Questions and Answers on Land Application of Biosolids

Every day, wastewater treatment facilities across the country treat billions of gallons of wastewater generated by homes and businesses. The stringent controls and sophisticated treatment technologies mandated by the Clean Water Act have yielded significant improvements in public health and the condition of our nation's waters. Wastewater treatment facilities produce a high-quality liquid effluent for discharge to water bodies or for reuse. As a byproduct of the treatment process, these facilities also produce solid residues (sewage sludge) that, with further treatment, can yield biosolids, defined by the 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.*"[1]

1. What is the federal regulation that governs the management of biosolids?
The federal regulation governing the management of biosolids is 40 CFR Part 503 and is based on statutory requirements under the Clean Water Act.

2. How was the 40 CFR Part 503 Regulation Developed?
The 1987 Clean Water Act amendments directed EPA to research and promulgate regulations for use and disposal of sewage sludge.[2] EPA undertook a comprehensive process to study land application and other biosolids management practices such as mine reclamation, silviculture, and incineration. Based on the results of its risk assessment, EPA identified and set numeric limits for nine trace elements (heavy metals) that may be found in biosolids. EPA also mandated that treatment facilities use at least one of several alternative technologies to significantly decrease or eliminate levels of pathogens in biosolids.[3]

3. What are the various options to manage biosolids?
There are several options that wastewater treatment facilities use to manage their solids. These include land filling, incineration, or treatment to meet criteria allowing beneficial recycling as a soil amendment. Beneficial recycling of biosolids can include heat and energy recovery following solids combustion, home use of dried and pelletized products, distressed land restoration, and fertilization and soil conditioning of farmland. When practiced in accordance with federal and state regulations and sound management practices, biosolids recycling is protective of public health, environmentally beneficial, and efficient.

4. How much biosolids are produced annually in the U.S.?
Approximately 7,100,000 dry tons of biosolids are generated each year at approximately 16,500 municipal wastewater treatment facilities in the U.S..[4]

[1] EPA, Biosolids: Frequently Asked Questions, http://www.epa.gov/owm/mtb/biosolids/ genqa.htm (last visited May 30, 2008), see also, EPA, Biosolids Recycling: Beneficial Technology for a Better Environment (1994).

[2] Water Quality Act of 1987, Pub. L. No. 100-4, § 405, 101 Stat. 7, 72 (1987) (codified at 33 U.S.C. § 1345).
[3] EPA, Standards for the Use or Disposal of Sewage Sludge, 58 Fed. Reg. 9,248 (Feb. 19, 1993)
[4] 2004 U.S. EPA data

5. How much of the biosolids produced annually is land applied?
Approximately 55% of the total biosolids generated each year are land applied, with the remainder either incinerated/processed for energy recovery, composted or landfilled.[5]

6. Are biosolids treated before they are land applied?
Biosolids that are land applied have been further treated to minimize odors and to reduce or eliminate pathogens and trace metals. There are two classes of biosolids that are land applied, referred to as "Class B" and "Class A."

7. What is the difference between Class B and Class A biosolids?
Biosolids that are treated to achieve significant (i.e., 99%) pathogen reduction and subject to site use and access restrictions are categorized as "Class B" biosolids. Biosolids disinfected to a level that inactivates pathogens are subject to fewer site-specific controls and are called "Class A" biosolids. 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).[6] In fact, Class A biosolids have been used to fertilize the White House grounds. According to 2004 data, approximately 23% of all biosolids produced were processed to meet Class A treatment standards; 34% were processed to meet Class B treatment standards.[7]

8. Do states implement their own land application programs?
After EPA issued the final 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.[8]

9. 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.

10. What did these reports conclude about biosolids land application practices?
In 1996, the NRC published *Use of Reclaimed Water and Sewage Sludge in Food Crop Production*. The report 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.[9]

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 reached several important conclusions:

- "There is no documented scientific evidence that the Part 503 Rule has failed to protect public health."

[5] North East Biosolids and Residuals Association (NEBRA), *A National Biosolids Regulation, Quality, End Use & Disposal Survey* (2007); www.nebiosolids.org.
[6] 40 C.F.R. § 503.10(g) (2008).
[7] Ibid. NEBRA.
[8] Ibid.
[9] National Research Council (NRC), *Use of Reclaimed Water and Sewage Sludge in Food Crop Production* (1996).

- "[A] causal association between biosolids exposures and adverse health outcomes has not been documented."
- "There are no scientifically documented outbreaks or excess illnesses that have occurred from microorganisms in treated biosolids."[10]

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.

11. 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 disposal method 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 local decision.

12. What are some of the benefits of biosolids land application?

The benefits of biosolids for both soil and vegetation are numerous and well recognized.[11]

- Biosolids provide primary nutrients (nitrogen and phosphorous) and secondary nutrients such as calcium, iron, magnesium and zinc;
- Use of biosolids increases crop yields and maintains nutrients in the root zone;
- 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;[12]
- 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.[13]

13. How do biosolids differ from other fertilizers?

Biosolids also offer a sound alternative to chemical and manure-based fertilizers. Because manure is often untreated or is minimally treated before field application, it may pose a greater risk of transmitting pathogens or trace organic constituents such as antibiotics to soil or humans. Pathogen concentrations are magnitudes higher in untreated manures than in biosolids and, unlike biosolids, pathogen concentrations in manures are not strictly regulated.[14] 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.

[10] NRC, *National Biosolids Applied to Land: Advancing Standards and Practices* (2002).
[11] Eliot Epstein, *Land Application of Sewage Sludge and Biosolids* 143-158 (2003).
[12] 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).
[13] 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_2 for both agricultural and forest application sites," even without including the potential for biosolids to increase carbon reserves in soil).
[14] 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).

14. 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.[15] A 4-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. [16]

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

Current biosolids programs mitigate the risk of contamination by anthropogenic chemicals and trace metals in the following ways:

- Federal guidelines limit the amount of biosolids that may be applied to the land, ensuring 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. [17]
- Industrial pretreatment programs required under the Clean Water Act reduce or eliminate many hazardous chemicals entering the treatment facility, protecting biosolids quality.[18]

16. 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 "[b]ecause 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."[19]

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[15] EPA, *A Guide to the Biosolids Risk Assessments for the Part 503 Rule* (1995).

[16] 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).

[17] 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).

[18] 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).

[19] Michael Overcash et al., *Beneficial Reuse and Sustainability: The Fate of Organic Compounds in Land-Applied Waste*, 34 J. Envtl. Quality 29, 30 (2005).

17. 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 biosolids. 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.
- Pathogens are enteric organisms that prefer and need the conditions inside the human body to thrive. Many pathogens do not survive passage through the collection and treatment system and through the additional treatment processes that further disinfect solids and effluent.[20]

18. What does the scientific literature conclude about pathogens in biosolids?

A recent review of biosolids pathogen research literature concluded: "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." [21] This conclusion is consistent with the practical experience in the wastewater treatment sector where exposure to biosolids has not been associated with illness.[22] Microbial risk assessment and control remains a priority for the scientific community, however, and pathogen-related issues continue to be closely monitored.[23] The 2002 NRC study recommended that an epidemiological study be completed to determine whether there is a link between land applied biosolids and adverse health impacts; however, NRC also recognized that such a study would be expensive and that "priority should be given to studies that can address serious or widespread problems and help reduce uncertainty." [24]

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

Like any nutrient-rich fertilizer, biosolids should only 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

[20] Raina M. Maier et al., *Environmental Microbiology* 512-13 (2000).

[21] Ian Pepper, Huruy Zerzghi, John P. Brooks, and Charles P. Gerba, *Sustainability of Land Application of Class B Biosolids*, J. of Envtl. Quality (In Press) (2008).

[22] 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.*

[23] For example, Water Environment Research Foundation is studying pathogen reactivation and regrowth.

[24] Ibid, NRC (2002).

minimizing these risks through regulation and best management practices, including:

- 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.[25]
- Additional state requirements include limits on maximum slopes, prohibition on application during significant precipitation, and bans on biosolids application on standing water or wetlands.

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

Studies have concluded the lack of impacts on groundwater quality at properly managed 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.[26]
- A 2008 literature survey concluded: "[G]roundwater contamination from land-application of biosolids does not appear to be likely other than in areas where karst soils predominate with the potential for preferential flow."[27]

[25] 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.*

[26] See, e.g. Draeger et al., supra, at 3-13 (1999).

[27] Ibid. *Sustainability in Land Application of Biosolids* (2008)

21. 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.

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

No data have shown that odors from biosolids can cause toxicological effects on individuals.[28] Most odors in biosolids are caused by sulfur compounds that only cause toxic effects in concentrations vastly greater than that which triggers a smell. Any gases with a possible toxic effect simply are not present in biosolids in concentrations that anyone living near a land application site would be exposed to them in dangerous amounts. Though there have not been observed health risks, good BMPs and site and process-specific stabilization or vector attraction reduction criteria are essential. Accordingly, local agencies invest significant resources for odor control.

[28] *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).

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

The Water Environment Research Foundation (WERF) recently completed a project that produced a draft investigative protocol entitled *Epidemiologic Surveillance and Investigation of Illness Reported by Neighbors of Biosolids Land Application Sites* [Available online at http://www.werf.org/AM/CustomSource/Downloads/uGetExecutiveSummary.cfm?FILE=06HHE5PP.pdf&ContentFileID=4741]. The protocol is intended to be used by medical providers and public health officials 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. The protocol collects the following information: documentation of reported symptoms; recent land application of soil amendments in the vicinity; sources, amounts, and characteristics of the soil amendment; factors that could lead to off-site impacts; and other exposures that could be related to reported symptoms of illness.

In addition, WERF is providing up to $400,000 for researchers to pilot test and refine the draft investigative protocol. Pilot testing will take place under real-world land application conditions by those local health officials and environmental agencies that have direct responsibility for local health issues and/or biosolids land application practices and requirements.

24. Are there any initiatives to develop and implement good best management practices for biosolids?

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. 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.

Founded in 1928, WEF is a non-profit technical and educational organization with members from varied disciplines who work toward the WEF vision of preservation and enhancement of the global water environment. The WEF network includes water quality professionals from 79 Member Associations in 32 countries.

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