirements and BMPs for the most common scenarios of land application of sewage sludge removed from lagoons. Typically, sewage sludge removed from lagoons is applied as bulk sewage sludge to lands with low potential for human exposure: agricultural lands, forests, reclamation sites in unpopulated areas, as Class B sewage sludge. This document focuses on those scenarios, which assume relatively lower public exposure. If sewage sludge removed from a lagoon were to meet Class A pathogen requirements and/or be applied to, Part 503 should be consulted and the information in this document may not apply. If sewage sludge were applied to be applied to land with high potential for exposure, more stringent site restrictions would apply (see Section 4.2.4 for more information). Additionally, if sewage sludge removed from a lagoon were managed using an alternative practice like disposal in a municipal waste landfill, the information centric to land application in this document may not apply.

2. Get Ready – Planning

The first step in setting up a lagoon sewage sludge removal project is project planning.

2.1 Submitting a Plan

Part 503 does not require a lagoon operator to submit a lagoon emptying or maintenance plan to the permitting authority. However, some states, territories, or Tribes may have their own requirements. Whether or not a state has specific planning requirements, project planning is an important step in the process and a checklist can be beneficial. A plan can include elements such as coordination with the parties involved in the project, assessment of use or disposal options, consideration of funding options, and project scheduling. Before beginning lagoon emptying/maintenance, the operator should consult their environmental agency for any relevant regulations, policies, or guidance related to a lagoon emptying/maintenance plan.

2.2 Permitting

Part 503 is self-implementing, meaning that the requirements may be implemented through a permit, but use or disposal of sewage sludge must meet the Part 503 requirements regardless of whether such a permit has been issued. Some states, territories, or Tribes may require a permit or letter or approval for

lagoon emptying/maintenance and/or land application of sewage sludge. The operator should consult their environmental agency for any relevant regulations, policies, or guidance related to permitting.

2.3 Infrastructure Assessment

While planning a lagoon clean out, the operator may also plan to do a physical assessment of the lagoon infrastructure. When excess sewage sludge is removed from a lagoon, structures, pipework, and liners can be repaired or replaced as needed before the lagoon is put back into service. Planning for infrastructure improvements will allow the operator to begin work after sewage sludge is removed from the lagoon. Infrastructure repairs and upgrades may include but are not limited to:

- Pipework (including moving locations to reduce short circuiting)
- Valves
- Monitoring points/ clean-out accesses
- Structures (e.g., repairing concrete)
- Liners

2.4 Cost & Funding

Removing sewage sludge from a lagoon can be an extensive and expensive project. Understanding the costs and exploring funding opportunities during planning is an important step.

2.4.1 Cost Estimates

After the operator has an estimate of the volume and characterization of the chemical quality of sewage sludge in a wastewater treatment lagoon, a contractor or specialists can provide a cost estimate for dewatering, removal, and land application (see Section 4 for more information). When considering land application sites and costs, the operator should account for transportation costs to the land application site and any cost associated with the need for additional amendments to stabilize the sewage sludge removed.

Pumping, transporting, and land application of large quantities of sewage sludge from a lagoon requires specialized equipment and capabilities. Utilizing a contractor who specializes in these projects can be the most cost-effective way to complete this project. The operator may use the information collected in the later sections of this document including sewage sludge quality and volume to bid a project. Some contractors may also offer the option of doing the initial analysis described in previous sections as part of their services.

2.4.2 Clean Water State Revolving Funds for Lagoon Clean Outs

The EPA believes that sludge removal from a lagoon is not a routine operations and maintenance (O&M) event (see Appendix B for more information). Over the design life of a wastewater treatment lagoon, sewage sludge accumulates up to several feet deep and eventually, lagoons must have sludge removed in order to make necessary infrastructure repairs and regain treatment capacity. This is usually a once in 20 to 30-year event that occurs when the lagoon has reached its design life and the infrastructure must be rehabilitated to original conditions that existed when the infrastructure was new. For this reason, sludge removal in a lagoon is considered infrastructure rehabilitation and is eligible for Clean Water State Revolving Loan Fund (CWSRF) assistance. Lagoon closing and demolition activities may be eligible for CWSRF assistance if it meets one of the twelve eligibility criteria of CWSRF. The operator should consult their state CWSRF programs to discuss possible funding sources for the lagoon projects. A list of CWSRF programs is available on EPA's

website State CWSRF Program Contacts. Projects that utilize CWSRF funding may have additional requirements not presented in this document. The operator should consult their state CWSRF program for a full list of requirements.

The Bipartisan Infrastructure Law (BIL) signed on November 6, 2021, provides an additional $11.7 billion in funding to the CWSRF through fiscal year 2026. Forty-nine percent of those funds are available as grants and principal forgiveness loans to communities that meet the state's affordability criteria or for certain project types that meet eligibility requirements, consistent with the CWA. More information about the EPA's BIL initiatives and ongoing water technical assistance programs are available on the EPA's website Water Technical Assistance: Ensuring Equitable Access to Water Infrastructure Funding.

3. Get Set – Assessment & Analysis

For sewage sludge that will be land applied, Part 503 includes requirements to analyze for chemical pollutants and pathogens, requirements that land application be at agronomic rate, and requirements for VAR (among others). An assessment of the volume of sewage sludge along with its quality (pollutant concentrations, pathogen densities, and nitrogen content) provides the operator with the necessary information required to comply with Part 503, secure a land application specialist, and a land application site. The volume of sewage sludge also determines the number of samples that must be taken to satisfy the monitoring requirements in Part 503.

Monitoring conducted during the initial stages of the project enables the operator to adequately proceed in planning with the information necessary to comply with Part 503. An analysis of chemical pollutants, nutrients, pathogens, and sewage sludge stability (for some VAR options) are necessary for complying with Part 503.

To complete an assessment of the volume and quality of sewage sludge in a lagoon, the operator will need to analyze for:

- Percent solids
- Fecal Coliform density
- Nine chemical pollutants (arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc)
- Nitrogen
    - Total Kjeldahl Nitrogen (TKN)
    - NH_4-N (ammonium nitrogen)
    - NO_3-N (nitrate nitrogen)

States, territories, or Tribes may regulate additional pollutants in sewage sludge besides those listed above (e.g., contaminants of emerging concern (CECs), Polychlorinated Biphenyls (PCBs), phosphorus, etc.). The operator should consult their environmental agency for any relevant regulations, policies, or guidance related to pollutants before finalizing an assessment and analysis plan.

3.1 Sampling Sewage Sludge

Sampling sewage sludge to comply with the Part 503 chemical pollutant, pathogen, and VAR requirements requires the operator to know the volume of sewage sludge that will be removed from the

lagoon. However, estimating the volume of sewage sludge requires the operator to first map the lagoon and take some samples for analysis (see Section 3.2 for more information). All in all, this is an iterative and circular process. The operator may benefit from doing a preliminary assessment of volume of sewage sludge and then refining the sampling plan. If the volume of sewage sludge removed from the lagoon exceeds the initial estimate and requires a greater number of minimum samples than were taken, the operator may be out of compliance for frequency of monitoring (see Section 3.2.3 for more information). If the estimate of the volume of sewage sludge in the lagoon is near the maximum end of the ranges in Table 1 of Section 503.16, the operator may choose to take the minimum number of samples from next higher range.

3.1.1 Sampling Plan

To sample sewage sludge in a lagoon, the operator may consider using a grid system to determine sample locations. A grid system will aid the operator in collecting random samples from the lagoon. When setting up a grid system, consider the size of the lagoon and its current condition. The grid should be detailed enough for sewage sludge accumulations due to wind, depth around dikes, mounding near inlet structures, and age and condition of the lagoon. The operator should develop a grid for each individual lagoon cell. More information on setting up a grid system and selecting sample location points in available in *Biosolids Management Handbook for Small Publicly Owned Treatment Works (POTWs)* – Section 2.4.I.B. After sample locations have been determined, equipment can be used to determine sewage sludge depths and to take grab samples. When sampling, the operator should ensure not to include liner material or liner cover material in samples, which can skew the analysis and volume estimates. More information on sampling plans is available in *The Wastewater Treatment Plant Operators Guide to Biosolids Sampling Plans* published by the New England Interstate Water Pollution Control Commission (NEIWPCC). Some states, territories, or Tribes may have additional sampling plan requirements. The operator should consult their environmental agency for any additional regulations, policies, or guidance related to sampling plans.

3.2 Estimating Amount of Sewage Sludge

With a map of sludge depth in the lagoon gleaned from the grid, the area of the lagoon, and percent total solids, the operator can estimate the volume of sewage sludge in a lagoon.

There is no formula in Part 503 for estimating the volume of sewage sludge in a lagoon. This document provides two potential formulas for calculating sludge volume based on the form of the sewage sludge in the lagoon. These formulas may provide the operator with a rough estimate of sewage sludge volume. However, these formulas do not consider potential layers of accumulated sewage sludge with different densities and percent solids. In many cases, the operator may benefit from utilizing a specialized contractor or engineer to calculate the volume of sewage sludge in a lagoon.

Some states may provide required formulas for calculating sewage sludge volume. The operator should consult their environmental agency for any relevant regulations, policies, or guidance for estimating volume of sewage sludge in a lagoon.

3.2.1 Sewage Sludge in Liquid Form

1.Estimate the volume of sewage sludge:

To estimate the volume of sewage sludge in gallons (g), multiply the depth of the lagoon in inches (in) by the surface area of the lagoon in acres (ac). Then use the conversion factor of 27,154 gallons/acre-inch (g/acre-in) to convert the volume into gallons.

$$V\ (g) = d\ (in.) * SA\ (ac) * 27{,}154 \frac{g}{acre\text{-}in.}$$

Where V = volume in gallons, d = depth in inches, and SA = surface area in acres

2.Convert gallons to dry metric tons:

To convert volume to weight in dry metric tons, assume that the sludge has the same weight as water (8.34 pounds/gallon). Then convert pounds (lbs) to metric tons (MT) using the conversion factor 2205 lbs/MT. Finally, convert metric tons to dry metric tons using the analytical result of percent solids of the sludge (% solids).

$$W_{DMT} = \frac{V\ (g) * 8.34 \frac{lb}{g}}{2205 \frac{lb}{MT}} * \%\ solids$$

Simplified as: $W_{DMT} = V\ (g) * \%\ solids\ * 0.00378 \frac{MT}{g}$

Where W_{DMT} = weight in dry metric tons and V = volume in gallons

Example:

An example of this calculation for a 3-acre pond with 16-inch-deep layer of sludge, 5% solids is as follows:

$$V\ (g) = d\ (in.) * SA\ (ac) * 27{,}154 \frac{g}{acre\text{-}in.} = 1{,}303{,}392\ gallons$$

$$W_{DMT} = V\ (g) * \%\ solids\ * 0.00378 \frac{MT}{g} = 246.3\ DMT$$

3.2.2 Sewage Sludge in Cake Form

1.Estimate the volume of sewage sludge:

To estimate the sludge volume in cubic yards (yd^3), multiply the depth of sludge in feet (ft) by the surface area of the lagoon in acres (ac). Then convert to acres square feet (ft^2) using the conversion factor 43,460 square feet/acre (ft^2/ac). Finally convert square feet to cubic feet (ft^3) using the conversion factor of 27 ft^3/yd^3.

$$V\ (yd^3) = \frac{d\ (ft) * SA\ (ac) * \ 43{,}560 \frac{ft^2}{acre}}{27 \frac{ft^3}{yd^3}}$$

Simplified as: $V\ (yd^3) = \ d\ (ft) * SA\ (acres) * 1{,}613.3 \frac{yd^3}{acre-ft}$

Where V = volume in cubic yards, d = depth in feet, and SA = surface area in acres

2.Calculate the wet weight of sewage sludge:

a. Weigh an empty five-gallon bucket. Record this weight in pounds (lbs).

b. Fill the bucket with sludge.

c. Scrape the surface to level the sludge.

d. Weigh the full bucket. Record this weight.

e. Calculate the wet weight per gallon of the sludge:

$$W_{WET} = \frac{weight\ of\ full\ bucket\ (lbs) - weight\ of\ empty\ bucket\ (lbs)}{5\ gallons}$$

Where W_{WET} = wet weight in pounds per gallon

3.Convert wet weight to dry metric tons:

To convert wet weight per gallon to dry metric tons, multiply the wet weight by the analytical result of percent solids of the sludge (% solids). Then multiply by the volume of sewage sludge removed from the lagoon in cubic yards (yd^3). Then multiply by the conversation factor 202 gallons per cubic yard (g/yd^3). Finally divide by the conversion factor of 2205 pounds per metric ton (lbs/MT).

$$W_{DMT} = \frac{W_{WET}\ \left(\frac{lbs}{g}\right) * \%\ solids * V\ (yd^3) * 202\frac{g}{yd^3}}{2{,}205\frac{lbs}{DMT}}$$

Simplified as: $W_{DMT} = W_{WET}\ \left(\frac{lbs}{g}\right) * \%\ solids * V\ (yd^3) * 0.0916\frac{g-DMT}{yd^3-lbs}$

Where W_{DMT} = weight in dry metric tons, W_{WET} = wet weight in pounds per gallon, and V = volume in cubic yards

Example:

An example of this calculation for a 3-acre pond with 15-inch-deep layer of sludge, 25% solids, empty bucket weight of 2 lbs and full bucket weight of 57 lbs is as follows:

$$V\ (yd^3) =\ 1.25\ (ft) * 3\ (acres) * 1{,}613.3\frac{yd^3}{acre-ft} = 6{,}049.9\,yd^3$$

$$W_{WET} = \frac{57\ (lbs) - 2\ (lbs)}{5\ gallons} = 11\ lbs$$

$$W_{DMT} = 11\ \left(\frac{lbs}{g}\right) * 0.25 * 6049.9\ (yd^3) * 0.0916\frac{g-DMT}{yd^3-lbs} = 1{,}524\ DMT$$

This estimate will help aid the operator gauge the minimum number of samples required for compliance with the frequency of monitoring requirements and estimate costs of removal, transport, and land application.

3.2.3 Number of Samples Required

Part 503 provides a frequency of monitoring requirement based on the amount of sewage sludge used or disposed of annually. For a lagoon clean out project, the frequency of monitoring requirements can be thought of as the minimum number of samples of sewage sludge that must be taken for analysis to comply with Part 503. The volume of sewage sludge removed from the lagoon and used or disposed determines the frequency of monitoring and therefore the minimum number of samples needed. For lagoon clean outs, the volume of sewage sludge removed determines the minimum number of samples that needed to be taken, not the frequency of use or disposal.

40 C.F.R. Section 503.16 Frequency of monitoring.

(a) *Sewage sludge.* (1) The frequency of monitoring for the pollutants listed in Table 1, Table 2, Table 3, and Table 4 of §503.13; the pathogen density requirements in §503.32(a) and §503.32(b)(2); and the vector attraction reduction requirements in §503.33 (b)(1) through (b)(4) and §503.33 (b)(7) through (b)(8) shall be the frequency in Table 1 of §503.16.

Table 1 of §503.16—Frequency of Monitoring—Land Application

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

[1]Either the amount of bulk sewage sludge applied to the land or the amount of sewage sludge prepared for sale or give-away in a bag or other container for application to the land (dry weight basis).

…

The requirements in Section 503.16 Table 1 may be thought of as a minimum number of samples based on the volume removed from the lagoon. If the volume of sewage sludge in a lagoon is:

- Greater than zero but less than 290 dry metric tons (DMT), the operator should take a minimum of (1) one sample;
- Equal to or greater than 290 DMT but less than 1,500 DMT, the operator should take a minimum of 4 (four) samples;
- Equal to or greater than 1,500 DMT but less than 15,000 DMT, the operator should take a minimum of 6 (six) samples;
- Equal to or greater than 15,000 DMT, the operator should take a minimum of 12 (twelve) samples.

The minimum number of samples required by Table 1 of Section 503.16 apply when analyzing sewage sludge for chemical pollutants (see Section 3.3 for more information). When analyzing sewage sludge for pathogens, the minimum number of samples required must be multiplied by seven to calculate the geometric mean of the density of fecal coliform in the sewage sludge (see Section 3.4 for more information). If the sewage sludge has already been removed from the lagoon and is mixed into a homogenous pile, the minimum number of samples applies to the pile of sewage sludge. If the sewage sludge is still in the lagoon the number of samples required applies to each lagoon cell.

An example of this requirement is if 2000 DMT of sewage sludge were removed from a lagoon for land application, Table 1 of Section 503.16 requires that the operator collect six representative samples to be analyzed for chemical pollutants and 42 samples (6 x 7) to be analyzed for fecal coliform.

States, territories, or Tribes may require a greater minimum number of samples based on factors besides volume of sewage sludge like surface area. The operator should consult their environmental agency for any relevant regulations, policies, or guidance related to number of samples required.

> 40 C.F.R. Section 503.8 Sampling and analysis.
> (a) *Sampling.* Representative samples of sewage sludge that is applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator shall be collected and analyzed.

In addition to a minimum number, Part 503 requires that samples be representative of the sewage sludge that will be applied to land. In some cases, individual grab samples may not be adequately representative of the sewage sludge in a lagoon. For example, a grab sample taken near the influent inlet may have a higher concentration of pollutants than other areas of the lagoon. However, if the sampling plan does not include a grab sample located near the influent inlet, the calculated concentration of pollutants in the sewage sludge may be lower than actuality. Whatever the situation, representative samples must be collected to show compliance with Part 503. Although Table 1 of Section 503.16 may only require one, four, six or twelve samples to be taken, that may not result in a representative sample and additional grab samples should be taken to create a representative composite sample. Mapping the lagoon will aid the operator in selecting appropriate lagoon locations for sampling.

3.3 Pollutant Limits

Bulk sewage sludge must meet two types of pollutant limits in Part 503: ceiling concentrations, and either the pollutant concentrations or the cumulative pollutant loading rate.

> 40 C.F.R. Section 503.13 Pollutant limits.
> (a) *Sewage sludge.* (1) Bulk sewage sludge or sewage sludge sold or given away in a bag or other container shall not be applied to the land if the concentration of any pollutant in the sewage sludge exceeds the ceiling concentration for the pollutant in Table 1 of §503.13.
> (2) If bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site, either:
>
> (i) The cumulative loading rate for each pollutant shall not exceed the cumulative pollutant loading rate for the pollutant in Table 2 of §503.13; or
>
> (ii) The concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3 of §503.13.
>
> …

All sewage sludge applied to land must meet the ceiling concentrations in Section 503.13 Table 1 (see Section 3.3.1 for more information). After the ceiling concentrations in Table 1 of Section 503.13 are met, either the pollutant concentrations in Table 3 of Section 503.13 or cumulative pollutant loading rates in Table 2 of Section 503.13 must be met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site. The differences between Table 2 – Cumulative Pollutant Loading Rates and Table 3 – Pollutant Concentrations are the units and what the limit applies to (see Sections 3.3.2 and 3.3.3 for more information).

3.3.1 Ceiling Concentrations

All sewage sludge applied to land must meet the ceiling concentrations in Section 503.13 Table 1. If pollutant ceiling concentrations are exceeded, the operator should consult their environmental agency to explore alternative management practices such as landfilling.

40 C.F.R. Section 503.13 Pollutant limits.

(b) *Pollutant concentrations and loading rates—sewage sludge—*

(1) *Ceiling concentrations.*

Table 1 of §503.13—Ceiling Concentrations

Pollutant	Ceiling concentration (milligrams per kilogram)[1]
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7500

[1] Dry weight basis.

…

3.3.2 Pollutant Concentrations

After the ceiling concentrations in Table 1 of Section 503.13 are met, either the pollutant concentrations in Table 3 of Section 503.13 or cumulative pollutant loading rates in Table 2 of Section 503.13 must be met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site. The pollutant concentrations in Table 3 of Section 503.13 are monthly average concentrations in sewage sludge. The monthly average concentration of the pollutant in the sewage sludge that is applied to the land cannot exceed the value for the pollutant in Table 3 of Section 503.13. However, because most land application events for sewage sludge removed from a lagoon typically occur in less than one month, this would require the total concentrations of pollutants in the sewage sludge meet the concentrations in Table 3 of 503.13 without averaging over a several month-long period.

40 C.F.R. Section 503.13 Pollutant limits.

(b) *Pollutant concentrations and loading rates—sewage sludge—*

…

(3) *Pollutant concentrations.*

Table 3 of §503.13—Pollutant Concentrations

Pollutant	Monthly average concentration (milligrams per kilogram)[1]
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

[1] Dry weight basis.

…

3.3.3 Cumulative Pollutant Loading Rate

If pollutants exceed the values of Table 3 of Section 503.13, then the cumulative pollutant loading rates in Table 2 of Section 503.13 must be used to meet the chemical pollutant requirements in Part 503. A cumulative pollutant loading rate is the cumulative amount of an inorganic pollutant that can be applied to an area of land. To comply with this requirement, the amount of each pollutant in the bulk sewage sludge applied to a site must be known. Records must be kept of the amount of each pollutant applied to each site beginning July 20, 1993, when Part 503 went into effect. When the cumulative pollutant loading rate for any of the pollutants in Table 2 of Section 503.13 is reached for a site, no more bulk sewage sludge may be applied to that site.

40 C.F.R. Section 503.13 Pollutant limits.

(b) *Pollutant concentrations and loading rates—sewage sludge—*

…

(2) *Cumulative pollutant loading rates.*

Table 2 of §503.13—Cumulative Pollutant Loading Rates

Pollutant	Cumulative pollutant loading rate (kilograms per hectare)
Arsenic	41
Cadmium	39
Copper	1500
Lead	300
Mercury	17
Nickel	420
Selenium	100
Zinc	2800

…

3.3.4 Analytical Methods for Chemical Pollutants

Part 503 identifies specific methods that must be used to analyze for the regulated inorganic pollutants in Tables 1, 2, and 3 of Section 503.13.

> 40 C.F.R. Section 503.8 Sampling and analysis.
> (b) *Methods.* The materials listed below are incorporated by reference in this part.... The methods in the materials listed below (or in 40 CFR part 136) shall be used to analyze samples of sewage sludge.
> …
> (4) Inorganic pollutants. "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", EPA Publication SW-846, Second Edition (1982) with Updates I (April 1984) and II (April 1985) and Third Edition (November 1986) with Revision I (December 1987). Second Edition and Updates I and II are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (PB-87-120-291). Third Edition and Revision I are available from Superintendent of Documents, Government Printing Office, 941 North Capitol Street, NE., Washington, DC 20002 (Document Number 955-001-00000-1).
> …

An updated list of available methods for chemical pollutants found in sewage sludge is available on EPA's website Sewage Sludge Analytical Methods and Sampling Procedures. States, territories, or Tribes may regulate additional chemical pollutants in sewage sludge besides the nine pollutants regulated in Part 503. The operator should consult their environmental agency for any relevant regulations, policies, or guidance related to chemical pollutant limits.

3.3.5 PCBs

Part 503 does not contain pollutant limits for PCBs; however, sewage sludge with a total PCB concentration greater than 50 mg/kg must be disposed of under procedures in 40 C.F.R. part 261-258.

> 40 C.F.R. Section 503.6 Exclusions.
> (f) *Sewage sludge with high PCB concentration.* This part does not establish requirements for the use or disposal of sewage sludge with a concentration of polychlorinated biphenyls (PCBs) equal to or greater than 50 milligrams per kilogram of total solids (dry weight basis).
> …

More information on disposal of hazardous waste is available on EPA's website Resource Conservation and Recovery Act (RCRA) Regulations. If the operator has reason to believe that a lagoon may have historic PCB contamination, they may consider analyzing for PCBs in the sewage sludge before land application.

Some states, territories, or Tribes may require analysis of PCBs in sewage sludge removed from lagoons The operator should consult their environmental agency for any relevant regulations, policies, or guidance related to PCBS.

3.3.6 Future Regulated Pollutants

As the EPA evaluates pollutants found in sewage sludge for potential risk to human health and the environment, Part 503 may be amended to include additional or more stringent chemical pollutant limits. This document is not a substitute for the regulation 40 C.F.R. Part 503, *Standards for the Use or Disposal of Sewage Sludge* and does not supersede the requirements in the regulation. The operator should review the Code of Federal Regulations to ensure they are complying with all regulated pollutants.

3.4 Pathogen Requirements

Sewage sludge applied to land must meet the requirements for one of two classes of pathogen reduction options.

> 40 C.F.R. Section 503.15 Operational standards—pathogens and vector attraction reduction.
> *(a) Pathogens—sewage sludge.* (1) The Class A pathogen requirements in §503.32(a) or the Class B pathogen requirements and site restrictions in §503.32(b) shall be met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation
> ..

The type and level of treatment for pathogens help determine how the sewage sludge can be applied or distributed. It is the EPA's understanding that, it is likely that in most cases, sewage sludge removed from a lagoon will not meet the Class A pathogen requirements in Part 503 without further treatment.

> 40 C.F.R. Section 503.32 Pathogens.
> (b) *Sewage sludge—Class B.* (1)(i) The requirements in either §503.32(b)(2), (b)(3), or (b)(4) shall be met for a sewage sludge to be classified Class B with respect to pathogens.
> (ii) The site restrictions in §503.32(b)(5) shall be met when sewage sludge that meets the Class B pathogen requirements in §503.32(b)(2), (b)(3), or (b)(4) is applied to the land.
> (2) *Class B—Alternative 1.*
>
> (i) Seven representative samples of the sewage sludge that is used or disposed shall be collected.
>
> (ii) The geometric mean of the density of fecal coliform in the samples collected in paragraph (b)(2)(i) of this section shall be less than either 2,000,000 Most Probable Number per gram of total solids (dry weight basis) or 2,000,000 Colony Forming Units per gram of total solids (dry weight basis).
>
> (3) *Class B—Alternative 2.* Sewage sludge that is used or disposed shall be treated in one of the Processes to Significantly Reduce Pathogens described in appendix B of this part.
> …

Thus, this section focuses on meeting Class B pathogen requirements, which are applicable for most of the sewage sludge removed from lagoons.

There are three alternatives in Part 503 for meeting the Class B pathogen requirements, but they are not applicable for sewage sludge removed from lagoons. In most cases, sewage sludge removed from a lagoon and applied as bulk Class B sewage sludge must meet 'Class B – Alternative 1'. In rare cases the operator may choose to further treat sewage sludge removed from a lagoon in one of the Processes to

Significantly Reduce Pathogens (PSRPs) in 'Class B – Alternative 2.' In these cases, the operator should consult with their environmental agency.

3.4.1 Class B – Alternative 1

Alternative 1 requires that seven samples of treated sewage sludge be collected, and that the geometric mean fecal coliform density of these samples be less than 2 million colony forming units (CFU) or most probable number (MPN) per gram of sewage sludge (dry weight basis). This approach uses fecal coliform density as an indicator of the average density of bacterial and viral pathogens. Detailed guidance on meeting the Part 503 pathogen requirements is available in EPA's document, *Pathogens and Vector Attraction in Sewage Sludge.*

3.4.2 Analytical Methods for Pathogens

Part 503 identifies specific methods that must be used to analyze for fecal coliform in sewage sludge. An updated list of available methods for fecal coliform available on EPA's website on Sewage Sludge Analytical Methods and Sampling Procedures.

> **40 C.F.R. Section 503.8 Sampling and analysis.**
> (b) *Methods.* The materials listed below are incorporated by reference in this part... The methods in the materials listed below (or in 40 CFR part 136) shall be used to analyze samples of sewage sludge.
> …

Part 503 requires that fecal coliform samples be analyzed using either one of the methods provided in Section 503.8 including those included by reference in 40 C.F.R. Part 136 – *Guideline Establishing Test Procedures for the Analysis of Pollutants* (or "Part 136"). The EPA recommends the use of EPA Method 1680 or EPA Method 1681.

> **40 C.F.R. Section 136.3 Identification of test procedures.**
>
> Table II - Required Containers, Preservation Techniques, and Holding Times

Parameter number/name	Container [1]	Preservation [2 3]	Maximum holding time [4]
Table IA—Bacterial Tests			
1-4. Coliform, total, fecal, and *E. coli*	PA, G	Cool, <10 °C, 0.008% $Na_2S_2O_3$ [5]	8 hours.[22 23]

> Footnotes available in Part 136: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-136

Part 136 contains maximum holding times and temperature requirements during transportation to the laboratory. These requirements apply to available methods for analyzing fecal coliforms. Sewage sludge from lagoons must be held at 10° Celsius (39.2° Fahrenheit) or less (do not freeze) during transportation, and subsequent fecal coliform testing must occur within 8 hours from the time of collection, including transportation time. Therefore, proper planning and coordination with the courier service as well as the analytical laboratory are essential to meet the regulatory requirements for pathogens. The EPA recommends that the laboratory be notified several days in advance so they

can be prepared to initiate the analysis within the maximum hold time from the time of collecting the sample. Some states, territories, or Tribes may require that certain labs are used for fecal coliform analysis. In the event where it is infeasible to meet the fecal coliform holding times using a state specified lab, the operator should contact their environmental agency for guidance. All bulk Class B sewage sludge applied to agricultural land, forests, public contact sites, and reclamation sites must meet this alternative. If the operator cannot meet this alternative, sewage sludge may not be land applied as bulk Class B sewage sludge. The operator will either need to further treat the sewage sludge to meet the Class A pathogen requirements or seek an alternate management practice such as landfilling.

Part 503 requires that samples be representative of sewage sludge. Therefore, fecal coliform testing should take place at the time of use or disposal. If a facility stores the material before it is distributed for land application, microbiological testing should take place after storage, just prior to application. For sewage sludge removed from a lagoon, pathogen sampling should occur after dewatering as pathogens could concentrate in the lower volume of sewage sludge and exceed the limit.

3.5 Vector Attraction Reduction

Part 503 requires that sewage sludge applied to land utilize one of ten options to achieve VAR. Vectors are any living organisms capable of transmitting a pathogen from one organism to another either mechanically by simply transporting the pathogen or biologically by playing a specific role in the life cycle of the pathogen. Examples of vectors for sewage sludge pathogens include insects, rodents, and birds. The pathogens in sewage sludge pose a disease risk if there are routes by which the pathogens are brought into contact with humans or animals. A principal route for transport of pathogens is vector transmission.

VAR can be accomplished by (1) biological processes that break down volatile solids (reducing the available food nutrients for microbial activities and odor producing potential); (2) chemical or physical conditions that stop microbial activity; or (3) physical barriers between sewage sludge and potential vectors.

> 40 C.F.R. Section 503.15 Operational standards—pathogens and vector attraction reduction.
> (c) *Vector attraction reduction—sewage sludge.* (1) One of the vector attraction reduction requirements in §503.33 (b)(1) through (b)(10) shall be met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site.
> …

There are ten options in Part 503 for VAR when land applying bulk Class B sewage sludge to agricultural lands, forests, public contact sites, and reclamation sites but not all are applicable for sewage sludge removed from lagoons. VAR options Sections 503.33(b)(2), (9), and (10) are often the most appropriate for lagoon sewage sludge land application events. Several of the options, Sections 503.33(b)(1), (3), and (4) would not be appropriate for sewage sludge removed from a lagoon as the sewage sludge has not gone through a documented aerobic treatment process. VAR option Section 503.33(b)(7) would also not be applicable if the lagoon contains unstabilized solids. VAR options Sections 503.33(b)(5), (6), and (8) could be available although they require additional treatment after the sewage sludge has been removed from the lagoon. In these cases, the operator should consult with their environmental agency.

40 C.F.R. Section 503.33 Vector attraction reduction.

…

(b)

…

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

…

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

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

…

(10)(i) Sewage sludge applied to the land surface or placed on an active sewage sludge unit shall be incorporated into the soil within six hours after application to or placement on the land, unless otherwise specified by the permitting authority.

…

While the operator may be able to demonstrate VAR using several of the options in Part 503, this section focuses on the options that are most applicable to sewage sludge removed from lagoons.

3.5.1 Option 2 – Volatile Solids

Under this option, anaerobically digested sewage sludge is considered to have achieved satisfactory VAR if it loses less than 17% additional volatile solids when it is anaerobically batch-digested in the laboratory in a bench-scale unit at 30°C to 37°C (86°F to 99°F) for an additional 40 days. Procedures for this test are presented in *Pathogens and Vector Attraction in Sewage Sludge* – Appendix D. As noted in Appendix D, the material balance method for calculating additional volatile solids reduction will likely show greater reductions than the Van Kleeck method.

Sewage sludge removed from lagoons has undergone anaerobic digestion and lost most of its volatile solids. It is only recognized by the regulations as a sewage sludge when it is removed from the lagoon. If it were to be further processed by anaerobic digestion, the likelihood of achieving 38% volatile solids reduction is very low. The additional anaerobic digestion test which requires a long period of batch digestion at temperatures between 30° and 37°C is an appropriate test to determine whether such sewage sludge has the potential to attract vectors.

Sampling to meet the VAR requirements using Option 2 should occur before a lagoon is dewatered or mixed to avoid altering the anaerobic environment. If the volatile solid reduction requirement is met using Option 2, the operator need not resample and reanalyze after further dewatering or mixing during the removal process. Detailed guidance on meeting the Part 503 VAR requirements is available in *Pathogens and Vector Attraction in Sewage Sludge.*

3.5.2 Option 9 – Injection

VAR can be achieved by injecting the sewage sludge below the ground. Under this option, no significant amount of the sewage sludge can be present on the land surface within 1 hour after injection. Injection of sewage sludge beneath the soil places a barrier of earth between the sewage sludge and vectors. Detailed guidance on meeting the Part 503 VAR requirements is available in *Pathogens and Vector Attraction in Sewage Sludge.* The operator should consult their environmental agency for any additional regulations, policies, or guidance related to injection of sewage sludge.

3.5.3 Option 10 – Incorporation

Under this option, sewage sludge must be incorporated into the soil within six hours after application. Detailed guidance on meeting the Part 503 VAR requirements is available in *Control of Pathogens and Vector Attraction in Sewage Sludge.* The operator should consult their environmental agency for any additional regulations, policies, or guidance related to incorporation of sewage sludge.

3.6 Nitrogen

Part 503 requires that the sewage sludge land application rate must be equal to or less than the agronomic rate (except in the case of a reclamation site where a different rate of application is allowed by the permitting authority). The agronomic rate is a rate designed to provide the amount of nitrogen needed by a crop or vegetation to attain a desired yield while minimizing the amount of nitrogen that will pass below the root zone of the crop or vegetation to the groundwater.

> 40 C.F.R. Section 503.14 Management practices.
> (d) Bulk sewage sludge shall be applied to agricultural land, forest, a public contact site, or a reclamation site at a whole sludge application rate that is equal to or less than the agronomic rate for the bulk sewage sludge, unless, in the case of a reclamation site, otherwise specified by the permitting authority.

> 40 C.F.R. Section 503.11 Special definitions.
> (b) *Agronomic rate* is the whole sludge application rate (dry weight basis) designed:
> (1) To provide the amount of nitrogen needed by the food crop, feed crop, fiber crop, cover crop, or vegetation grown on the land; and
> (2) To minimize the amount of nitrogen in the sewage sludge that passes below the root zone of the crop or vegetation grown on the land to the ground water.

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

many factors and will vary from site to site and at the same site. When monitoring sewage sludge, the operator may consider analyzing for different forms of nitrogen to calculate necessary rates including Total Kjeldahl Nitrogen (TKN), NH_4-N (ammonium nitrogen), and NO_3-N (nitrate nitrogen). Once nitrogen content is determined the operator may use this data and additional site-specific data to ensure application at or below agronomic rate. More information on agronomic rate is available in Section 4.1.2.

3.6.1 Analytical Methods for Nitrogen

Currently there are no required methods in Part 503 for analyzing nitrogen in sewage sludge. States, territories, or Tribes may require specific methods be used in analysis. The operator should consult their environmental agency for any relevant regulations, policies, or guidance related to nitrogen analysis. In the absence of a requirement, the operator should ensure that the method selected is appropriate for the sewage sludge matrix as many methods are written for analysis of aqueous samples. A sample preparation may be necessary for solid or semi-solid samples.

4. Go – Land Application

Using the planning, analysis, and information from the previous steps of this process, the work of emptying a lagoon and subsequent land application can occur.

Part 503 contains additional site-specific management practices for where sewage sludge can be land applied. While the requirements are explicit, these requirements are site-specific, and questions may arise about which factors to consider in order to meet these requirements. This section aims to provide BMPs for meeting the site-specific land application requirements.

4.1 Using Nitrogen as a Factor to Select a Site for Land Application

Part 503 requires that the sewage sludge land application rate must be equal to or less than the agronomic rate based on nitrogen. Calculating agronomic rate is a complex process and requires site-specific information including soil testing. However, the operator can also use analytical results from different forms of nitrogen in sewage sludge to estimate the land base, or number of acres, for land application.

4.1.1 Estimating Plant Available Nitrogen

Nitrogen concentrations in sewage sludge can be utilized to calculate plant available nitrogen (PAN) (or available nitrogen). Estimates of PAN along with the volume of sewage sludge allows the operator to estimate the land base that will be needed for land application.

There is no formula in Part 503 for calculating the land base needed for a given amount of sewage sludge using PAN. This document provides a potential formula for calculating land base to provide the operator with a rough estimate of number of acres required for planning purposes. This formula utilizes a generalized volatilization factor and mineralization factor (see Appendix A for more information). The volatilization factor estimates the amount of ammonium-nitrogen remaining after atmospheric loses, and the mineralization rate estimates the conversion of organic nitrogen to inorganic nitrogen. States, territories, or Tribes may have site-specific information readily available which will help the operator better estimate PAN. In many cases, the operator may benefit from utilizing a certified agronomist, soil scientist, or extension service to estimate land base using PAN.

Note that the example factors provided cannot be used to calculate agronomic rate as they are not site specific. Additionally, this formula assumes that there are no other sources of nitrogen (e.g., nitrogen in soil, supplemental fertilizers, etc.) which is not appropriate for calculating agronomic rate. This formula is not a substitute for agronomic rate calculations required by the regulation (see Section 4.1.3 for more information).

1. Calculate mineralized organic nitrogen:

To calculate mineralized organic nitrogen content of the sewage sludge, first calculate total organic nitrogen by subtracting the analytical result ammonium-nitrogen from the analytical result of Total Kjeldahl Nitrogen. Then calculate the mineralization organic nitrogen content in milligrams per kilogram (mg/kg) for the first-year application by multiplying organic nitrogen by the mineralization factor. See Appendix A for generalized mineralization rates.

$$Org\text{-}N\left(\frac{mg}{kg}\right) = TKN\left(\frac{mg}{kg}\right) - NH_4\text{-}N\left(\frac{mg}{kg}\right)$$

$$Org\text{-}N_{MIN}\left(\frac{mg}{kg}\right) = Org\text{-}N\left(\frac{mg}{kg}\right) * F_{0-1}$$

Where Org-N = total organic nitrogen in milligrams per milligram, TKN = Total Kjeldahl Nitrogen in milligrams per kilogram, NH_4-N = ammonium-nitrogen in milligrams per kilogram, Org-N_{MIN} = mineralized organic nitrogen in milligrams per kilogram, and F_{0-1} = the mineralization factor

2. Calculate available ammonium-nitrogen:

Calculate available ammonium-nitrogen in milligrams per kilogram (mg/kg) by multiplying the analytical result for ammonium-nitrogen by the volatilization factor. See Appendix A for generalized mineralization rates.

$$NH_4\text{-}N_{AVAIL}\left(\frac{mg}{kg}\right) = NH_4\text{-}N\left(\frac{mg}{kg}\right) * K_v$$

Where NH_4-N_{AVAIL} = available ammonium nitrogen in milligrams per kilogram, NH_4-N = ammonium-nitrogen in milligrams per kilogram, and K_v = the volatilization factor

3. Calculate PAN:

To calculate plant available nitrogen in milligrams per kilogram (mg/kg), add available ammonium-nitrogen to mineralized organic-nitrogen and the analytical result for nitrate nitrogen.

$$PAN\left(\frac{mg}{kg}\right) = NH_4\text{-}N_{AVAIL}\left(\frac{mg}{kg}\right) + Org\text{-}N_{MIN}\left(\frac{mg}{kg}\right) + NO_3\text{-}N\left(\frac{mg}{kg}\right)$$

Simplified as: $$PAN\left(\frac{mg}{kg}\right) = \left(NH_4\text{-}N\left(\frac{mg}{kg}\right) * K_v\right) + \left(\left(TKN\left(\frac{mg}{kg}\right) - NH_4\text{-}N\left(\frac{mg}{kg}\right)\right) * F_{0-1}\right) + NO_3\text{-}N\left(\frac{mg}{kg}\right)$$

Where PAN = plant available nitrogen in milligrams per kilogram, NH_4-N_{AVAIL} = available ammonium nitrogen in milligrams per kilogram, K_v = the volatilization factor, TKN = Total Kjeldahl Nitrogen in milligrams per kilogram, NH_4-N = ammonium-nitrogen in milligrams per kilogram, F_{0-1} = the mineralization factor, NO_3-N = nitrate-nitrogen in milligrams per kilogram, and Org-N_{MIN} = mineralized organic nitrogen in milligrams per kilogram

4. Convert to total available nitrogen:
To calculate the total plant available nitrogen in kilograms (kg) in the amount of sewage sludge removed from the lagoon, multiple PAN by the dry weight of sewage sludge in milligrams per milligram (mg/kg) (see Section 3.2 for more information). Then convert weight in dry metric tons (DMT) to kg by dividing by 1000.

$$Total\ Available\ Nitrogren\ (kg) = PAN\ \left(\frac{mg}{kg}\right) *\ W_{DMT}\ (MT)\ \div 1000$$

Where PAN = plant available nitrogen in milligrams per kilogram, and W_{DMT} = weight in dry metric tons

4.1.2 Estimating Land Base Using PAN

With the PAN content of the sewage sludge and an estimate of the nitrogen requirement for crops provided by a knowledgeable source such a state agency or local extension service, the operator can estimate the number of acres that will be needed in order to land apply the sewage sludge removed from lagoons.

This formula utilizes generalized crop nitrogen requirements. States, territories, or Tribes may have more local crop requirements readily available which will help the operator better estimate land base. In many cases, the operator may benefit from utilizing a certified agronomist, soil scientist, or extension service to estimate land base using PAN.

Note that the example crop nitrogen requirements provided cannot be used to calculate agronomic rate as they are not site specific. Additionally, this formula is not a substitute for agronomic rate calculations required by the regulation (see Section 4.1.3 for more information).

1. Estimate the nitrogen requirement:
First ensure that the nitrogen requirement of planned crop is in kilograms per acre (kg/ac). If not, convert the estimated crop nitrogen requirement using the conversion factor 0.454 kilograms per pound (kg/lb). See Appendix A for estimated crop nitrogen requirements.

$$Nitrogen\ Requirement\ \left(\frac{kg}{ac}\right) = Nitrogen\ Requirement\ \left(\frac{lbs}{ac}\right) * 0.454\frac{kg}{lb}$$

2. Estimate the land base:
To estimate the land base, divide the total available nitrogen in kilograms (kg) by the nitrogen requirement in kilograms per acre (kg/acre).

$$Land\ base\ (acres) = \frac{Total\ Available\ Nitrogen\ (kg)}{Nitrogen\ Requirement\ \left(\frac{kg}{acre}\right)}$$

Example:
An example of this calculation for a facility with 500 dry metric tons of sewage sludge, with a PAN of 15,000 mg/kg, and using the generalized nitrogen requirement for a planned corn crop in Appendix A is as follows:

$$Total\ Available\ Nitrogen\ (kg) = 15{,}000\ \left(\frac{mg}{kg}\right) *\ 500\ (MT)\ \div 1000 = 7{,}500\ (kg)$$

$$Nitrogen\ Requirement\ \left(\frac{kg}{acre}\right) = 100\,\frac{lbs}{acre} * 0.454\,\frac{kg}{lb}\ = 45.4\,\frac{kg}{acre}$$

$$Land\ base\ (acres) = \frac{7{,}500\ kg}{45.4\ \left(\frac{kg}{acre}\right)} = 165.2\ acres$$

Again, this estimate will help aid the operator gauge costs, find an appropriate land application specialist, and find a potential land application site. These calculations are not a substitute for agronomic rate and the acreage required will likely change as agronomic rate is calculated. Agronomic rate is site specific and includes analysis of soil nitrogen and many other parameters.

4.1.3 Agronomic Rate

Calculating agronomic rate is a complex process. Assistance in designing the agronomic rate should be obtained from a knowledgeable person, such as the local extension agent or the soil testing department at the Land Grant University in each state. Land application specialists may also be experienced at calculating agronomic rate. For an understanding of how agronomic rate is calculated, more information is available in *A Guide for Land Appliers on the Requirements of the Federal Standards for the Use or Disposal of Sewage Sludge, 40 CFR Part 503* – Appendix E. Some states, territories, or Tribes may require agronomic rate calculations be done by a certified agronomist, soil scientist, or extension service. Additionally, Part 503 specifies that agronomic rate is based on nitrogen concentrations. However, some states, territories, or Tribes may have additional requirements for agronomic rate based on phosphorus in sewage sludge. The operator should consult their environmental agency for any additional regulations, policies, or guidance on agronomic rate. Once agronomic rate is calculated, the operator should work with nearby landowners to locate parcels of land large enough and in close enough proximity to be economically feasible.

4.2 Site-Specific Requirements

Part 503 contains several categories of site-specific requirements that must be met when sewage sludge removed from a lagoon is applied to land. Bulk Class B sewage sludge may only be applied to agricultural lands, forests, public contact sites, or reclamation sites. Bulk Class B sewage sludge may not be applied to lawns or home gardens. Additionally, when bulk Class B sewage sludge is land applied, site restrictions must be met (see Section 4.2.4 for more information).

4.2.1 Endangered Species

Part 503 requires that bulk sewage sludge not be applied if it is likely to negatively affect a federally-listed threatened or endangered species or its designated critical habitat.

> 40 C.F.R. Section *503.14 Management practices.*
> *(a) Bulk sewage sludge shall not be applied to the land if it is likely to adversely affect a threatened or endangered species listed under section 4 of the Endangered Species Act or its designated critical habitat.*

If there is any question of a need for making the endangered species determination, the operator should contact the U.S. Fish and Wildlife Services (USFWS) Endangered Species Protection Program, the National Marine Fisheries Service (NMFS) (also called National Oceanic and Atmospheric Administration (NOAA Fisheries)), or one of their field offices for more information about the general area being considered for land application and contacting state fish and game departments for specific state requirements. Contact information for the USFWS is available on USFWS's website Endangered Species – Contact Us. The USFWS also publishes the Environmental Conservation Online System (ECOS) which hosts an interactive map of critical habitats for threatened and endangered species available on their website U.S. Fish & Wildlife Service – ECOS. Contact information for the NMFS is available on NOAA's website NOAA Fisheries – Contact Us. NOAA Fisheries also publishes a directory of threatened and endangered species available on their website NOAA Fisheries – Species Directory. The operator may use these resources to get a better understanding of critical habitats.

Some states, territories, or Tribes may have additional requirements for preventing adverse effects to endangered species. The operator should consult their environmental agency for any additional regulations, policies, or guidance that apply to endangered species.

4.2.2 Flooded, Frozen or Snow-Covered Lands

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

Part 503 requires that bulk sewage sludge cannot be applied to flooded, frozen, or snow-covered agricultural land, forest, public contact, or reclamation site, so that sewage sludge enters a WOTUS (except as allowed in a NPDES permit). While the intent of the requirement is clear, the conditions or management practices the operator should implement to meet this requirement, may be unclear. In order to comply with this requirement, the operator may need to consider whether the application site:

- is isolated from wetlands and WOTUS;
- has less than 5% slope;
- has grass/crop residue cover;
- is terraced to prevent rapid runoff;

- has a berm to prevent runoff; and/or
- has a grass/tree filter strip at potential runoff points.

These site conditions and management practices may help ensure that bulk land application of sewage sludge to a flooded, frozen, or snow-covered site does not enter a WOTUS.

Some states, territories, or Tribes may have specific or additional requirements for preventing runoff of sewage sludge into a WOTUS. The operator should consult their environmental agency for any additional regulations, policies, or guidance that apply to site conditions.

4.2.3 Buffer Zones

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

Part 503 requires that bulk sewage sludge not be applied to an agricultural land, forest, or reclamation site within 10 meters or less of a WOTUS. A buffer zone of 10 meters to a WOTUS is the only distance requirement for land applied sewage sludge in Part 503.

Some states, territories, or Tribes have additional distance or buffer requirements to surface waters, groundwater, wells, property lines, public contact sites, or other locations. The operator should consult their environmental agency for any additional regulations, policies, or guidance that apply to buffer zones.

4.2.4 Site Restrictions

The implicit goal of the Class B pathogen requirements is to reduce the pathogens load in the sewage sludge. Land application of Class B sewage sludge must be followed by site restrictions. The purpose of the site restrictions is to allow further reduction of the pathogen population in the applied sewage sludge through environmental conditions such as sunlight, desiccation, and natural attenuation.

40 C.F.R. Section 503.32 Pathogens.

(b) *Sewage sludge—Class B.*

…

(5) *Site restrictions.*

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

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

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

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

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

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

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

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

Part 503 distinguishes between land with a high potential for public exposure and land with a low potential for public exposure. Land with a high potential for exposure include, but are not limited to, parks, ball fields, and a reclamation site located in a populated area (e.g., a construction site). All public contact sites are lands with high potential for exposure. However, lands with high potential for exposure can include additional sites including reclamation sites in a populated area. Lands with high versus low potential for exposure differ the restriction length for public access. When Class B sewage sludge is applied to land with high potential for human exposures Part 503 requires that public access be restriction of one year after application. Land with a low potential for public

exposure is land used infrequently by the public. This includes, but is not limited to, agricultural land, forests, and secluded reclamation sites. These types of land are expected to be infrequently used by the public. When Class B sewage sludge is applied to land with low potential for human exposure Part 503 requires that public access must be restricted for 30 days after application. Note that the public does not include people who apply the sewage sludge to the land or farm workers. The operator should consult their environmental agency to clarify whether certain sites are considered high potential or low potential for exposure.

In addition to the site restrictions in Part 503 some states, territories, or Tribes may have additional or more stringent requirements for restricting access to a site. The operator should consult their environmental agency for any additional regulations, policies, or guidance that apply to site restrictions.

4.2.5 Additional Conditions

Some states, territories, or Tribes may have additional requirements for land application of sewage sludge including site assessments, additional site conditions, methods for application, and timing. The operator should consult their environmental agency for any additional regulations, policies, or guidance related to site-specific conditions for land application.

4.3 Dewatering & Removal

There are no requirements in Part 503 related to dewatering and removal of sewage sludge from lagoons. However, there are some circumstances or conditions the operator may choose to consider.

In some cases, lagoon-treated sewage sludge can be removed and hauled without dewatering (these typically occur in situations with small volumes of sewage sludge and short hauling distances). In most cases sewage sludge from wastewater treatment lagoons is normally removed from a lagoon and then dewatered, or in dry climates, it may be possible to dry the sewage sludge before removal. In either case, the process involves an assessment of the volume of sludge (see section 3.2 for more information) to understand how much must be removed and where to route incoming wastewater if the treatment system is still in use. In addition, the operator should evaluate how to properly dispose of the liquids after separation from the sewage sludge.

The operator should consult their environmental agency for any additional regulations, policies, or guidance that apply to sewage sludge dewatering.

4.4 Transport & Storage

There are no requirements in Part 503 addressing transport and storage after sewage sludge is removed from a lagoon.

Once sewage sludge is tested and approved for application to land, it must be transported to the application site. Most projects do not include temporary storage of sludge to avoid potentially having to address issues such as odors, spillage, leachate, or visibility. Some states, territories, or Tribes have specific requirements or guidance for sludge transport and temporary storage. State requirements and guidance related to sewage sludge transport generally are aimed at preventing spills or leakage. State requirements and guidance related to storage are aimed at preventing odor, visibility of the storage site, and environmental protection (e.g., groundwater).

The operator should consult their environmental agency for any regulations, policy, or guidance that apply to sewage sludge transport and storage prior to land application.

4.5 Monitoring

Part 503 requires that samples be representative of sewage sludge. If sewage sludge is dewatered prior to land application, monitoring for pathogens should be done post dewatering as pollutants can concentrate in the sewage sludge during dewatering and samples taken before dewatering would not be representative of what will be land applied.

Monitoring requirements for chemical pollutants, pathogens, and VAR are discussed in more depth in Section 3.

4.6 Recordkeeping

Part 503 requires that certain records be kept by the person who prepares sewage sludge for application to the land and the person who applies sewage sludge to the land. Recordkeeping requirements are available in Section 503.17. The requirements depend on which pollutant, pathogen, and VAR requirements were met.

Some of the records that must be kept when sewage sludge is land applied include descriptions of how the requirements in Part 503 were met and statements certifying whether certain land application requirements are met. Most records are required to be retained for 5 years or indefinitely for cumulative amounts of pollutants applied to any site based on cumulative pollutant loading rates (see section 3.3.3. for more information). Required records may be requested for review at any time by the permitting or enforcement authority.

States, territories, or Tribes may have additional recordkeeping requirements. The operator should consult their environmental agency for any regulations, policy, or guidance related to recordkeeping.

4.7 Reporting

Part 503 contains reporting requirements for POTWS that 1) have a design flow rate equal to or greater than one million gallons per day or more (e.g., are majors), 2) serve 10,000 people or more, or 3) are Class I Sludge Management facilities.

> 40 C.F.R. Section 503.18 Reporting.
> (a) Class I sludge management facilities, POTWs (as defined in §501.2 of this chapter) with a design flow rate equal to or greater than one million gallons per day, and POTWs that serve 10,000 people or more shall submit a report on February 19 of each year. As of December 21, 2016 all reports submitted in compliance with this section must be submitted electronically by the operator to EPA when the Regional Administrator is the Director in compliance with this section and 40 CFR part 3 (including, in all cases, subpart D to part 3), 40 CFR 122.22, and 40 CFR part 127. Otherwise, as of December 21, 2025, or an EPA-approved alternative date (see 40 CFR 127.24(e) or (f)), all reports submitted in compliance with this section must be submitted electronically in compliance with this section and 40 CFR part 3 (including, in all cases, subpart D to 40 CFR part 3), 40 CFR 122.22, and 40 CFR part 127. 40 CFR part 127 is not intended to undo existing requirements for electronic reporting. Prior to the compliance deadlines for electronic reporting (see Table 1 in 40 CFR 127.16), the Director may also require operators to electronically submit annual reports under this section if required to do so by State law.
>
> (1) The information in §503.17(a), except the information in §503.17 (a)(3)(ii), (a)(4)(ii) and in (a)(5)(ii), for the appropriate requirements on February 19 of each year.
>
> (2) The information in §503.17(a)(5)(ii)(A) through (G) on February 19th of each year when 90 percent or more of any of the cumulative pollutant loading rates in Table 2 of §503.13 is reached at a land application site.

If the lagoon system meets any of these requirements, the operator must report the recordkeeping requirements in Section 4.6 to the permitting authority. In most states, the permitting authority is the EPA and reports can be submitted through the Central Data Exchange (CDX). Biosolids Annual Reports are due by February 19 of each year for the period covering the previous calendar year to the EPA's NeT electronic reporting system. Guidance on registering in CDX and submitting a biosolids annual report is available on the EPA's website Compliance and Annual Biosolids Reporting. In states where the EPA is not the permitting authority (Arizona, Idaho, Michigan, Ohio, Oklahoma, South Dakota, Texas, Utah, and Wisconsin), the operator must submit the reporting requirements to the state.

States, territories, or Tribes may have additional reporting requirements. The operator should consult their environmental agency for any regulations, policy, or guidance related to recordkeeping.

5. References

Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 C.F.R. § 136 (1979). Accessed 08/11/2023. Retrieved from: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-D/part-136

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Standards for the Use or Disposal of Sewage Sludge, 40 C.F.R. § 503 (1993). Accessed 02/23/2024. Retrieved from: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-O/part-503

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USEPA, 2023. *Pathogens and Vector Attraction in Sewage Sludge*. (EPA600R22194). Washington, DC. Retrieved from: https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=356976&Lab=CESER

EPA Webpages:

- Biosolids: https://www.epa.gov/biosolids
- Sewage Sludge Analytical Methods and Sampling Procedures: https://www.epa.gov/biosolids/sewage-sludge-analytical-methods-and-sampling-procedures
- Clean Water State Revolving Fund – State Program Contacts: https://www.epa.gov/cwsrf/state-cwsrf-program-contacts
- Compliance and Annual Biosolids Reporting: https://www.epa.gov/biosolids/compliance-and-annual-biosolids-reporting
- Regional and State Contacts for Biosolids: https://www.epa.gov/biosolids/epa-regional-and-state-contacts-biosolids
- Resource Conservation and Recovery Act (RCRA) Laws and Regulations: https://www.epa.gov/rcra
- Small and Rural Wastewater Systems – Lagoon Wastewater Treatment Systems: https://www.epa.gov/small-and-rural-wastewater-systems/lagoon-wastewater-treatment-systems
- Water Technical Assistance Programs: https://www.epa.gov/water-infrastructure/water-technical-assistance-programs
- Waters of the United States: https://www.epa.gov/wotus

Appendix A

The figures in Appendix A have been taken from the EPA document *Land Application of Sewage Sludge, A Guide for Land Appliers on the Requirements of the Federal Standards for Use or Disposal of Sewage Sludge, 40 CFR Part 503*, 1994 (EPA831B93002b).

Exhibit E-l. Examples of Crop Nitrogen Requirements*

Crop	Expected Yield (bushel/acre/year)	Nitrogen Requirement (lb N/acre/year)*
Corn	**100**	**100**
Oats	90	60
Barley	**70**	**60**
Grass and Hay	4 tons/acre	200
Sorghum	60	60
Peanuts	**40**	**30**
Wheat	70	105
Wheat	150	250
Soybeans	40	30
Cotton	1 bale/acre	50
Cotton	1.5 bales/acre	90

***These figures are very general and are provided only for illustration purposes.** They should not be used to determine your actual application rate. Crop fertilization requirements vary greatly with soil type, expected yields, and climatic conditions. To get more specific information on crop fertilization needs specific to your location, contact local agricultural extension agents. (Source: Domestic *Septage Regulatory Guidance: A Guide to the EPA 503 Rule, p. 28* [EPA, 1993].)

Exhibit E-2. Example Volatilization Factors (Kv)

If Sewage Sludge Is:	Factor Kv Is:
Liquid and surface applied	.50
Liquid and injected into the soil	1.0
Dewatered and applied in any manner	.50*

*Use value obtained from State regulatory agencies if available.

Exhibit E-3. Example Mineralization Rates*

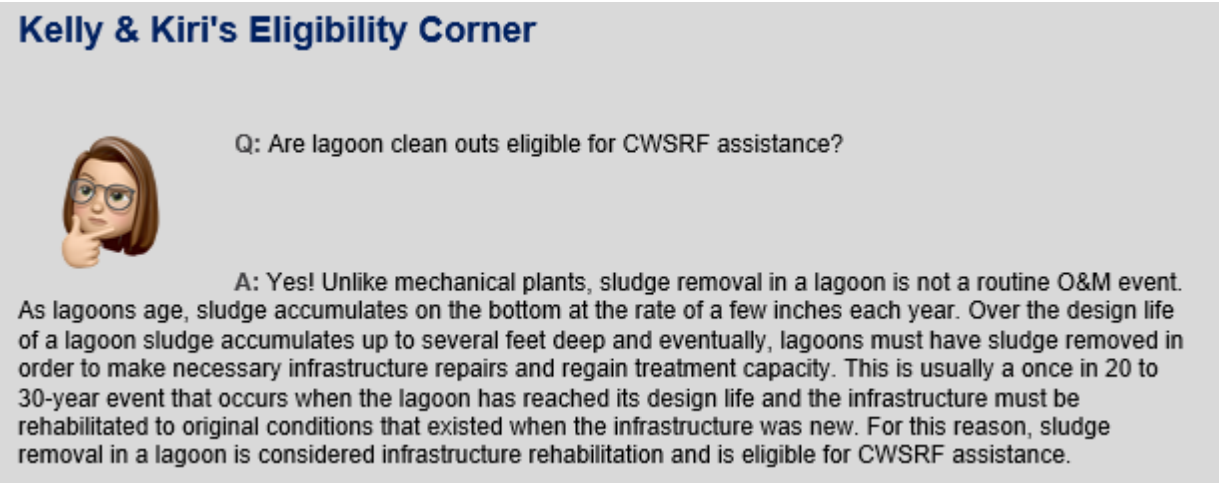
Time After Sewage Sludge Application (Year)	Fraction of Org-N Mineralized From Stabilized Primary and Waste Activated Sewage Sludge	Fraction of Org-N Mineralized From Aerobically Digested Sewage Sludge	Fraction of Org-N Mineralized From Anaerobically Digested Sewage Sludge	Fraction of Org-N Mineralized From Composted Sewage Sludge
0-1	.40	.30	.20	.10
1-2	.20	.15	.10	.05
2-3	.10	.08	.05	.03

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

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

Appendix B

The language in Appendix B has been taken from the U.S. EPA's State Revolving Fund Newsletter, *SRF Up,* Fall 2022.



Plain Text:

Kelly & Kiri's Eligibility Corner

Q: Are lagoon clean outs eligible for CWSRF assistance?

A: Yes! Unlike mechanical plants, sludge removal in a lagoon is not a routine O&M event. As lagoons age, sludge accumulates on the bottom at the rate of a few inches each year. Over the design life of a lagoon sludge accumulates up to several feet deep and eventually, lagoons must have sludge removed in order to make necessary infrastructure repairs and regain treatment capacity. This is usually a once in 20 to 30-year event that occurs when the lagoon has reached its design life and the infrastructure must be rehabilitated to original conditions that existed when the infrastructure was new. For this reason, sludge removal in a lagoon is considered infrastructure rehabilitation and is eligible for CWSRF assistance.