

Metal Concentration Standards for Land Application of Biosolids and Other By-Products in Georgia

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Purpose

This bulletin provides the general public a quick reference for some commonly used standards for metal concentrations in biosolids and various by-products intended for land application. Most of the standards presented here are regulatory; however, we have also included information on average metal concentrations in agricultural soils.

By-Products and Biosolids

By-product materials used for land application include municipal biosolids, drinking water residuals, by-product gypsum, pulp and paper lime mud and boiler ash, as well as animal wastes and composts. These by-products are used because they may contain plant nutrients, lime value, organic matter and other benefits to soils.

Biosolids are materials removed from municipal wastewater treatment plants after undergoing treatment and meeting land application criteria. The treatment process includes reducing pathogenic organisms and stabilizing organic matter. Once treated, biosolids can be recycled as soil amendments because they contain essential nutrients for plant growth. Biosolids can be solid, semi-solid or liquid. Biosolids can also have beneficial effects on soil physical properties such as improving soil tilth and increasing water holding capacity.

Regulatory Limits of Metals in Biosolids

Biosolids contain nitrogen, phosphorus and potassium. With the rising cost of chemical fertilizers, the use of biosolids in agriculture is expected to increase. In Georgia, about 25 percent or 44,000 dry tons of biosolids per year are currently land applied (UGA Engineering Outreach Report, 2000).



Loading and transporting biosolids from a wastewater treatment plant to the farm.

Biosolids for land application must meet risk-based pollutant limits to protect public health and the environment. In 1993, the U.S. Environmental Protection Agency (EPA) implemented regulations for land application of biosolids — Code of Federal Regulations Title 40, Part 503 (40 CFR, Part 503). Part 503 sets regulatory limits for certain metals and requires that biosolids should be used in accordance with approved management practices including operational standards, monitoring, recordkeeping and reporting.

In Georgia, biosolids are regulated and permitted by GA EPD (Environmental Protection Division), but the metal standards in Part 503 are used as part of the regulatory framework. Nine heavy metal pollutants commonly found in biosolids included in Part 503 are: arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium and zinc. These limits determine if a permit is needed for land application.

Table 1. Pollutant limits and loading rates for land-applied biosolids^a.

Pollutant	Ceiling Concentration Limits (CCL)	Pollutant Concentration (PCL)	Cumulative Pollutant Loading Rate Limits for Biosolids (CPLR)	Annual Pollutant Loading Rate Limits for Biosolids (APLR)
	EPA Section 503.13 Table 1 -- mg/kg ^b --	EPA Section 503.13 Table 3 -- mg/kg ^b --	EPA Section 503.13 Table 2 -- kg/ha ^b --	EPA Section 503.13 Table 4 -- kg/ha/365-d period --
Arsenic (As)	75	41	41	2.0
Cadmium (Cd)	85	39	39	1.9
Copper (Cu)	4,300	1,500	1,500	75
Lead (Pb)	840	300	300	15
Mercury (Hg)	57	17	17	0.85
Molybdenum (Mo)	75	--- ^c	---	---
Nickel (Ni)	420	420	420	21
Selenium (Se)	100	100	100	5.0
Zinc (Zn)	7,500	2,800	2,800	140
Applies to:	All biosolids that are land applied	All biosolids that are land applied	Bulk biosolids	
Regulatory status:	Biosolids that are land applied cannot exceed	Biosolids below these do not need a permit if other regulatory requirements are met	Cumulative metal concentrations cannot exceed	Biosolids above PCL cannot exceed

^aSource: EPA Guide to Part 503 Rule Chapter 2.

^b Dry-weight basis: mg/kg - milligrams per kilogram; kg/ha - kilograms per hectare.

^c The February 25, 1994 Part 503 Rule Amendment deleted the molybdenum limits but retained the molybdenum CCL.

The regulatory limits include:

Ceiling concentration limits (CCL). This is the maximum concentration of each pollutant allowed in biosolids for land application. According to Part 503, biosolids containing any metal that exceeds the CCLs cannot be land applied. The municipality must reduce the levels of metals entering the wastewater treatment plant to produce biosolids that can be land applied. This is also known as EPA Table 1, which is shown in the second column of Table 1 of this bulletin.

Pollutant concentration limits (PCL). The PCLs are used along with the pathogen level and requirements to stabilize organic matter as quality standards for “exceptional quality” (EQ) biosolids. Biosolids with metal concentrations below PCL can be land applied without obtaining a permit from the GA EPD. Biosolids with metal concentrations above the PCL require a permit for each site and the rate applied is based on the nitrogen need of the crop on the site. The cumulative amount of metals must be tracked. This is also known as EPA Table 3, which is shown in the third column of Table 1 of this bulletin.

Cumulative pollutant loading rate (CPLR). This is the maximum amount of a pollutant that can be applied to a site over its lifetime by all biosolid applications meeting ceiling concentration limits. Biosolid applications must be discontinued when any one of the pollutants reaches its maximum cumulative pollutant loading rate. This is also known as EPA Table 2 and is shown in the fourth column of Table 1 of this bulletin.

Annual pollutant loading rate (APLR). APLR sets the maximum amount of a pollutant that can be applied during a 365-day period. This is also known as EPA Table 4, which is shown in the last column of Table 1 of this bulletin.

Metal Standards in Other By-Products

Unlike biosolids, there are no existing rules or standards set for heavy metal concentrations for other by-products intended for land application in Georgia. By default, some states including Georgia use the biosolids Part 503 rule as a guide for land application of other by-products. It should be recognized that the risk-based metal limits for biosolids are based on research specific for that organic material and may not be applicable for other by-products.

Materials with metal concentrations below the PCL (Part 503 Table 3) may be suitable for land application based on metal contents. However, the by-product chemical characteristics, the soil, the crop, application rates, and potential metal availability should be considered before using the by-product. For instance, metals in materials that are more alkaline than biosolids will have different plant availability than the metal at the same concentration in biosolids.



Biosolid application on a cropland.

Soil Metal Concentrations

Natural soils contain all the metals concerned, but metal concentrations can be very different depending on the rocks or sediments from which the soil developed.

Land use can also affect soil metal concentrations. For example, lead arsenate was commonly used as a pesticide during the 1940s; consequently, soils from old orchards or cotton fields can have higher arsenic and lead concentrations than those from forestlands. However, this does not necessarily mean these soils are contaminated excessively. Table 2 contains average metal concentrations in agricultural soils from Georgia. These metal concentrations can be considered background for soils that have been used for agriculture.

The Georgia EPD of the Department of Natural Resources has developed rules to protect the public from exposure to hazardous substances as defined under the Georgia Hazardous Site Response Act (HSRA). These include standards for when GA EPD must be notified and a cleanup may be triggered (Release Notification) and standards for residential soils (Risk Reduction Standards).

Table 2. Geometric average of certain metals and related soil parameters in the mineral agricultural soils of Georgia.

Parameter	Average
Cadmium (mg kg ⁻¹)	0.037
Copper (mg kg ⁻¹)	5.3
Lead (mg kg ⁻¹)	6.71
Nickel (mg kg ⁻¹)	6.8
Zinc (mg kg ⁻¹)	11.4
Cation Exchange Capacity (cmol kg ⁻¹)	3.2
Organic Matter (%)	0.68
pH (S.U.)	5.88

Adapted from Holmgren et al., 1993. Metals determined from acid digests.

Release Notification Soil Concentrations (NCs)

Notification Soil Concentrations (NCs) are maximum soil concentrations or background soil concentrations (BG) of various pollutants as specified in the rules of Hazardous Site Response Chapter 391-3-19 by the GA-DNR, EPD. In these rules, if a maximum soil concentration is listed, then concentration of a particular soil contaminant should not be greater than that level, otherwise, the user is obliged to notify the appropriate regulatory office in compliance with the requirements of the Rule 391-3-19-.04(3)(b). An exception to this rule is when the user can establish, through sampling, that the background concentration of the contaminant in the soil is greater than the maximum. This provision recognizes situations where levels in the soil are higher than the maximum concentrations due to the native sources such as the parent materials. These Release Notification rules are used where spills or deliberate applications of materials have the potential to contaminate the soil. Table 3 gives the trace metal standards for NCs. The Hazardous Site Response document includes other pollutants such as manmade organic compounds specified in the Release Notification rules, which are not reported here.

Risk Reduction Standards

Table 3 also includes Risk Reduction Standards for Type I Soil Criteria. Soil concentrations below these values do not pose significant risk to the public in residential settings. If soil concentrations are found to be greater than the maximum or background concentration, the Risk Reduction Standards of Rule

391-3-19-.07 gives information and procedures necessary to provide corrective action and bring the site into compliance with requirements under HSRA. Details of the Risk Reductions Standards can be found at: <http://rules.sos.state.ga.us/docs/391/3/19/07.pdf>

Table 3. Pollutant limits for selected elements in soil^a.

Pollutant	Release Notification Concentration (NC) Limits	Risk Reduction Standards Type I Soil Criteria ^d
	-- mg/kg --	-- mg/kg --
Arsenic (As)	41	20
Barium (Ba)	500/BG ^b	1,000
Cadmium (Cd)	39	2
Chromium (Cr)	1200	100
Cobalt (Co) ^c	25/BG	20
Copper (Cu)	1500	100
Lead (Pb)	400	75
Mercury (Hg)	17	0.50
Nickel (Ni)	420	50
Selenium (Se)	36	2
Silver (Ag)	10/BG	2
Thallium (Tl)	10/BG	2
Vanadium (V) ^c	100/BG	100
Zinc (Zn)	2,800	100

^a Source: Rules of Georgia DNR, EPD, Chapter 391-3-19 Hazardous Site Response.

^b The numerical value preceding the slash shall be an NC, unless the background concentration is greater, in which case the background value shall supplant the numerical value as an NC.

^c Reference only, not regulated substance Rules of GA DNR, EPD, Chapter 391-19-0.04(3)(b).

^d Values that pose no significant risk for residential use. Rules of GA DNR, EPD, Chapter 391-19-0.07 Hazardous Waste Response.

Summary

This bulletin provides a brief description of commonly used standards for metal concentrations in by-products for land application and in soils requiring further action. For more information contact your county agent or consult the references listed below.

References

- Engineering Outreach Report on Biosolids, 2000. University of Georgia ([http://www.engr.uga.edu/service/outreach/Publications%20\(Articles%20and%20Reports\)](http://www.engr.uga.edu/service/outreach/Publications%20(Articles%20and%20Reports))).
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