

# Land Application and Composting of Biosolids

## What are biosolids?

Every day, wastewater treatment facilities across the country treat billions of gallons of wastewater generated by homes and businesses. The treatment process produces liquid effluent that is discharged to water bodies or reused as well as a byproduct of solid residues (sewage sludge) that must be managed in an environmentally responsible manner. Although the terms “biosolids” and “sewage sludge” are often used interchangeably, they are not the same. With further treatment, sewage sludge can yield biosolids, which is defined by the U.S. Environmental Protection Agency (EPA) as *“nutrient-rich organic materials resulting from the treatment of domestic sewage in a treatment facility... that can be recycled and applied as fertilizer to improve and maintain productive soils and stimulate plant growth.”*<sup>1</sup>

## What are the various options to manage solid residuals?

Approximately 7,100,000 dry tons of solid residuals are generated each year from the treatment process at the more than 16,000 municipal wastewater treatment facilities in the U.S.<sup>2</sup> Since most U.S. wastewater treatment facilities are publicly owned and operated, management options are decided by local professionals. Behind the scenes, they must balance the needs of their communities for sanitation and public health protection with environmentally sound and sustainable methods of residuals management. Approximately 55% of the total residuals generated each year are further treated and land applied as biosolids. Other management options include incineration/processing for energy recovery or landfill disposal.<sup>3</sup>

## Are biosolids treated before they are land applied?

Biosolids that are land applied have been treated to minimize odors and to reduce or eliminate pathogens. There are two classes of biosolids that are land applied, referred to as Class B and Class A. Class B biosolids are treated to achieve significant (i.e., 99%) pathogen reduction and subject to site use and access restrictions, and Class A biosolids are disinfected to a level that inactivates pathogens and are subject to fewer site-specific controls. If, in addition, heavy metal concentrations are sufficiently low, Class A biosolids can be bagged and distributed for home garden use without further regulation—referred to as Class A, EQ (exceptional quality) biosolids.<sup>4</sup> Composted biosolids generally achieve Class A, EQ status.

## What are some of the benefits of biosolids land application?

The benefits of biosolids for both soil and vegetation are numerous and well recognized.<sup>6</sup> Biosolids provide primary nutrients (nitrogen and phosphorous) and secondary nutrients such as calcium, iron, magnesium and zinc. Also, the use of biosolids increases crop yields and maintains nutrients in the root zone and unlike chemical fertilizers, biosolids provide nitrogen that is released slowly over the growing season as the nutrient is mineralized and made available for plant uptake.<sup>7</sup> Land application of biosolids can also offer net greenhouse gas benefits by recycling carbon to the soil and fertilizing vegetation for further carbon dioxide capture.<sup>8</sup>

## What is the federal regulation that governs the management of biosolids and how was it developed?

The federal regulation governing the management of biosolids is 40 CFR Part 503 and is based on the 1987 Clean Water Act amendments that directed EPA to research and promulgate regulations for use and disposal of sewage sludge.<sup>9</sup> EPA undertook a comprehensive process to study land application and other biosolids management practices. Based on the results of its risk assessment, EPA identified and set numeric limits for the nine trace elements (heavy metals), which have high enough potential risk to require monitoring. EPA also mandated that treatment facilities use at least one of several alternative technologies to significantly decrease or eliminate levels of pathogens in biosolids.<sup>10</sup>

## Do states implement their own land application programs?

Land application is widely practiced in the U.S. In fact after EPA issued the Part 503 rule in 1993, most states implemented complementary land application programs to strengthen oversight and safety of the practice. Only nine states have no biosolids specific regulations and rely exclusively on Part 503.

### What is the scientific basis for biosolids land application?

The broad weight of scientific evidence and opinion supports recycling biosolids to land as an environmentally responsible method of reuse when managed utilizing best practices and in compliance with the Part 503 rule. Federal policies supporting and promoting the beneficial recycling of biosolids are based upon science demonstrating the safety and benefits of such recycling. These policies are not driven by economics, and the choice to recycle biosolids remains a state or local decision.

### Has EPA requested any independent studies to determine if the science supports biosolids land application?

Since the implementation of Part 503 rule, two reports of the National Research Council (NRC) of the National Academy of Sciences have considered whether land application of biosolids is safe and beneficial. In 1996, the NRC published *Use of Reclaimed Water and Sewage Sludge in Food Crop Production*, which concluded that the application of biosolids to farmland—when practiced in accordance with existing federal guidelines and regulations—presents negligible risk to the consumer, to crop production, and to the environment. The report concluded that current technology to remove pollutants from wastewater, coupled with existing regulations and guidelines governing the use of reclaimed wastewater and sludge in crop production, are adequate to protect human health and the environment.<sup>11</sup> In 2000, EPA asked the NRC to review the science and methods supporting Part 503 to address concerns regarding human health impacts of land application of biosolids. As a result of its “search for evidence on human health effects related to biosolids,” the NRC’s 2002 report concluded that “there is no documented scientific evidence that the Part 503 rule has failed to protect public health”; “[a] causal association between biosolids exposures and adverse health outcomes has not been documented”; and “there are no scientifically documented outbreaks or excess illnesses that have occurred from microorganisms in treated biosolids.”<sup>12</sup> The NRC also observed that “persistent uncertainties” regarding the safety of land application necessitate more scientific research, but it did not call for any specific changes to Part 503. EPA continues to reevaluate the adequacy of the Part 503 regulations and has not found a need to establish more stringent requirements or regulate additional pollutants.

### Did EPA assess trace metals and chemicals in biosolids?

After reviewing over 200 specific compounds and elements from an initial candidate list of thousands, EPA targeted at least 22 constituents for a formal risk assessment to examine the quantities of the metals and chemicals in biosolids, their toxicity, routes of potential exposure to humans and the environment, and many other factors. The risk assessment ultimately determined that limits were advisable for nine trace elements (arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc), primarily to protect against toxic effects to plants and entry into the food chain.<sup>13</sup> A four-year study by the U.S. Geological Survey (USGS) of Denver Metro Wastewater Reclamation District land application sites measured the effects of the application of Class B biosolids on the nutrient and metal content of soils, groundwater, and surface waters and found that “soil data indicated that biosolids have no measurable effect on the concentrations of constituents monitored.” Further, the study did not establish any adverse biosolids-related effects on soils, crops, or groundwater on or near the biosolids application site.<sup>14</sup>

### How do biosolids programs and regulations reduce or mitigate the risk of these trace metals and chemicals?

Current biosolids programs mitigate the risk of chemicals and trace metals in several ways. Federal guidelines limit the amount of biosolids that may be applied to the land, which ensures that metal concentrations on biosolids-amended soils do not exceed safe levels. Trace chemicals that on occasion have been identified in biosolids have not been found in environmentally or toxicologically significant amounts; and, the trace amounts of these substances that may be present typically bind to soil constituents, limiting human exposure.<sup>15</sup> Industrial pretreatment programs required under the Clean Water Act also reduce or eliminate many hazardous chemicals entering the treatment facility.<sup>16</sup>

### What does the scientific literature state about the potential risk of these contaminants?

A 2005 literature review on the issue of trace contaminants concluded that, “because of the capacity of land-based systems to buffer the potential toxic effects of waste-associated organic contaminants and to contribute to their assimilation into the soil, the majority of studies conclude that they pose little or no risk to the environment when applied appropriately.”<sup>17</sup>

## How are pathogens in biosolids regulated?

As established by the Part 503 rule, treatment of biosolids to Class B or Class A standards eliminates 99% or more of the pathogens that may exist in sewage sludge. Ongoing research has continued to validate a technology-driven approach to reducing or eliminating pathogens in biosolids and shows low risk for the transmission of pathogens from land application sites to surrounding residents. No scientific studies have demonstrated any link between the existence of human pathogens in biosolids and illnesses in nearby residents. The conclusion that application of biosolids utilizing best management practices poses negligible health risks from pathogens is based on scientific understanding about pathogen survivability in the environment. Many pathogens do not survive passage through the collection and treatment system and through the additional treatment processes that further disinfect solids and effluent.<sup>18</sup> Further, pathogens are enteric organisms that prefer and need the conditions inside the human body to thrive.

## What does the scientific literature conclude about pathogens in biosolids?

A recent review of biosolids pathogen research literature stated that “the overall conclusion we have reached based on all of our land-application studies over the past two decades and an in depth review of other relevant land application studies is that land application of Class B biosolids is sustainable. Specifically, the risks to human health posed by many microbiological entities within biosolids have been shown to be low if current EPA regulatory guidelines are followed. In addition, risks from indirect exposures such as aerosolized pathogens or contaminated groundwaters appear to be particularly low.”<sup>19</sup> This conclusion is consistent with the practical experience in the wastewater treatment sector where exposure to biosolids has not been associated with illness.<sup>20</sup> Microbial risk assessment and control remains a priority for the scientific community, however, and pathogen-related issues continue to be closely monitored.<sup>21</sup>

## What is the potential for contamination of water resources from biosolids land application?

Like any nutrient-rich fertilizer, biosolids should be applied in ways that minimize risk of leaching of nutrients or other constituents to groundwater or runoff to nearby surface waters. Current land application programs have been successful in minimizing these risks through regulation and best management practices. For example, the amount of biosolids applied to a field is limited to the amount needed to meet the nitrogen requirement of the crop grown (referred to as the agronomic rate); biosolids may not be applied within a 10 meter setback

from waterbodies; state regulations typically require site specific data on proposed land application sites so that sites with shallow water tables or inappropriate soils will be precluded<sup>22</sup>; and additional state requirements include limits on maximum slopes, prohibition on application during significant precipitation, and bans on biosolids application on standing water or wetlands.

## Have there been long-term studies on ground water safety where biosolids have been land-applied?

Studies have concluded that there are no impacts on groundwater quality at properly managed biosolids application sites. For example, a 1999 study reported that after 20 years of land application, tests of deep wells at an agricultural research site demonstrated no evidence of nitrate leaching and negligible fecal coliform concentrations.<sup>23</sup> Also, a 2008 literature survey concluded that “groundwater contamination from land application of biosolids does not appear to be likely.”<sup>24</sup>

## Can odors from biosolids land-applied sites cause health problems?

No data has shown that odors from biosolids cause toxicological effects on individuals.<sup>25</sup> Most odors in biosolids are caused by sulfur compounds that only cause toxic effects in concentrations vastly greater than that which triggers a smell. Further, gases with a possible toxic effect are not present in biosolids in concentrations that would endanger nearby residents. Although there has not been any observed health risks, site and process-specific stabilization or vector attraction reduction criteria are essential. Accordingly, local agencies invest significant resources for odor control.

## What is being done to address complaints of alleged health impacts from individuals living near land-application sites?

The Water Environment Research Foundation (WERF) has produced a draft investigative protocol entitled, *Epidemiologic Surveillance and Investigation of Illness Reported by Neighbors of Biosolids Land Application*.<sup>26</sup> The protocol was developed for medical providers and public health officials to use when citizens report health symptoms that they attribute to the application of soil amendments such as fertilizer, biosolids, animal manures, and food residuals. The goal is to provide a practical, objective, and reliable protocol that will be broadly implemented.

### How do biosolids differ from other fertilizers?

Biosolids offer a sound alternative to chemical and manure-based fertilizers, which are often untreated or minimally treated before field application. Pathogen concentrations are magnitudes higher in untreated manures than in biosolids and, unlike biosolids, pathogen concentrations in manures are not strictly regulated.<sup>27</sup> Since they are unregulated, manure-based fertilizers may pose a greater risk of transmitting pathogens or trace organic constituents such as antibiotics to soil or humans. Many chemical fertilizers are petroleum-based products, which increases the costs to farmers and contributes to the release of greenhouse gas emissions in the production cycle.

### Are there federal and state regulations for other fertilizers?

Federal and state requirements for biosolids are significantly more stringent than the controls over the use of chemical fertilizers and manures. In many cases, untreated manure and chemical fertilizers may legally be applied in the setback areas where biosolids land application is prohibited.

### Why compost biosolids?

According to the EPA<sup>28</sup>, composting is a viable, beneficial option in biosolids management. It is a proven method for pathogen reduction and results in a product that is easy to handle, store, and use. The end product is usually a Class A, humus-like material without detectable levels of pathogens that can be applied as a soil conditioner and fertilizer to gardens, food and feed crops, and rangelands. This compost provides large quantities of organic matter and nutrients (such as nitrogen and phosphorus) to the soil, improves soil texture, and elevates soil exchange capacity, all characteristics of a good organic fertilizer. Biosolids compost is safe to use<sup>29</sup> and generally has a high degree of acceptability by the public, making it a good alternative to other bulk and bagged products available to homeowners, landscapers, farmers, and ranchers.

### How is biosolids compost regulated and is it safe?

Composting of biosolids is an approved “Process to Further Reduce Pathogens (PRFP)” under EPA’s Part 503 biosolids regulations. Applying compost in accordance with Part 503 poses little risk to the environment or public health.<sup>30</sup> In fact the use of biosolids compost can have a positive impact on the environment. In addition to soil improving characteristics, reduced dependence on inorganic fertilizers can significantly decrease nitrate contamination of ground and surface waters often associated with use of inorganic fertilizers.

### Are pathogens present in biosolids compost?

Composting is not a sterilization process and a properly composted product maintains an active population of beneficial microorganisms that compete against the pathogenic members. Composting biosolids reduces bacterial and viral pathogens to non-detectable levels if the temperature of the compost is maintained at greater than 55° C for three days or more.

### Do odors from biosolids compost pose a health risk?

Odors from a composting operation can be a nuisance and a potential irritant but there is no documented link to health risks. In fact, offensive odors from composting sites are the primary source of public opposition to the practice. Although research shows that biosolids odors do not pose a health threat, many experts in the field of biosolids recycling believe that biosolids generating and processing facilities have an ethical responsibility to control odors and protect nearby residents from exposure to such nuisances. Recently, a better understanding of the generation of compost odors has allowed engineers to develop means of capturing and treating these odors so that emissions from composting facilities do not create offsite odor nuisance conditions.

### Are there any initiatives to develop and implement best management practices for biosolids recycling?

Wastewater treatment professionals are committed to promoting environmental stewardship and best management practices by utilities for their biosolids management programs. The Water Environment Federation (WEF) publishes technical books, peer reviewed journal articles and technical practice bulletins on issues relating to biosolids. WEF also sponsors annual conferences on biosolids management practices. Wastewater professionals also strongly support research to further understanding of sound biosolids management practices to ensure that these remain protective of public health and the environment. The Water Environment Research Foundation conducts on-going scientific research on biosolids management questions. In addition to these efforts, WEF, the National Association of Clean Water Agencies and the EPA founded the National Biosolids Partnership (NBP) to promote biosolids best management practices. The Partnership has over 100 municipal members and has created a certified environmental management system (EMS) for biosolids that exemplifies the steps being taken at the local level to ensure biosolids safety and public participation in biosolids management decisions. Congress has supported this effort since 1999.



## About WEF

Formed in 1928, the Water Environment Federation (WEF) is a not-for-profit technical and educational organization with 36,000 individual members and 75 affiliated Member Associations representing water quality professionals around the world. WEF and its Member Associations proudly work to achieve our mission of preserving and enhancing the global water environment.

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## References

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- 2 2004 U.S. EPA data
- 3 North East Biosolids and Residuals Association (NEBRA), *A National Biosolids Regulation, Quality, End Use & Disposal Survey* (2007); [www.nebiosolids.org](http://www.nebiosolids.org).
- 4 40 C.F.R. § 503.10(g) (2008).
- 5 Ibid. NEBRA.
- 6 Eliot Epstein, *Land Application of Sewage Sludge and Biosolids* 143-158 (2003).
- 7 See generally Gary Pierzynski, *Soils and Environmental Quality* 174-80 (3d ed. 2005); Gary Pierzynski, *Plant Nutrient Aspects of Sewage Sludge, in Sewage Sludge: Land Utilization and the Environment* 21 (C.E. Clapp et al., eds. 1994).
- 8 Sally Brown & Peggy Leonard, *Biosolids and Global Warming: Evaluating the Management Impacts*, BioCycle, Aug. 2004, at 54, 58 (conducting a carbon accounting of the King County, WA, biosolids program and finding that “using biosolids as a substitute for commercial fertilizers results in a net savings in CO<sub>2</sub> for both agricultural and forest application sites,” even without including the potential for biosolids to increase carbon reserves in soil).
- 9 Water Quality Act of 1987, Pub. L. No. 100-4, § 405, 101 Stat. 7, 72 (1987) (codified at 33 U.S.C. § 1345).
- 10 EPA, Standards for the Use or Disposal of Sewage Sludge, 58 Fed. Reg. 9,248 (Feb. 19, 1993)
- 11 National Research Council (NRC), *Use of Reclaimed Water and Sewage Sludge in Food Crop Production* (1996).
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- 13 EPA, *A Guide to the Biosolids Risk Assessments for the Part 503 Rule* (1995).
- 14 Tracy J.B. Yager, et.al., U.S. Geological Survey Scientific Investigations Report, *Effects of Surface Applications of Biosolids on Soil, Crops, Groundwater, and Streambed Sediment Near Deer Trail, Colorado, 1999-2003*, 5289 (2004).
- 15 Ian Pepper et al, *Environmental and Pollution Science* 459 (2nd. ed. 2006) See also R.Y. Surampalli et al., *Long-term Land Application of Biosolids—A Case Study*, 57 *Water Sci. & Tech* 345, 349 (2008) (finding “the cumulative metal loading rates after 10 years of biosolids application were far less than USEPA limits”) Gregory Evanylo et al., *Bioavailability of Heavy Metals in Biosolids Amended Soil*, 37 *Comm’n in Soil Sci. & Plant Analysis* 2157, 2163 (2006) (finding that crops grown in biosolid-amended soils had higher metal concentrations than a control, but that metal concentrations in all plants were within the values observed for uncontaminated soils); Rufus Chaney, *Trace Metal Movement: Soil-Plant Systems and Bioavailability of Biosolids-Applied Metals in Sewage Sludge: Land Utilization and the Environment* (1994).
- 16 Clean Water Act §§ 301(b)(2), 304(g) (33 U.S.C. §§ 1311(b) (2), 1314(g)); and, National Ass’n of Clean Water Agencies (NACWA), *Biosolids Management: Options, Opportunities and Challenges* 10-13 (2006) (case studies of reduction of metals in influent and biosolids in Los Angeles and greater Cleveland).
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- 18 Raina M. Maier et al., *Environmental Microbiology* 512-13 (2000).

- 19 Ian Pepper, Huruy Zerzghi, John P. Brooks, and Charles P. Gerba, *Sustainability of Land Application of Class B Biosolids*, J. of Env'tl. Quality (In Press) (2008).
- 20 Studies demonstrate that workers at wastewater treatment facilities, highly exposed to untreated sewage and biosolids, do not have significantly higher rates of illness than similar unexposed workers. California State Water Resources Control Board, *Statewide Program Environmental Impact Review (EIR) covering General Waste Discharge Requirements for Biosolids Land Application* (2004), (“Studies of the incidence of disease among wastewater personnel have indicated that they have no greater incidence of disease than the population in general.”). Similarly, no differences have been found in the health of farm families from farms using biosolids compared to the health of families on farms not using biosolids. *Id.*
- 21 For example, Water Environment Research Foundation is studying pathogen reactivation and regrowth.
- 22 The extent to which biosolids affect groundwater or surface water quality depends upon “a wide range of factors, including climate, topography, land use, soil characteristics, and the chemical composition and application rate of the biosolids” and therefore requires case-by-case analysis. Kathryn J. Draeger et al., Water Env’t Research Found., *Watershed Effects of Biosolids Land Application: Literature Review* 2-8 (1999). This is true of any fertilizer. *Id.*
- 23 See, e.g. Draeger et al., *supra*, at 3-13 (1999).
- 24 *Ibid.* *Sustainability in Land Application of Biosolids* (2008)
- 25 See Paul Chrostowki & Sarah Foster, *Odor Perception and Health Effects*, 76th Annual Water Environment Federation Technical Exhibition and Conference Workshop (2003). A 2004 literature review of the health effects of odors from municipal wastewater operations presented five reasons to conclude that odors do not cause illness: (1) odors do not cause signs of illness in healthy individuals; (2) odor acceptability varies with circumstances of exposure and the meaning people associate with the exposure; (3) below toxic levels of exposure, symptoms associated with odors involve no pathology; (4) symptoms are reduced almost immediately when the source of an odor is removed; and (5) nonphysical variables, such as anxiety and stress, seem to mediate symptoms from odors. William S. Cain and J. Enrique Cometto-Muñiz, Water Env’t Research Found., *Identifying and Controlling Odor in the Municipal Wastewater Environment* 6-1 (2004).
- 26 <http://www.werf.org/AM/CustomSource/Downloads/uGetExecutiveSummary.cfm?FILE=06HHE5PP.pdf&ContentFileID=4741>
- 27 Lynne H. Moss et al., *Comparing the Characteristics, Risks and Benefits of Soil Amendments and Fertilizers Used in Agriculture*, 16th Annual Water Environment Federation Residuals and Biosolids Management Conference 14 (2002).
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- 30 Hay, J.C., 1996. “Pathogen Destruction and Biosolids Composting.” *BioCycle, Journal of Waste Recycling*, 37(6):67-72.