SS = Stainless steel (not steel-or zinc-coated)
Souce: 40 CFR Part 136, and EPA, December 1999.

503 Biosolids Rule

By

Dr. Donald A. Hendrickson
HML, Inc.

I. Pollutants
II. Pathogen densities
III. Vector attraction reduction (reduction of volatile solids)

Frequency of Monitoring - Land Application

Amount of sewage sludge Metric tons per 365 day period	Frequency
Greater than zero but less than 290	Once per Year
Equal to or greater than 290 but less than 1,500	Once per Quarter (four times per ear)
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)

Table 1 of 503.13
Ceiling Concentrations

■ Arsenic	75	mg/kg
■ Cadmium	85	mg/kg
■ Copper	4,300	mg/kg
■ Lead	840	mg/kg
■ Mercury	57	mg/kg
■ Molybdenum	75	mg/kg
■ Nickel	420	mg/kg
■ Selenium	100	mg/kg
■ Zinc	7,500	mg/kg

■ It’s on the dry weight basis.

Table 2 of 503.13
Cumulative Loading Rates

- This table lists the cumulative pollutant loading rates for sites that receive biosolids.

Arsenic	37	pounds/acre
Cadmium	35	pounds/acre
Copper	1,339	pounds/acre
Lead	268	pounds/acre
Mercury	15	pounds/acre
Nickel	375	pounds/acre
Selenium	89	pounds/acre
Zinc	2,499	pounds/acre

Table 3 of 503.13
Pollutant Concentrations
327 IAC 6.1-4-9(c)

- This table applies to Non site-specific permits or for marketing and distribution.

Arsenic	41	mg/kg
Cadmium	39	mg/kg
Copper	1,500	mg/kg
Lead	300	mg/kg
Mercury	17	mg/kg
Nickel	420	mg/kg
Selenium	100	mg/kg
Zinc	2,800	mg/kg

- Dry weight basis

Table 4 of 503.13
Annual Pollutant Loading Rates

■ Arsenic	1.8	lbs/acre/year
■ Cadmium	0.45	lbs/acre/year
■ Copper	66.0	lbs/acre/year
■ Lead	13.4	lbs/acre/year
■ Mercury	0.7	lbs/acre/year
■ Nickel	18.7	lbs/acre/year
■ Selenium	4.4	lbs/acre/year
■ Zinc	124.9	lbs/acre/year

Appendix A – Procedure to Determine the Annual Whole Sludge Application Rate for a Sewage Sludge

Section 503.13 (a) (4) (ii) requires that the product of the Concentration for each pollutant listed in Table 4 of 503.13 in sewage sludge sold or given away in a bag or other container for application to the land and the annual whole sludge application rate (AWSAR) for the sewage sludge not cause the annual pollutant loading rate for the pollutant in Table 4 of 503.13 to be exceeded. This appendix contains the procedure used to determine the AWSAR for a sewage sludge that does not cause the annual pollutant loading rates in Table 4 of 503.13 to be exceeded.

The relationship between the annual pollutant loading rate (APLR) for a pollutant and the annual whole sludge application rate (AWSAR) for a sewage sludge is shown in equation (1).

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

Conversion Units

Hectare = 2.47 acres
Metric Ton = 2240 lb.
8.34 lb./gal.
7.48 gal./cu. ft.
62.4 lb./cu. ft.

Parameters that are required for Land Application by IDEM

(1) Percent (%) Total Solids.
(2) Total Nitrogen
(3) Ammonia Nitrogen
(4) Nitrate Nitrogen
(5) Phosphorus
(6) Potassium
(7) Arsenic must be below 75 mg/kg.
(8) Cadmium must be below 85 mg/kg. *Annual application of .45/lbs/acre/year.
(9) Copper must be below 4300 mg/kg.
(10) Lead must be below 840 mg/kg.
(11) Mercury must be below 57 mg/kg.
(12) Molybdenum must be below 75 mg/kg.
(13) Nickel must be below 420 mg/kg.
(14) Selenium must be below 100 mg/kg.
(15) Zinc must be below 7500 mg/kg.
(16) PCB must be below 10 mg/kg. New regs **Might** lower to 2 mg/kg.
(17) Pathogens depending on option of generator.

Loading Rate Limits
Plant Available Nitrogen (PAN)
327 IAC 6.1-4-10(a)

- Corn 200 lbs PAN/acre
- Soybeans 100 lbs PAN/acre
- Hay 100 lbs PAN/acre
- Cereal Grains 100 lbs PAN/acre
- Set aside/idle 50 lbs PAN/acre

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.

(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, or

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

(3) If bulk sewage sludge is applied to a lawn or a

home garden, the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3

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

(I) the concentration of each pollutant in the sewage sludge shall not exceed the concentration for the pollutant in Table 3, or

(II) the product of the concentration of each pollutant in the sewage sludge and the annual whole sludge application rate for the sewage sludge shall not cause the annual pollutant loading rate for the pollutant in Table 4 to be exceeded.

Note:

(a) Metals shall be analyzed as total metals.

(b) No analysis is required during periods when NO land application occurs.

(c) Samples for nutrients are to be taken while applying biosolids and shall be obtained by composting and preserving daily aliquots which proportionally represent the amount of biosolids applied.

(d) Samples for heavy metals, PCB’s and pathogens are to be obtained prior to application of biosolids by compositing representative grab samples which represent the volume of biosolids to be applied.

Pathogens

I. Rational

A. Risk of disease spread
1. Viruses
a. Enterovirus
1. Polio Virus
2. Echo Virus
3. Coxsacki Virus
b. Hepatitis
2. Helminth
a. Nematodes (Trichinosis, Hookworms)
b. Flukes
c. Tapeworms
3. Salmonellosis
4. Typhoid Fever
5. Shigellosis (Montezuma’s Revenge)
6. Asiatic Cholera
7. Uremic Fever (E.Coli)
8. Diarrhea

II. Classification-Based on Pathogen Density

A. Class A

1. FC shall be less than 1,000/gram or Salmonella shall be less than three/4 grams (<3/4 grams)
2. Enteric Virus shall be less than on plaque forming unit (PFU)/4 grams (<1/4 grams)
3. Viable Helminth Ova shall be less than one/4 grams (<1/4 grams)

B. Class B

Fecal coliform geometric mean of seven samples shall be less than 2,000,000/gram (dry weight basis)

III. Methods for meeting Class A Pathogen Requirements

A. The density of the fecal coliforms must be less than 1,000 MPN per gram total solids (dry weight basis) or the density of the salmonella must be less than 3 MPN per 4 grams of total solids (dry weight basis)

B. Alternatives
   1. Thermally treated biosolids
   2. Biosolids treated in high pH high temperature process
   3. Biosolids treated in other processes: Once shown to be present prior to treatment, the density of enteric virus in the biosolids must be less than 1 PFU/4 grams and helminth must be less than 1/4 grams after treatment

4. Biosolids treated in a unknown process

The biosolids must be analyzed for salmonella or fecal coliforms, enteric viruses and helminth ova at the time biosolids are used or disposed

5. Biosolids treated in a Process to Further Reduce Pathogens (PFRP)

a. **Composting**

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

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

b. **Heat drying**

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

c. **Heat treatment**

Liquid biosolids are heated to a temperature of 180 degrees Celsius or higher for 30 minutes.

d. **Thermophilic aerobic digestion**

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

e. **Beta ray irradiation**

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

f. **Gamma ray irradiation**

Biosolids are irradiated with gamma rays from certain isotopes, such as Cobalt 60 and Cesium 137, at room temperature (ca. 20 degrees Celsius).

g. **Pasteurization**

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

6. **Biosolids treated in a process equivalent to a PFPR**

They are treated by any process determined to be equivalent to a PFRP by the permitting authority; the EPA's Pathogen Equivalency Committee (PEC) is available as a resource to provide recommendations on equivalency determinations

IV. Class B Biosolids

A. Alternatives for meeting Class B Pathogen Requirements

1. Monitoring for indicator organisms (fecal coliform)

a. Geometric mean of seven samples shall be less than 2,000,000/gram.

b. Processes to significantly reduce pathogens (PSRP)

1. **Aerobic digestions**

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

2. **Air drying**

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

3. **Anaerobic digestion**

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

4. **Composting**

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

5. **Lime Stabilization**
   Sufficient lime is added to the biosolids to raise the pH of the biosolids to 12 after two hours of contact.

c. Site Restrictions
   1. Food crops with harvested parts that touch the biosolids above ground should not be harvested for 14 months after application.
   2. Food crops with harvested parts below the surface of land shall not be harvested for 20 months after application of biosolids when biosolids remains on land surface for 4 months before incorporation into soil.
   3. Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of biosolids when biosolids remains on surface of land less than 4 months before working into soil.
   4. Food crops, feed crops and fiber crops shall not be harvested for 30 days.
   5. No grazing for 30 days.

6. Turf land not harvested for 1 year.
7. Public access to land with high potential for public exposure shall be restricted for 1 year.
8. Public access to land with low potential for public exposure shall be restricted for 30 days.

Examples of Crops Impacted by Site Restrictions for Class B Biosolids

Harvested Parts That:		
Usually Do Not Touch the Soil/Biosolids Mixture	Usually Touch the Soil/Biosolids Mixture	Are Below the Soil/Biosolids Mixture
Peaches Apples Oranges Grapefruit Corn Wheat Oats Barley Cotton Soybeans	Melons Strawberries Eggplant Squash Tomatoes Cucumbers Celery Cabbage Lettuce	Potatoes Yams Sweet Potatoes Rutabaga Peanuts Onions Leeks Radishes Turnips Beets

Volatile Solid Reduction

(1) Reduction in Volatile Solids Content

The mass of volatile solids in the biosolids must be reduced by a minimum of 38 percent.

(2) Additional Digestion of Anaerobically Digested Biosolids

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

(3) Additional Digestion of Aerobically Digested Biosolids

When the 38 percent volatile solids reduction requirement cannot be met for an aerobically digested biosolids, vector attraction reduction can be demonstrated by digesting a portion of the previously digested biosolids that has a percent solids of two percent or less aerobically in the laboratory in a bench-scale unit for the 30 days at 20 degrees Celsius, if the volatile solids in the biosolids are reduced by less than 15 percent, vector attraction reduction is achieved. This applies to liquid aerobically digested biosolids.

(4) Specific Oxygen Uptake Rate (SOUR) for Aerobically Digested Biosolid

The SOUR for biosolids treated in an aerobic process shall be equal to or less than 1.5 milligrams of oxygen per hour per gram of total solids (dry weight basis) at a temperature of 20 degrees Celsius.

(5) Aerobic Processes at Greater then 40 degrees Celsius

Biosolids must be treated in aerobic process for 14 days or longer, during that time the temperature must be higher than 40 degrees and the average temperature of the sewage sludge shall be higher than 45 degrees Celsius.

(6) Addition of Alkaline Material

The pH of biosolids must be raised to 12 or higher by alkali addition and , without the addition of more alkali, shall remain at 12 or higher for two hours and then 11.5 or higher for an additional 22 hours.

(7) Moisture Reduction of Biosolids Containing no Unstabilized Solids

The percent solids of biosolids must not contain unstabilized solids generated in a primary wastewater treatment process and if the solids content of the biosolids are equal to or greater than 75 percent before the biosolids are mixed with other materials.

(8) Moisture Reduction of Biosolids Containing Unstabilized Solids

The percent solids of biosolids that contain unstabilized solids generated in a primary wastewater treatment process must be increased to or greater than 90 percent based on the moisture content and total solids prior to mixing with other materials.

(9) Biosolids Injection

Biosolids must be injected below the surface of the land and no significant amount of the biosolids can be present on the land surface within one hour after the biosolids are injected and when the biosolids that are injected below the surface of the land are Class A with respect to pathogens, the biosolids must be injected below the land surface within eight hours after being discharged from the pathogen treatment process.

(10)Incorporation of Biosolids into the Soil

Biosolids applies to the land surface or placed on a surface disposal site must be incorporated into the soil within six hours after application to or placement on the land and when biosolids that are incorporated into the soil are Class A with respect to pathogens, the biosolids must be applies to or placed on the land within eight hours after being discharged from the pathogen treatment process.

(11)Covering Biosolids

Biosolids placed on a surface disposal site must be covered with soil or other material at the end of each operating day.

(12)Alkaline Treatment for Domestic Septage

The pH of domestic septage must be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes.

Pathogen Redcuction Testing of Sewage Sludge using EPA503 Protocol

Test(s)	Method(s)	Size Sample Needed
A. Salmonella (Quantitation)	SM9260D	500 mL
B. Fecal Coliform	SM9222D(MF)	250 mL
C. Fecal Coliform	SM9221E(MPN)	250 mL
D. Enteric Virus	ASTMD4994-89	1 liter
E. Viable Helminth Ova	EPA600/1-87-014	1 liter
F. Total Solids	EPA 160.3	250 mL

Sampling Points for Biosolids

Biosolids Type	Sampling Point
Anaerobically Digested	Collect sample from taps on the discharge side of positive displacement pumps.
Aerobically Digested	Collect sample from taps on discharge lines from pumps. If batch digestion is used, collect sample directly from the digester. Cautions: 1. If biosolids are aerated during sampling, air entrains in the sample. Volatile organic compounds may be purged with escaping air. 2. When aeration is shut off, solids may settle rapidly.
Thickened	Collect sample from taps on the discharge side of positive displacement pumps.
Heat Treated	Collect sample from taps on the discharge side of positive displacement pumps *after* decanting. Be careful when sampling heat-treated biosolids because of: 1. High tendency for solids separation. 2. High temperature of sample (temperature $>60^0$C as sampled) can cause problems with certains ample containers due to cooling and subsequent contraction of entrained gases.
Dewatered, Dried, Composted, or Thermally Reduced	Collect sample from material collection conveyors and bulk containers. Collect sample from many locations within the biosolids mass and at various depths.
Dewatered by Belt Filter Press, Centrifuge, Vacuum Filter Press	Collect sample from biosolids discharge chute.
Dewatered by Biosolids Press (plate and frame)	Collect sample from the storage bin; select four points within the storage bin, collect equal amount of sample from each point and combine.
Dewatered by Brying Beds	Divide bed into quarters, grab equal amounts of

Compost Pile	sample from the center of each quarter and combine to form a composite sample fo the total bed. Each composite sample should include the entire depth of the biosolids material (down to the sand). Collect sample directly from front-end loader while biosolids are being transported or stockpiled within a few days of use.

Proper Conditions for Biosolids Sampling

Parameter	Wide-Mouthed Container	Preservative[a]	Maximum Storage Time[a]	Minimum Volume[b]
Metals				
Solid and semi-solid Samples	P,G	Cool, 4^0C	6 months	300 mL
Liquid (mercury only)	P,G	HNO_3 to pH <2	28 days	500 mL
Liquid (all other liquid metals)	P,G	HNO_3 to pH <2	6 months	1,000 mL
Pathogen Density and Vector Attraction Reduction				
Pathogens	G,P,B,SS	1. Cool in ice and water to $<10^0$C if analysis delayed >1 hr, or	6 hours	1-4 liters[c]
		2. Cool promplty to $<4^0$C, or	24 hours (bacteria and viruses) 1 month (helminth ova)	
		3. Freeze and store samples to be analyzed for viruses at 0^0C[d]	2 weeks	
Vector attraction Reduction		Varies[b]	Varies[b]	1-4 liters[c]

[a] Preservatives should be added to sampling containers prior to actual sampling episodes. Sotrage time commence upon addition of sample to sampling container. Shipping of preserved samples to the laboratory may be, but is generally not, regulated under Department of Transportation hazardous materials regulations.

[b] Varies with analytical method. Consult 40 CFR Parts 136 and 503.

[c] Reduced at the laboratory to approx. 300 mL samples.

[d] Do not freeze bacterial or helminth ova samples.

P = Plastic (polyethylene, polypropylene, Teflon)

G = Glass (non-etched Pyrex)

B = Presterilized bags (for dewatered or free-flowing biosolids)