United States Environmental Protection Agency

EPA 40CFR part 503 Regulations Biosolids 101: Pathogen and Vector Attraction Reduction Regulations

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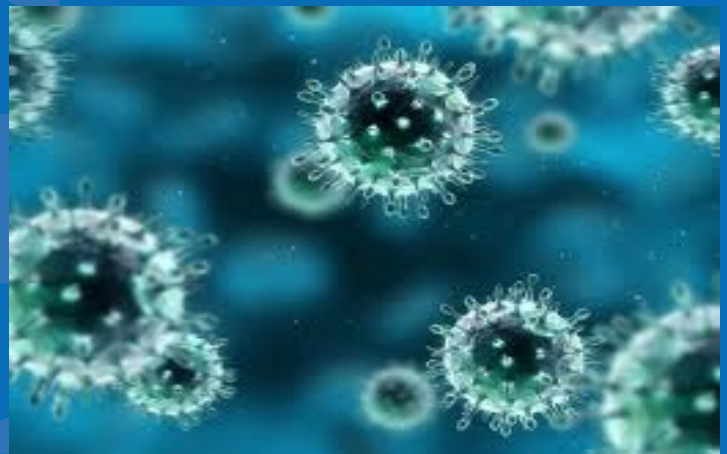

Office of Research and Development
Center for Environmental Solutions and Emergency Response

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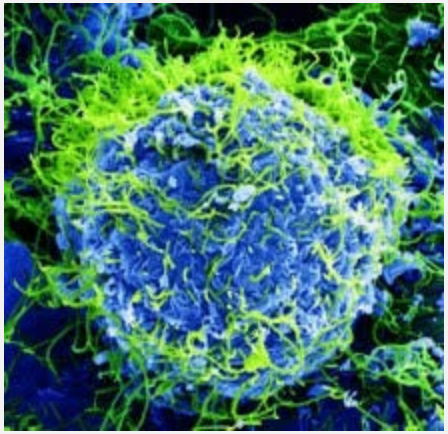
Estimating the Universe of Pathogens

Known
- Viruses
  - Hepatitis
  - Adenovirus 12
  - Norovirus
- Bacteria
  - *Salmonella* spp. (to include *S. enterica*)
  - *Escherichia coli*
  - *Enterococcus* spp.
  - *Campylobacter* spp.
- Parasites
  - *Giardia*
  - *Cryptosporidium*

Emerging
- Bacteria strains:
  - *Escherichia coli* [enterohemorrhagic / shiga-toxin]
  - Antibiotic-resistance / Horizontal Gene Transfer
- Viruses
  - Ebola



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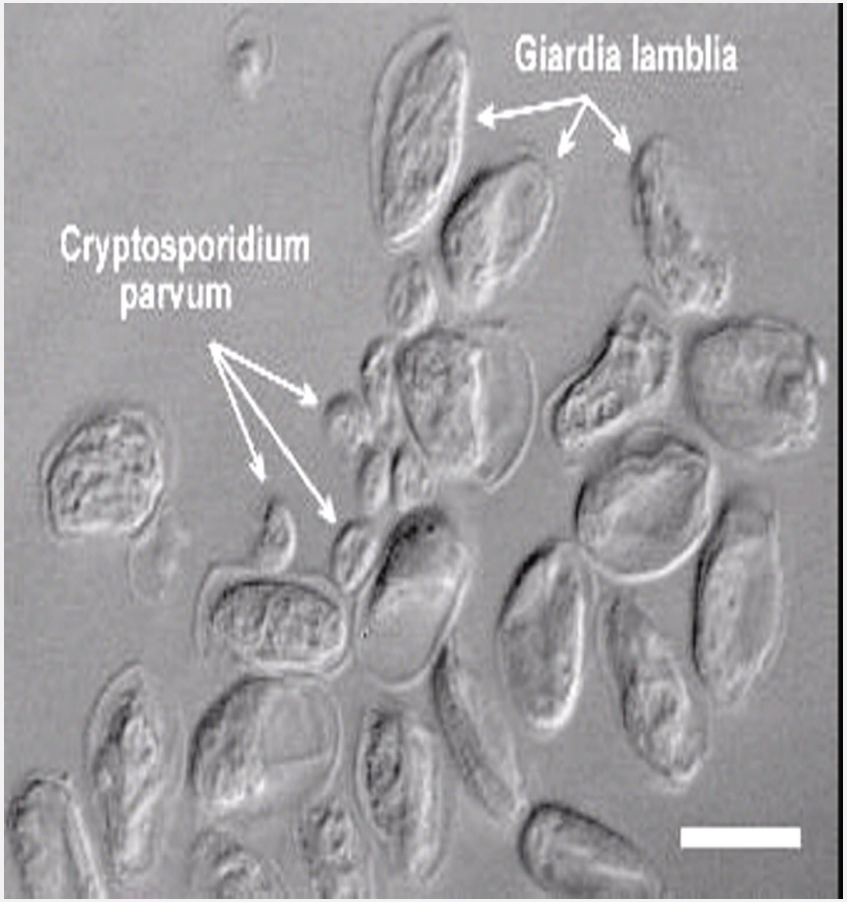
Size of Microbial Pathogens

Typical Bacterial Pathogens

- **Giardia 12-15 μm**
- **Crypto 5-7 μm**
- **Bacteria 1-5 μm**
- **Virus 0.02 - 0.3 μm**

Compare:

- **Human hair 80 μm**
- **Smallest visible 40 μm**
- **Red blood cell 4 μm**



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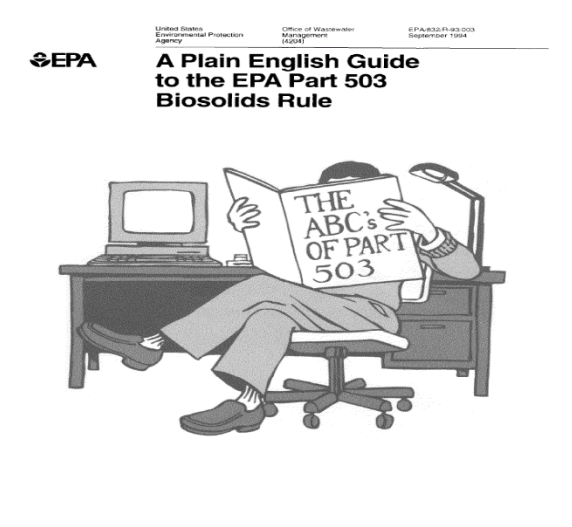
Prior to the Clean Water Act

Statute

- Clean Water Act (CWA)
- Enacted October 18, 1972 (PL 92-500)

- **Section 405** sets the framework for sewage sludge regulations (i.e., Part 503)
  - Requires EPA to establish standards for proper treatment, use and disposal of sewage sludge
  - Also requires EPA to conduct biennial reviews to determine if additional pollutants should be regulated

40 CFR Part 503



Self-implementing rule

- Federally enforceable without a permit
- Minimal standards for use or disposal

States have adopted Part 503 or something more restrictive

- Typically, additional requirements address environmentally sensitive areas (e.g., shallow ground water)
- Nine states formally delegated (SD, UT, OK, WI, TX, AZ, OH, MI, ID)

Choice of use or disposal practice is a local decision

Effective management practices help support the needs of local communities

- Renewable resource
- Too valuable to waste

40 CFR Part 503

Apply biosolids at or below the agronomic rate

No harm to endangered or listed species

Should not apply biosolids to flooded, frozen, or snow-covered land

10 meter (33 feet) buffer to U.S. waters

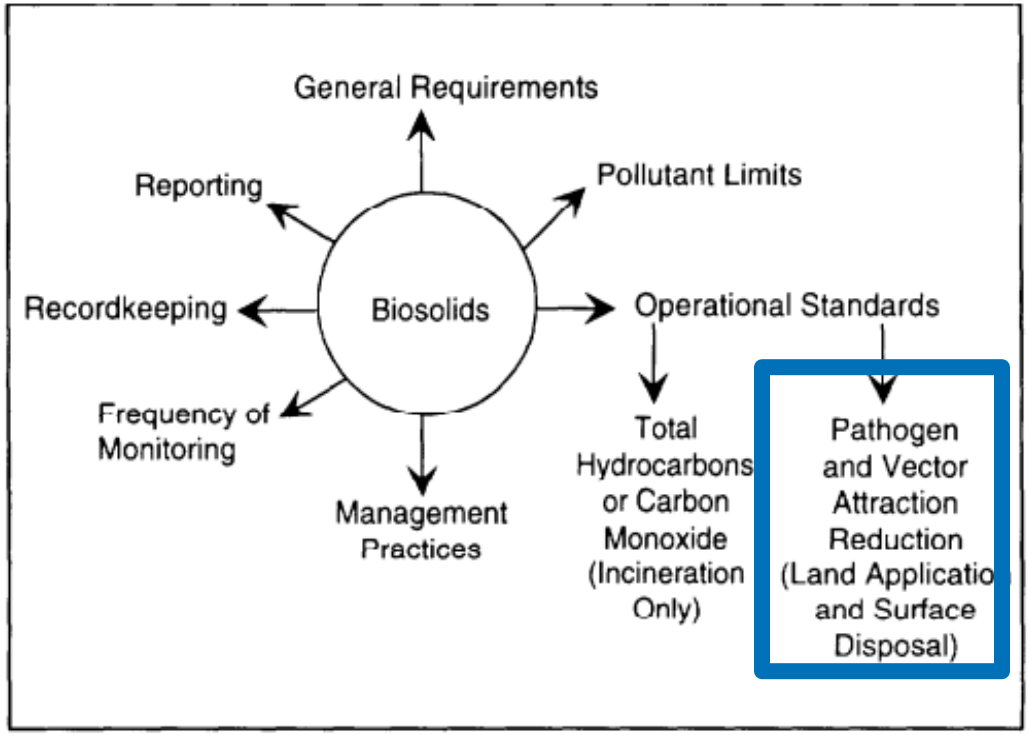


Figure 1-1. What a Part 503 standard includes.

40 CFR Part 503 Subpart D
Pathogens / Indicator Organisms

Microbial standards

Technology based

Salmonella sp.,
fecal coliforms
enteric viruses
viable helminth ova

Class A:

- Biosolids are treated and considered to be pathogen free
- Can be distributed to the public or land applied without restrictions

Class B:

- Sewage Sludge not treated as extensively as Class A
- Biosolids are not pathogen free
- Can only be land applied with site restrictions
- Can’t be distributed to the public

Vector Attraction Reduction

Employ one of the following examples:

- Biological processes that break down volatile solids, reducing available nutrients for microbial activities and odor producing potential
  - 38 % VS reduction via treatment
- Chemical or physical conditions that stop microbial activity
  - Alkali to raise pH to at least 12
- Physical barriers between vectors and volatile solids in the sewage sludge
  - Soil barrier

VAR Options

Table 8-2. Vector Attraction Reduction Options

Requirement	What is Required?
Option 1 503.33(b)(1)	At least 38% reduction in volatile solids during sewage sludge treatment
Option 2 503.33(b)(2)	Less than 17% additional volatile solids loss during bench-scale anaerobic batch digestion of the sewage sludge for 40 additional days at 30°C to 37°C (86°F to 99°F)
Option 3 503.33(b)(3)	Less than 15% additional volatile solids reduction during bench-scale aerobic batch digestion for 30 additional days at 20°C (68°F)
Option 4 503.33(b)(4)	SOUR at 20°C (68°F) is ≤1.5 mg oxygen/hr/g total sewage sludge solids
Option 5 503.33(b)(5)	Aerobic treatment of the sewage sludge for at least 14 days at over 40°C (104°F) with an average temperature of over 45°C (113°F)
Option 6 503.33(b)(6)	Addition of sufficient alkali to raise the pH to at least 12 at 25°C (77°F) and maintain a pH ≥12 for 2 hours and a pH≥11.5 for 22 more hours
Option 7 503.33(b)(7)	Percent solids ≥ 75% prior to mixing with other materials
Option 8 503.33(b)(8)	Percent solids ≥90% prior to mixing with other materials
Option 9 503.33(b)(9)	Sewage sludge is injected into soil so that no significant amount of sewage sludge is present on the land surface 1 hour after injection, except Class A sewage sludge which must be injected within 8 hours after the pathogen reduction process
Option 10 503.33(b)(10)	Sewage sludge is incorporated into the soil within 6 hours after application to land or placement on a surface disposal site, except Class A sewage sludge which must be applied to or placed on the land surface within 8 hours after the pathogen reduction process
Option 11 503.33(b)(11)	Sewage sludge placed on a surface disposal site must be covered with soil or other material at the end of each operating day
Option 12 503.33(b)(12)	pH of domestic septage must be raised to ≥12 at 25°C (77°F) by alkali addition and maintained ≥ 12 for 30 minutes without adding more alkali

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Pathogen Destruction / VAR Order Class A Materials

- VAR must occur SIMULTANIOUSLY or AFTER Pathogen Destruction
- Currently No VAR Equivalency – must meet one of the 12 listed alternatives

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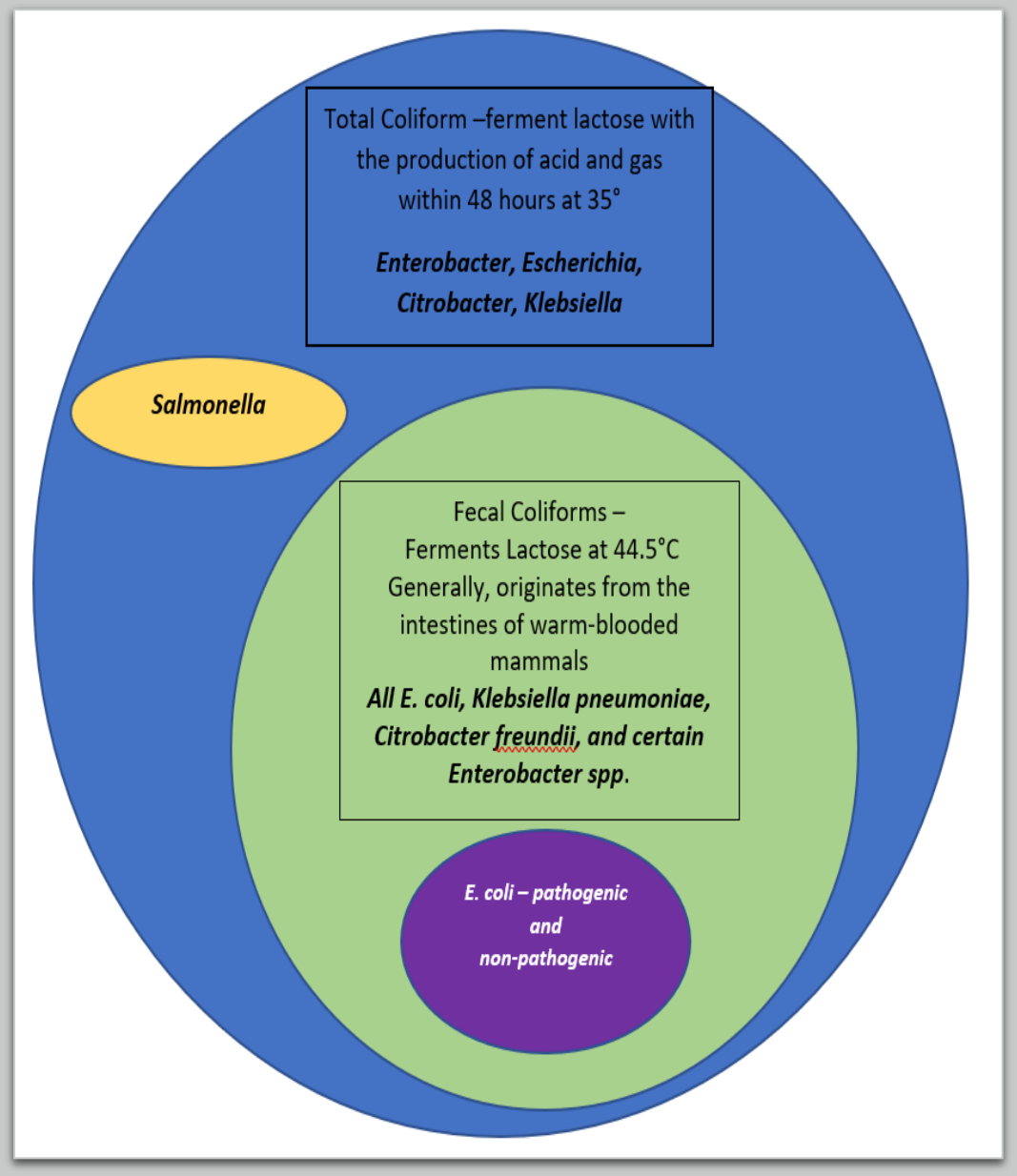
Pathogen Reduction Requirements

- Indicator Organisms
- Fecal Coliform
- Salmonella (pathogenic)
- Enteric Virus (pathogenic)
- Viable Helminth Ova (pathogenic)



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Class A Materials

- 6 alternative treatment processes to achieve Class A for pathogens
- Specific requirements with respect to bacterial monitoring must be met for Class A material regardless of what alternative methods are employed
  - Fecal coliform density <1,000 MPN/g dry solids or
  - Salmonella density <3 MPN/4g dry solids
- Additional pathogen requirements for alternatives 3, 4, and 6
  - Enteric Viruses <1 pfu/4g dry solids
  - Viable Helminth ova <1 ova/4g dry solids

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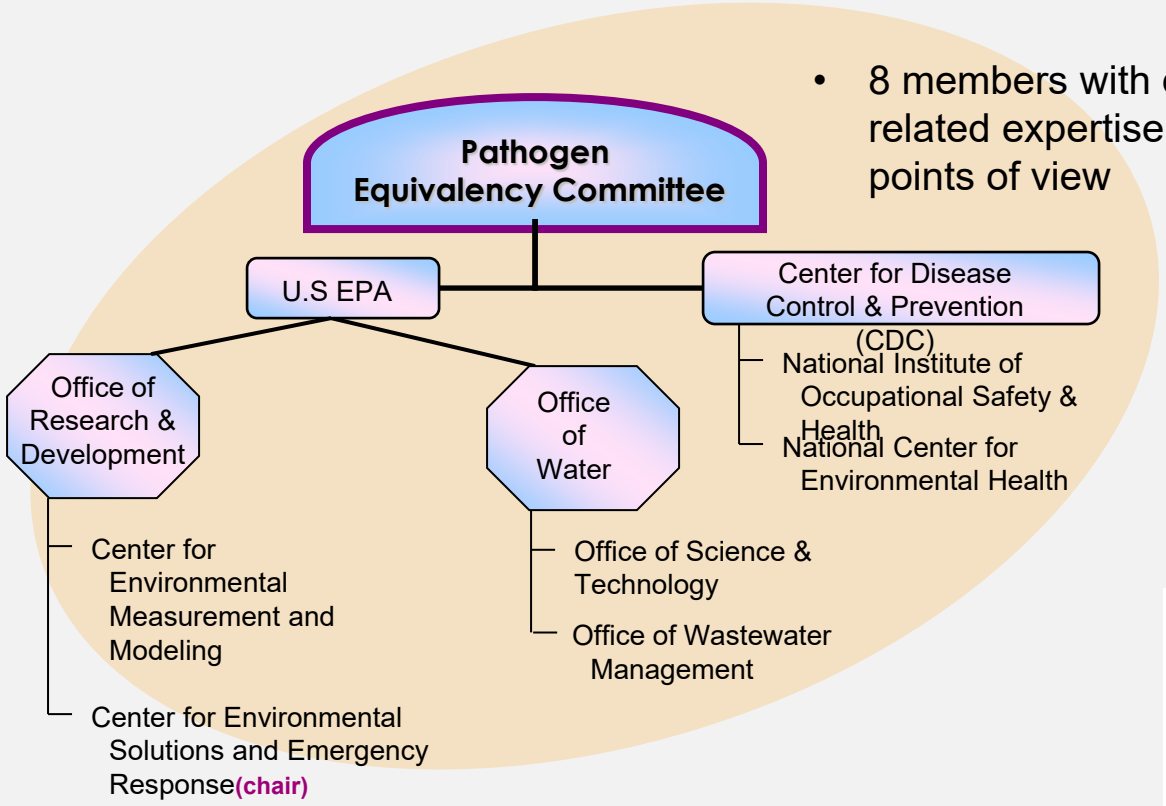
Summary of the 6 alternatives for Class A Pathogen Requirements

Alternative 1: Thermally Treated Biosolids	Biosolids must be subjected to 1 of 4 time and temperature regimes
Alternative 2: Biosolids Treated in a High pH – High Temperature Process	Biosolids must meet specific criteria with respect to pH, temperature, and air-drying
Alternative 3: Biosolids treated in other processes	Process must show ability to reduce enteric viruses, viable Helminth ova, along with maintenance of operating conditions
Alternative 4: Biosolids treated in unknown processes	Biosolids are tested for all pathogens and meet fecal coliform or *Salmonella* requirements at the time of use or disposal
Alternative 5: Biosolids treated in a PFRP	Biosolids must be treated in one of the processes to further reduce pathogens(PFRP) (composting, heat drying, heat treatment, thermophilic aerobic digesting, beta ray, gamma ray irradiation and pasteurization)
Alternative 6: Biosolids treated in a Process Equivalent to a PFRP	Biosolids must be equivalent to one of the PFRPs as determined by the permitting authority

Pathogen Equivalency Committee (PEC)

- Created in 1985 to provide technical expertise to permitting authorities on PFRP/PSRP Equivalencies



- 8 members with direct or related expertise and diverse points of view

✓ Microbiology
✓ Virology
✓ Parasitology
✓ Medicine
✓Engineering

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Summary of the 3 alternatives for Class B biosolids with respect to pathogens

Alternative 1: The monitoring of Indicator Organisms	Fecal coliform densities must be less than 2 million MPN or CFU/ g total solids at the time of disposal
Alternative 2: Biosolids treated in a process to significantly reduce pathogens(PSRP)	One of the following treatments must be used on biosolid material: Aerobic digestion, Air drying, Anaerobic digestion, Composting, and Lime Stabilization
Alternative 3: Biosolids treated in a process equivalent to a PSRP	Biosolids must be treated in a manner that is equivalent to one of the PSRP's in Alt 2 as deemed by the permitting authority

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Site Restrictions for Land Application of Class B Biosolids

FOOD CROPS WHERE HARVEST PARTS TOUCH BIOSOLID MATERIAL	FOOD HARVEST CAN'T OCCUR UNTIL 14 MONTHS AFTER LAND APPLICATION (LA)
Food crops with harvested parts below the land surface	•Harvest can't occur until 20 months after LA in situations where the biosolids remain in contact with the soil surface for 4 months or longer •Harvest can't occur until 38 months after LA if biosolid material is incorporated into soil
Food crops that do not touch the biosolid surface, feed crops, and fiber crops	Harvest can't occur for 30 days after LA
Animal Grazing	Grazing can't occur for 30 days after LA
Turf Growing	Turf can't be harvested until 1yr after LA, unless otherwise deemed by permit authority
Public Access	Public access is restricted for 1 yr following LA where the site has a high potential for public use, and 30 days for LA with a low public use potential

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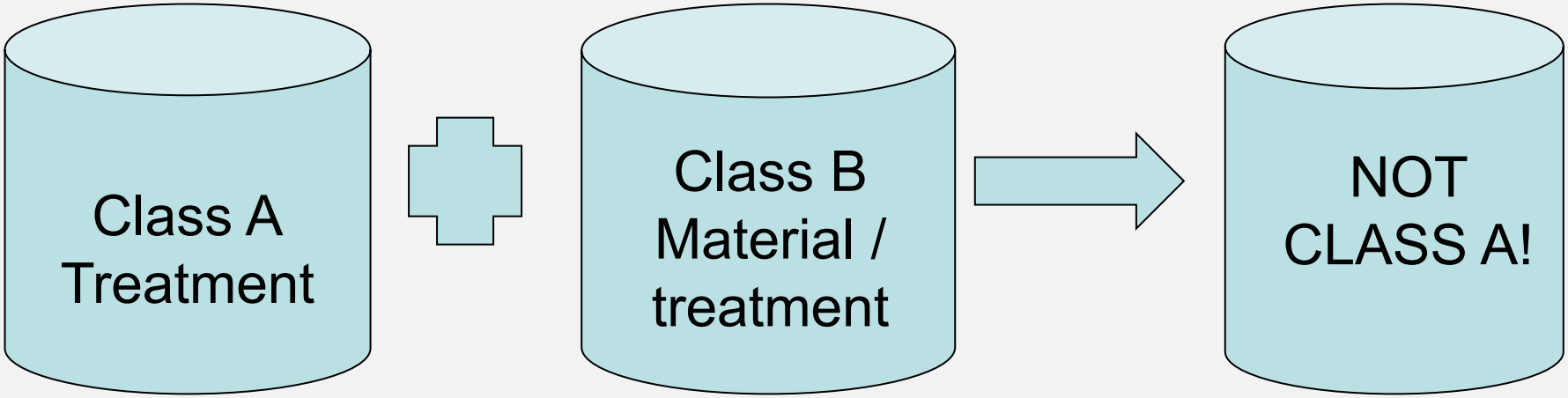
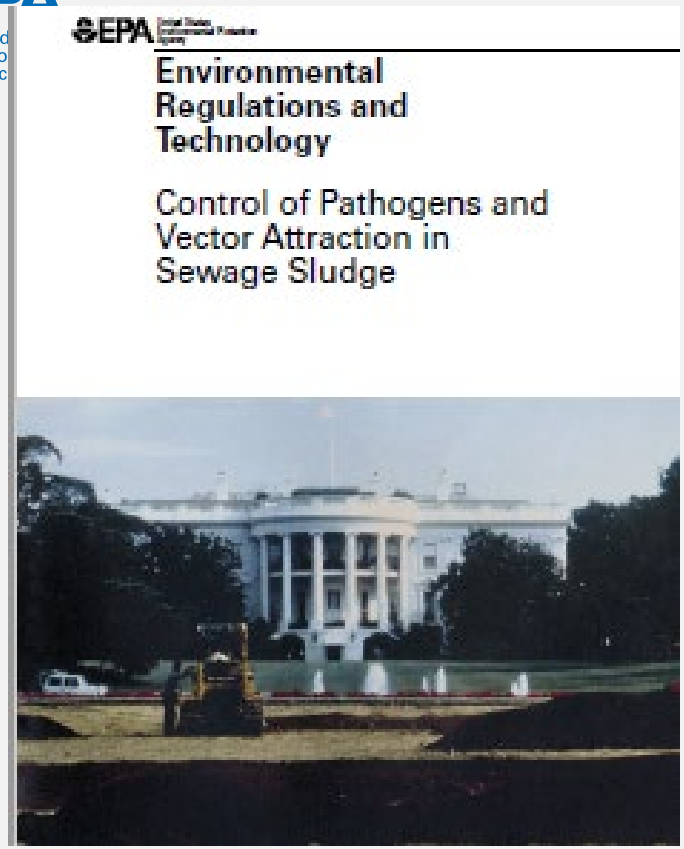
Important Process Considerations!

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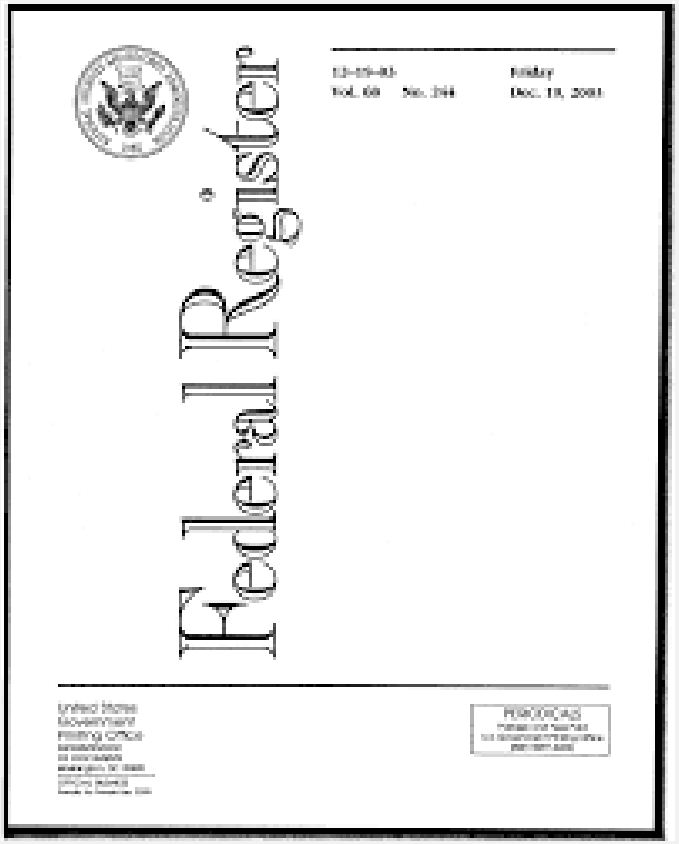
Federal Register

Methods

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Target Indicator	EPA Methods / References	Standard Methods	Holding time
Fecal Coliforms Class A	EPA 1680/1681 EPA/600/8-78-017 (MPN method only)	SM 9221 C E 2006	8 hours Max unless material is composted then can hold 24 Max
Fecal Coliforms Class B	EPA1680/1681 EPA600/8-78-017	SM 9221 C E SM 9222 D 2006	8 hours Max unless material is aerobically or anaerobically digested
Salmonella Class A only	EPA 1682		8 hours Max

https://www.ecfr.gov/cgi-bin/text-idx?SID=748055e141fdd87cb0aef5a78acda409&mc=true&node=pt40.25.136&rgn=div5#se40.25.136_13

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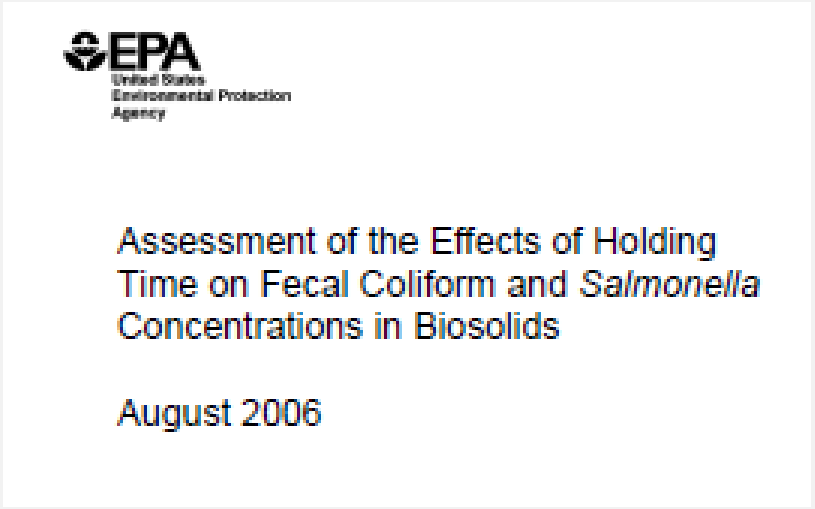
Holding Time References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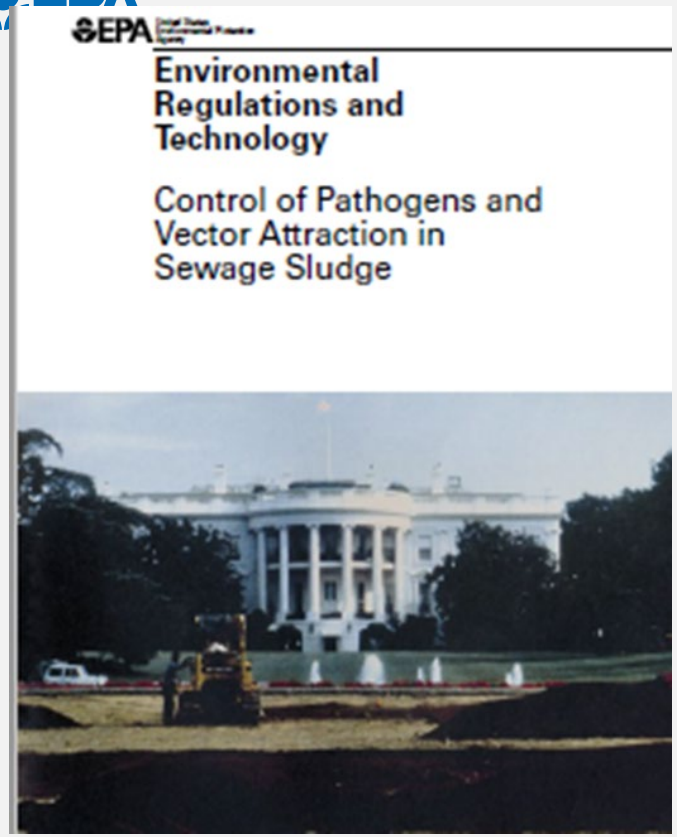
Assessment of the Effects of Holding Time on Fecal Coliform and *Salmonella* Concentrations in Biosolids

August 2006

[22]Sample analysis should begin as soon as possible after receipt; sample incubation must be started no later than 8 hours from time of collection.

[23]For fecal coliform samples for sewage sludge (biosolids) only, the holding time is extended to 24 hours for the following sample types using either EPA Method 1680 (LTB-EC) or 1681 (A-1): Class A composted, Class B aerobically digested, and Class B anaerobically digested.



Enteric Virus and Helminth Methods

Appendix H
Method for the Recovery and Assay of Total Culturable Viruses from Sludge

1. Introduction

1.1. Scope

This chapter describes the method that must be followed to produce Class A sludge when virus monitoring under 40 CFR Part 503 is required. The method is designed to demonstrate that sludges meet the requirement that human enteric viruses (i.e., viruses that are transmitted via the fecal-oral route) are less than one plaque-forming unit (PFU) per 4 g of total dry solids.

1.2. Significance

More than 100 different species of pathogenic human enteric viruses may be present in raw sludge. The presence of these viruses can cause hepatitis, gastroenteritis and numerous other diseases. Hepatitis A virus and noroviruses are the primary human viral pathogens of concern, but standard methods for their isolation and detection have not been developed. The method[1] detailed in this chapter detects total culturable viruses, which primarily include the human enteroviruses (e.g., polioviruses, coxsackieviruses, echoviruses) and reoviruses.

1.3. Safety

The sludges to be monitored may contain pathogenic human enteric viruses. Laboratories performing virus analy-

solids determination as described in section 3. The remaining portion is held at 4°C while the solids determination is being performed or frozen for later processing if the assay cannot be initiated within 8 hours.

Freeze/thawing biosolids may result in some virus loss.

3. Determination of Total Dry Solids[2]

3.1. Weigh a dry weighing pan that has been held in a desiccator and is at a constant weight. Place the 50 mL sludge portion for solids determination into the pan and weigh again.

3.2. Place the pan and its contents into an oven maintained at 103-105°C for at least one hour.

3.3. Cool the sample to room temperature in a desiccator and weigh again.

3.4. Repeat the drying (1 h each), cooling and weighing steps until the loss in weight is no more than 4% of the previous weight.

3.5. Calculate the fraction of total dry solids (T) using the formula:

Appendix I
Test Method for Detecting, Enumerating, and Determining the Viability of *Ascaris* Ova in Sludge

1.0 Scope

1.1 This test method describes the detection, enumeration, and determination of viability of *Ascaris* ova in water, wastewater, sludge, and compost. These pathogenic intestinal helminths occur in domestic animals and humans. The environment may become contaminated through direct deposit of human or animal feces or through sewage and wastewater discharges to receiving waters. Ingestion of water containing infective *Ascaris* ova may cause disease.

1.2 This test method is for wastewater, sludge, and compost. It is the user's responsibility to ensure the validity of this test method for untested matrices.

1.3 This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and de-

3.2 Descriptions of Terms Specific to This Standard:

3.2.1 The normal nematode life cycle consists of the egg, 4 larval stages and an adult. The larvae are similar in appearance to the adults; that is, they are typically worm-like in appearance.

3.2.2 Molting (*ecdysis*) of the outer layer (*cuticle*) takes place after each larval stage. Molting consists of 2 distinct processes, the deposition of the new cuticle and the shedding of the old one or exsheathment. The cuticle appears to be produced continuously, even throughout adult life.

3.2.3 A molted cuticle that still encapsulates a larva is called a *sheath*.

3.2.4 Ascarid egg shells are commonly comprised of layers. The outer tanned, bumpy layer is referred to as the mammillated layer and is useful in identifying

QUESTIONS ???

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The U.S. Environmental Protection Agency, through its Office of Research and Development, funded and managed, or partially funded and collaborated in, the research described herein. It has been subjected to the Agency's peer and administrative review and has been approved for external publication. Any opinions expressed in this paper are those of the author (s) and do not necessarily reflect the views of the Agency, therefore, no official endorsement should be inferred. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use.