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July 14, 2015

Sent Via Federal Express

Mr. Michael Latham
Director
Division of Land and Water Resources
NYS Department of Agriculture and Markets
10 B Airline Drive
Albany, NY 12235

RE: Town of Wheatfield Supplemental Response to Preliminary AML 305-a(1) Opinion re Town of Wheatfield Local Law No. 3-2014 As Applied to Milleville Farms

Dear Mr. Latham:

This is a follow-up to my May 11, 2015 letter to you on behalf of the Town of Wheatfield (the "Town") concerning the May 1, 2015 preliminary opinion of the New York State Department of Agriculture & Markets ("A&M") to the effect that the Town of Wheatfield's Local Laws No. 3-2014 and No. 4-2014 (collectively, the "Biosolids Law") unreasonably restricts the Milleville Brothers farm operation "in possible violation of AML §305-a(1)." For the reasons set forth herein and in the extensive public record supporting the Town's Biosolids Law, A&M's position is contrary to state and federal law, lacks any definitive scientific basis, and places the economic interests of a few over the Town's interest in minimizing threats to public health and safety.

As an initial matter, pursuant to my letter to you dated May 11, 2015, the Town requested from A&M (a) specified information concerning unidentified land application parcels discussed in A&M's May 1, 2015 letter in order for the Town and its technical consultant to fully and adequately respond; and (b) an opportunity for a conference call with A&M and Town representatives for the purpose of sharing the Town's perspective on the technical issues surrounding the public health threats posed by the land application of biosolids in the Town of Wheatfield. We are disappointed that to date, A&M has failed to respond to or even acknowledge the Town's May 11, 2015 request.

Further, based upon the scant information set forth in A&M's May 1, 2015 letter, it is evident that A&M has not conducted its own independent examination of the technical issues presented by the land application of biosolids in the Town of Wheatfield but, rather, has adopted wholesale the conclusory and unsupported opinions of a New York State Department of Environmental Conservation ("DEC") employee to the effect that DEC's current biosolids regulations and DEC's enforcement of them are sufficient to address the Town's myriad concerns regarding the conditions under which biosolids are allowed to be land applied and the potential for wholly unregulated chemicals to enter the local food chain and environment. A&M's resulting tentative opinion under AML 305-a(1) that the Town's authority to regulate biosolids is limited to local regulations that "mirror" those of the DEC not only fails to meaningfully address the public health and environmental threats posed by biosolids as detailed in the Town's extensive SEQRA Determination, but is plainly contrary to state and federal law.

The very New York State statute which governs DEC and which authorizes the regulation of biosolids under 6 NYCRR Part 360-4 specifically authorizes municipalities to go beyond state regulations to protect its citizens and the environment. In particular, as acknowledged in A&M's own guidelines, ECL § 27-0711 expressly provides that "[a]ny local laws, ordinances or regulations of a county, city, town or village which comply with at least the minimum applicable requirements set forth in any rule or regulation promulgated pursuant to this title shall be deemed consistent with this title or with any such rule or regulation." Numerous cases have recognized that this provision authorizes local regulations that are more strict than DEC's regulations, including outright bans of otherwise permissible activity. *See, e.g., Town of LaGrange v. Giovenetti Enterprises, Inc.*, 123 A.D.2d 688, 689, 507 N.Y.S.2d 54, 55 (2d Dept. 1986) (holding that exclusion of solid waste transfer stations from schedule of permitted uses within town was not preempted by, or inconsistent with, state Solid Waste Management Law and associated permitting regulations); see also *Town of Concord v. Duwe*, 4 N.Y.3d 870, 799 N.Y.S.2d 167 (2005) (upholding local law prohibiting siting of commercial composting facility on property zoned residential-agricultural); *Jancyn Mfg. Corp. v. County of Suffolk*, 71 N.Y.2d 91, 524 N.Y.S.2d 8 (1987) (holding that county law prohibiting sale of cesspool additives without county approval was not preempted by Solid Waste Management Law); *Monroe-Livingston Sanitary Landfill v. Town of Caledonia*, 51 N.Y.2d 679, 435 N.Y.S.2d 966 (1980) (upholding local law prohibiting importation of refuse into town); *Moran v. Village of Philmont*, 147 A.D.2d 230, 542 N.Y.S.2d 873 (3d Dept. 1986) (holding that town-wide ban on private landfills was valid health and safety measure within scope of village's police power).

Likewise, the federal Clean Water Act specifically authorizes local control over the use and disposal of sewage sludge so long as federal regulatory standards are met: "The determination of the manner of disposal or use of sludge is a local determination, except that it shall be unlawful for any person to dispose of sludge from a publicly owned treatment works or any other treatment works treating domestic sewage for any use for which regulations have been established pursuant to subsection (d) of this section, except in accordance with such regulations." 33 U.S.C.A. § 1345(e). EPA's 40 C.F.R. Part 503 biosolids regulations, on which DEC's Part 360-4 biosolids regulations are largely based, reiterate this local municipal authority: "Nothing in this part precludes a State or political subdivision thereof ... from imposing requirements for the use or disposal of sewage sludge more stringent than the requirements in this part or from imposing additional requirements for the use or disposal of sewage sludge." 40 C.F.R. § 503.5(b).

A&M's position that the Town's authority to regulate biosolids is limited to local regulations that "mirror" those of the DEC is directly at odds with the above state and federal statutes and is improper as a matter of law. A&M's tentative AML §305-a(1)(b) opinion not only is contrary to the statutory authorities cited above, but also runs afoul of the strong home rule powers afforded by N.Y. Const. Art. IX, Municipal Home Rule Law ("MHRL") § 10 and New York State Town Law § 130. The fundamental and constitutionally-protected police power of a municipality to enact local laws to protect the "safety, health and well-being of persons or property" within the municipality (Constitution Art. IX § 2(c)(10); MHRL § 10(1)(ii)(a)(12)) and to protect the "physical and visual environment" within the municipality (MHRL § 10(1)(ii)(a)(11)) has long been held to encompass the regulation (including prohibition) of waste disposal activities within a Town's borders. *See Town of Islip v. Zalak*, 165 A.D.2d 83,89, 566 N.Y.S.2d 303 (2d Dept. 1991)("In today's society, it can hardly be doubted that municipalities may regulate the disposal of refuse materials")(quoting *Moran v. Village of Philmont*, 147 A.D.2d 230, 542 N.Y.S.2d 873 (3d Dept. 1989); *See also* Town Law § 130(6)(authorizing a town board to enact laws "[p]rohibiting and/or regulating the use of any lands within the town as a dump or dumping ground"). This core police power cannot be abrogated by A&M for the economic benefit of an agricultural business, and certainly not for an energy company located outside of an agricultural district.

Further, legislative enactments like the Biosolids Law are afforded "a strong presumption of constitutionality, imposing a heavy burden on the party trying to overcome that presumption by proof beyond a reasonable doubt." *Murtaugh v. New York State Dept. of Environmental Conservation*, 42 A.D.3d 986, 841 N.Y.S.2d 189 (4th Dept. 2007). It is therefore A&M's burden to establish that the land application of biosolids presents no threat to public health and safety, and any suggestion that the Town bears this burden is legally invalid and fundamentally unfair.

In light of the extensive municipal record supporting the Town's enactment of the Biosolids Law, A&M has not and cannot meet its heavy burden of proof.

The Town enacted the Biosolids Law to minimize threats to agriculture, public health and the environment. A&M's May 1, 2015 letter serves to reinforce the underlying purpose of the Biosolids Law. Based upon DEC's purported position as summarized in A&M's May 1, 2015 letter, there is no dispute that DEC does not adhere to USEPA guidelines and best practices for the land application of Biosolids, which disfavor the application of biosolids upon soils with poor drainage and low permeability. As explained in the Town's SEQRA Determination, the Town's technical consultant, Matrix Environmental Technologies Inc. ("Matrix"), found that the soils in the Town of Wheatfield, including those at Milleville Farms' Nash Road land application site No. NIQ-01-11 (the "Nash Road Site"), are poorly drained, low permeability soils that are predominantly silty clay loam, silty clay and clay.

A&M acknowledges, but does not address, Matrix' observation that USEPA guidance ranks sites with these soil types as low for land application of biosolids. Instead, A&M relies on DEC's recent attempt to "re-write" the applicable Part 360-4 regulations to weaken the regulatory standards for land application of biosolids, on the basis of DEC's July 2, 2014 memorandum to the effect that an "oversight" occurred in connection with the 2003 amendments whereby the soil texture class "silty clay loam" was inadvertently left off the list of allowable soils classes. However, DEC issued Milleville Farms' DEC land application permit, which includes the 37.6 Nash Road Site in the Town of Wheatfield, **before** DEC's dubious retroactive amendment. That land application permit includes a Sludge Management Plan which in Section D, Item 6, does not authorize land application of biosolids on silty clay loam. In other words, Matrix has advised that DEC issued the land application permit for the Nash Road Site despite the fact that it did not meet the applicable permit criteria.

As explained in Town Supervisor Robert Cliffe's November 19, 2014 letter to you, DEC's July 2, 2014 attempt to retroactively amend the Pat 360-4 regulations to address the above soil texture noncompliance issue is in clear violation of both ECL § 27-0705 and the New York State Administrative Procedure Act. Moreover, as explained more fully in Matrix' July 14, 2015 letter to Town Supervisor Robert Cliffe enclosed as **Exhibit A** (the "Matrix Letter"), DEC's July 2, 2014 memorandum is contrary to long-standing USEPA guidelines and best practices for the land application of biosolids. The fact that DEC has elected not to err on the side of public health and safety in this matter does not render the Town powerless to do so, nor does it render the Biosolids Law an unreasonable exercise of the Town's police power.

In addition, there is no dispute that (a) DEC's Part 360-4 regulations are based on EPA's Part 503 regulations enacted over two decades ago, which in turn regulate the loading of only a small list of heavy metals and nutrients on agricultural lands; or (b) current biosolids regulations fail to address numerous unregulated pollutants known to be present in wastewater treatment sludge. As explained more fully in the enclosed Matrix Letter, the Town's finding that these unregulated pollutants present a threat to public health, agriculture and the environment was informed by studies conducted by scientists from the National Research Council, the United States Geological Survey, other reputable scientific institutions around the world, and well as recent studies conducted by EPA itself. A&M's assertion that "EPA and DEC continue to research this topic but have determined that additional regulations are not necessary **at this time**, and that the risk potential associated with such 'unregulated contaminants' **is low**" is unsupported by any conclusive epidemiological or other scientific study, and merely confirms the fact that health threats associated with biosolids do exist. In fact, as discussed more fully in the enclosed Matrix Letter, to date EPA has only partially addressed a small fraction of recommendations set forth in a 2002 report prepared at EPA's request by the National Research Council which focus on numerous deficiencies in the scientific basis for EPA's Part 503 Rule as well as issues in management practices which contribute to the uncertainty about the potential for adverse human health effects from exposure to biosolids. *See also* Exhibit A, Attachment 2.

Ultimately, A&M's opposition to the Biosolids Law and its promotion of the biosolids industry subverts the purpose of AML Title 25-AA. The legislative purpose of Title 25-AA (which contains AML § 305-a) is limited in scope. Specifically, AML Title 25-AA authorizes the creation of Agricultural Districts as a "locally-initiated mechanism for the protection and enhancement of New York state's agricultural land as a viable segment of the local and state economies and as an economic and environmental resource of major importance" by **protecting farming activities within such districts from the encroachment of "nonagricultural development ... into farm areas."** AML § 300 (emphasis supplied). Nothing in the Town's Biosolids Law fosters the encroachment of nonagricultural development into farm areas within the meaning of AML § 300. Conversely, A&M's opposition to the Biosolids Law and its promotion of the biosolids industry itself subverts the purpose of AML Title 25-AA by promoting the private sector disposal of contaminated municipal waste in farm areas.

A&M's own "Guidelines for Review of Local Laws Affecting Nutrient Management Practices" acknowledge that there are numerous nutrient management practices available to farmers that do not involve the use of human waste or contaminated sewage sludge and septage. In fact, farmers in Western New York and in the Town of Wheatfield in particular have utilized nutrient management practices for decades without resorting to the use of municipal sewage sludge, and the Biosolids Law does nothing to change this. *See, e.g.*, June 2011 Biosolids Management in New York State, New York State Department of Environmental Conservation, Division of Materials Management, Albany, NY, Table 5, which lists only two land application facilities as of September 2010 in the entire six-county WNY region (encompassing Niagara, Erie, Wyoming, Chautauqua, Cattaraugus and Allegany counties). Likewise, as of the date of enactment of the Biosolids Law, there was (and still is) only one land application site authorized by the DEC in the Town of Wheatfield that is affected by the Biosolids Law; namely, the Nash Road Site. A&M's May 1, 2105 letter acknowledges that Milleville Brothers has a total of 1,500 acres owned and approximately 2,500 acres rented within Niagara County Agricultural District Nos. 6, 7 and 8. The 37.6 acre Nash Road Site therefore represents a minute fraction of the approximately 4,000 acres of farmland owned and/or leased by Milleville Farms, and thus the restriction of the use of one form of nutrient management on such a small portion of Milleville Farms' acreage simply cannot be deemed an unreasonable restriction on its ability to conduct its farming operations as they historically have been conducted.

The Town's Biosolids Law therefore is not an unreasonable restriction on Milleville Farms' operations, particularly in light of the Town's overriding interest in minimizing threats to public health and safety and the growing organic farming industry in New York State. In this regard, we would note that the Oswego County Farm Bureau ("OCFB") recently voted to dissent from New York Farm Bureau policy on two resolutions that involve the spreading of biosolids, based upon OCFB's concerns regarding contamination of farmland and impacts on organic farming. *See* **Exhibit B**.

In view of the extensive municipal record underlying the Biosolids Law, the Town of Wheatfield Town Board urges A&M to rescind its tentative conclusion that the Biosolids Law is an unreasonable restriction on farming operations in the Town of Wheatfield. The Town and its consultants remain willing to participate in a discussion with A&M to further discuss the Town's perspective on the hazards of biosolids land application in view of local environmental conditions and the outdated federal and New York State biosolids regulatory program.

Thank you very much for your consideration of the above. Please do not hesitate to call me if you have any questions.

Very truly yours,

JAECKLE FLEISCHMANN & MUGEL, LLP

By:
Steven J. Ricca

cc: (via e-mail)

Robert Cliffe, Town Supervisor
Matthew E. Brooks, Town Attorney
Sean Carter

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July 14, 2015

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Hon. Robert B. Cliffe
Supervisor
Town of Wheatfield
2800 Church Road
Wheatfield, NY 14120-1099

RE: Town of Wheatfield Supplemental Response to Preliminary AML 305-a(1) Opinion re Town of Wheatfield Biosolids Law

This letter is in partial response to the May 1, 2015 preliminary opinion of the New York State Department of Agriculture & Markets ("A&M") to the effect that the Town of Wheatfield's Local Laws No. 3-2014 and No. 4-2014 (collectively, the "Biosolids Law") unreasonably restricts the Milleville Brothers' farm operations "in possible violation of AML §305-a(1)" (the "A&M Letter)." These comments are intended to supplement the Town's SEQRA Determination supporting the enactment of the Biosolids Law, and the extensive public record incorporated into that SEQRA Determination.

Unfavorable Local Soil Conditions (A&M Letter, p. 3)
According to A&M, "DEC staff state that silty clay and clay are not allowed under Part 360 for land application of biosolids. The soils maps for the fields or portions of fields permitted did not contain prohibited soils." The soils at the DEC permitted Nash Road land application site in Wheatfield ("Site") are mapped as primarily Odessa silty clay loam (OdA and OdB) and Hilton silt loam (H1B). The dominant USDA textures of Hilton soils are allowable for land application under § 360-4.6(b)(6). The dominant USDA textures of Odessa soils are silty clay loam and silty clay to clay. Table 7 of the Niagara County Soil Survey indicates that the typical profile of Odessa soils is 0-8 inches of silty clay loam overlying 8-56 inches of silty clay to clay. Soil boring logs from a nearby remediation site in Wheatfield (NYSDEC Spill #99-75017) that is mapped in the same Odessa soils (OdA) as the Site, characterize overburden soils as silty clay and clayey silt to the bedrock surface. Silty clay, the primary soil texture of Odessa soil, is not an allowable soil texture under § 360-4.6(b)(6). Contrary to the statement by DEC, the Site contains prohibited soils with a thin layer of silty clay loam overlying silty clay and clay and therefore should not be approved for land application. DEC's assertion that the soil maps for the permitted fields do not contain prohibited soils is also contradicted by the Niagara County Soil Survey. Furthermore, the soil borings from the nearby DEC spill site and field sampling by Matrix at other locations in Wheatfield raise questions as to the accuracy of the soil texture classification in the Milleville Farms permit for the Site and other DEC permitted locations in Niagara County.

While it is true that USEPA's decades-old Part 503 regulations do not contain soil texture restrictions, that agency's own Land Application of Biosolids, Process Design Manual (1997) provides a ranking of soil types for land application. Table 5-15 indicates that site suitability is based in part on the permeability of the most restrictive layer in the top 1 meter of soil. A site selection example is provided in Chapter 5.9 and includes soils nearly identical to the Nash Road Site described as silty clay loam texture, 0-2% slope and 1-3 feet seasonal high water table are ranked the lowest and determined to be not suitable for land application, and thus excluded from the allowable area.

Unregulated Contaminants (A&M Letter, p. 4)

DEC's Part 360-4 regulations are based on EPA's Part 503 regulations enacted over two decades ago, which in turn regulate the loading of only a small list of heavy metals and nutrients on agricultural lands. Current biosolids regulations fail to address numerous emerging and unregulated pollutants known to be present in wastewater treatment sludge. An illustrative list of pollutants found in sewage sludge, most of which are currently unregulated, is included as **Attachment 1**. The Town's Biosolids Law does not differentiate between Class A and Class B Biosolids because neither classification is tested for these unregulated pollutants.

As detailed in the Town's SEQRA Determination, the Town's finding that these unregulated pollutants present a threat to public health, agriculture and the environment is based on studies conducted by scientists from the National Research Council, the United States Geological Survey (USGS), Cornell University and other reputable scientific institutions around the world. These studies concern a host of adverse potential environmental and health effects associated with the land application of biosolids including, but not limited to, endocrine disruption, adverse impacts on livestock, groundwater contamination, human health risks presented by aerosols, detection of persistent organic pollutants in soil and soil organisms, bacterial regrowth and antibiotic resistance in sludge bacteria. *See* Biosolids Applied to Land: Advancing Standards and Practices, Committee on Toxicants and Pathogens in Biosolids Applied to Land, Board on Environmental Studies and Toxicology, National Research Council of the National Acadamies (2002) (the "2002 NRC Recommendations"). A copy of NRC's "In Summary" is included as **Attachment 2**. Case for Caution Revisited: Health and Environmental Impacts of Application of Sewage Sludges to Agricultural Land, Cornell Waste Management Institute, September 2008 (Updated March 2009) included as **Attachment 3**. *See also* USGS http://toxics.usgs.gov/regional/emc/ (USGS website concerning Emerging Contaminants In the Environment); http://toxics.usgs.gov/highlights/biosolids.html (USGS study "Household Chemicals and Drugs Found in Biosolids from Wastewater Treatment Plants"); Dissipation of Contaminants of Emerging Concern in Biosolids Applied to Nonirrigated Farmland in Eastern Colorado, Tracy J.B. Yager, Edward T. Furlong, Dana W. Kolpin, Chad A. Kinney, Steven D. Zaugg, and Mark R. Burkhardt, Journal of the American Water Resources Association, Vol. 50, No. 2 (April 2014). Unfortunately, however, none of these issues were even mentioned, much less addressed, in DEC's SEQRA review of the Milleville Farms land application permit prior to its approval.

In fact, EPA itself recently documented the prevalence of a wide array of emerging or unregulated organic pollutants in municipal sludge from wastewater treatment plants, including pharmaceuticals, steroids and hormones. *See* Jan 2009 / EPA-822-R-08-016: "Targeted National Sewage Sludge Survey ("TNSSS") Sampling and Analysis Technical Report" (the "USEPA Report") (http://water.epa.gov/scitech/wastetech/biosolids/tnsss-fs.cfm) and Feb 2015 / EPA-830-R-13-009: Biennial Review of 40 CFR Part 503 as Required Under the Clean Water Act Section 405 (d)(2)(C) Report Period 2011 Biennial Review ("EPA 2015 Biennial Review") (http://water.epa.gov/scitech/wastetech/biosolids/upload/2011-biosolids-summary.pdf). As reflected in the EPA 2015 Biennial Review, EPA as only partially addressed a small fraction of the 2002 NRC recommendations, and neither EPA nor DEC has taken any steps to strengthen their respective biosolids regulations over the past two decades, despite the many new chemicals and drugs being discharged to municipal wastewater treatment plants, the development of more advanced analytical methodologies, and the numerous recent published scientific studies concerning the potential adverse environmental and health effects of biosolids.

The prevalence of a wide array of pharmaceuticals, steroids and hormones, as summarized in the USEPA Report, demonstrates that the influent to municipal wastewater treatment plants has changed and current monitoring requirements for biosolids are inadequate since the EPA's Part 503 regulations were enacted. Similarly, EPA's Office of Inspector General (OIG) recently evaluated the effectiveness of EPA's regulation of hazardous chemicals passing through sewage treatment plants. Significantly, OIG concluded that the management controls put in place by the EPA to regulate and control hazardous chemical discharges from sewage treatment plants to water resources have "limited effectiveness." According to OIG, this is due, in large part, to EPA regulations which focus on a priority pollutants list that has not been updated since 1981 and which include limited monitoring requirements, effluent limits and notification requirements. *See* EPA Report No. 14-P-0363 September 29, 2014 ("More Action Is Needed to Protect Water Resources From Unmonitored Hazardous Chemicals") included herewith as **Attachment 4**.

The above conclusions in OIG's study are significant because wastewater treatment plants are not designed to break down or degrade emerging and unregulated contaminants and therefore many of these contaminants will concentrate in biosolids. OIG's conclusion that EPA's list and regulation of priority pollutants is out of date and incomplete reinforces the Town's concern that the chemical composition of municipal wastewater sludge, and the public health and environmental threats associated with them, are ill-defined at best. Unfortunately, as noted above, neither EPA nor DEC has taken any steps to improve the existing biosolids regulations to ensure that they are protective of public health and the environment.

Conclusion
For the reasons set forth above, and those detailed in the Town's extensive SEQRA review of the Biosolids Law, the Biosolids Law serves to minimize threats to agriculture, public health and the environment in the Town of Wheatfield.

Sincerely,
Matrix Environmental Technologies Inc.

Sean R. Carter, P.E.
Principal Engineer

Attachments

cc: Steve J. Ricca, Esq.

Town of Wheatfield Supplemental Response to
Preliminary AML 305-a(1) Opinion re
Town of Wheatfield Biosolids Law

Exhibit A

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July 14, 2015

Hon. Robert B. Cliffe
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The above conclusions in OIG's study are significant because wastewater treatment plants are not designed to break down or degrade emerging and unregulated contaminants and therefore many of these contaminants will concentrate in biosolids. OIG's conclusion that EPA's list and regulation of priority pollutants is out of date and incomplete reinforces the Town's concern that the chemical composition of municipal wastewater sludge, and the public health and environmental threats associated with them, are ill-defined at best. Unfortunately, as noted above, neither EPA nor DEC has taken any steps to improve the existing biosolids regulations to ensure that they are protective of public health and the environment.

Conclusion

For the reasons set forth above, and those detailed in the Town's extensive SEQRA review of the Biosolids Law, the Biosolids Law serves to minimize threats to agriculture, public health and the environment in the Town of Wheatfield.

Sincerely,
Matrix Environmental Technologies Inc.

Sean R. Carter, P.E.
Principal Engineer

Attachments

cc: Steve J. Ricca, Esq.

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Town of Wheatfield Supplemental Response to
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Attachment 1

Sewage Sludge Contents / Tip of Iceberg

Heavy Metals, Pathogens, Synthetic Chemicals, Hydrocarbons, Petrochemicals & Organochlorines, Pharmaceuticals, Steroids & Hormones.

This list of contents represents only the "tip of the iceberg" of toxics concentrated in sewage sludge. Federal and most state and local land application regulations limit concentrations of only nine heavy metals and one "indicator" pathogen in land applied sewage sludge (in **BOLD**).

Heavy Metals

Aluminum, Antimony, **ARSENIC**, Barium, Beryllium, Bismuth, Boron, Bromine, **CADMIUM**, Cerium, Cesium, Chromium, **COPPER**, Cobalt,

Dysprosium, Erbium, Europium, Gadolinium, Germanium, Gold, Hafnium, Holmium, Iron, Lanthanum, Lutetium, **LEAD**, Magnesium, Manganese,

MERCURY, **MOLYBDENUM**, **NICKEL**, Niobium, Palladium, Praseodymium, Rhodium, Rubidium, Ruthenium, Samarium, Scandium, **SELENIUM**, Silver, Strontium,

Tantalum, Tellurium, Terbium, Thallium Thorium, Thulium, Tin, Titanium, Tungsten, Uranium, Vanadium, Yttrium, Ytterbium, **ZINC**

Pathogens

Bacteria

FECAL COLIFORM, Salmonella (2,000 types), Shigella (4 spp.), E. coli 0157:H7, Staphylococcus aureus, Enteropathogenic E. coli, Yersinia enterocolitica, Campylobacter jejuni, Vibrio cholera, Leptospira, Listeria, Helicobacter, Mycobacteria, Aeromonas, Legionella, Burkholderia, Endotoxins, antibiotic resistant bacteria,

Viruses

Adenovirus, Astrovirus, Calcivirus, Coronavirus, Enterovirus (Poliovirus, Coxsackie A, Coxackie B, Echovirus, Enterovirus 68-72), Hepatitis A virus, Hepatitis E virus, Norwalk virus, Reovirus, Rotavirus

Protozoa

Cryptosporidium, Entamoeba histolytica, Giardia lamblia, Balantidium coli, Toxoplasma gondii

Helminths (Parasites)

Ascaris lumbicoides (roundworm), Ancylostoma duodenale (hookworm), Necator americanus (hookworm), Tainia saginata (tapeworm), Trichuris (whipworm), Toxocara (roundworm), Strongyloides (threadworm), Ascaris suum, Toxocara canis, Taenia solium, Hymenolepis nana

Fungi

Aspergillus fumigatus, Candida albicans, Cryptococcus neoformans, Epidermophyton spp., Trichophyton spp., Trichosporon spp., Phialophora spp.,

Prions (spongiform encephalopathy)

While Federal law and regulations limit none of contents below, they allow localities to set more restrictive limits on sewage sludge and soil contamination. Some states do so &/or permit precautionary local control, and others do neither.

Once spread on land, the contaminants above and below persist for centuries - to decades - to months affecting soil, water, plants, air, animals and people.

Unlike pesticides (distinct chemicals subject to specific analysis), sewage sludge is a very complex, variable and concentrated mixture of the vast multitude of unstudied and unregulated hazardous wastes dumped into sewer systems.

Synthetic Chemicals

Dioxins & Furans

Dioxins, Octachlorodibenzo-P-Dioxin, 1,2,3,4,6,7,8-Heptachlorodibenzo-P-Dioxin, Octachlorodibenzo Furan, 1,2,3,4,6,7,8-Heptachlorodibenzo-Furan (71), 2,3,7,8-Tetrachlorodibenzo-Furan, 1,2,3,6,7,8-Hexachlorodibenzo-P-Dioxin, 1,2,3,4,7,8-Hexachlorodibenzo-Furan , 1,2,3,7,8,9- Hexachlorodibenzo-P-Dioxin, 1,2,3,6,7,8-Hexachlorodibenzo-Furan, 2,3,4,6,7,8- Hexachlorodibenzo-Furan, 1,2,3,4,7,8,9-Heptachlorodibenzo-Furan, 2,3,4,7,8-Pentachlorodibenzo-Furan, 1,2,3,4,7,8- Hexachlorodibenzo-P-Dioxin, 1,2,3,7,8- Pentachlorodibenzo-Furan, 1,2,3,7,8- Pentachlorodibenzo-P-Dioxin, 1,2,3,7,8,9- Hexachlorodibenzo-Furan, 2,3,7,8- Tetrachlorodibenzo-P-Dioxin, Polychlorinated Dibenzodioxin/Polychlorinated Dibenzofuran (PCDD/PCDF), Tetrahydrofuran, 2,4-D, 2,4,5-T, dioxin (TCDD),

"Organics" (carbon-based)

Acetone, Chloroform, Cyclohexanone, Bis(2-ethylhexyl) Phthalate, Bis(2-ethylhexyl) tetrabromophthalate, Di-n-undecyl phthalate, Alkyl benzyl Phthalate, Di-(2-Ethylhexyl) Phthalate (DEHP), Butyl Benzyl Phthalate, Toluene, 2-Propanone, Methylene Chloride, Hexanoic Acid, 2-Butanone, Methyl Ethyl Ketone, Alcohol Ethoxylate, Alkylphenolethoxylates, Phenol, Nonylphenol, 2,2'-methylenebis[4-methyl-6- nonyl-Phenol, p-Nonylphenol, 4,4'-butylidenebis[2-(1,1-dimethylethyl)-5-methyl-, 4-Methylphenol, Phenol, 4,4'-(1-methylethylidene)bis[2-(1,1-dimeth, Phenol, 4,4'-(1-methylethylidene)bis[2-(1,1-dimeth, 2,4-dicumylphenol, p-Dodecylphenol, 2,4,5-Trichlorophenol, N-Hexacosane, N-Tetracosane, N-Dodecane, N-Tetradecane, N-Triacontane, N-Eicosane, N-Hexadecane, N-Octacosane, Carbon Disulfide, N-Decane, N-Docosane, N-Octadecane, P-Cymene, Benzo(B)fluranthene, Fluoranthene, P-Chloroaniline, Pyrene, Tetrachloromethane, Trichlorofluoromethane, 2-Hexanone, 2-Methylnaphthalene, 4-Chloroaniline, Benzo(a)pyrene

Pesticides & Insecticides

Aldrin, Chlordane, Cyclohexane, Heptachlor, Endosulfan, Endosulfan-II, Lindane, Dieldrin, Endrin, DDT, DDD, DDE, 2,4,5-Trichlorophenoxyacetic Acid, Acetic Acid (2,4-Dichlorophenoxy), 2,4,5-Trichlorophenoxypropionic Acid, Pentachloronitrobenzene, Chlorobenzilate, Beta-BHC, Kepone, Mirex, Methoxychlor,

PCBs (PolyChlorinated Biphenyls)

PCB-1016,	PCB-1232,	PCB-1248,	PCB-1260
PCB-1221,	PCB-1242,	PCB-1254,	

PBDEs (PolyBrominated Diphenyl Ethers)

BDE-28,	BDE-85,	BDE-138,	BDE-183,
BDE-47,	BDE-99,	BDE-153,	BDE-209,
BDE-66,	BDE-100,	BDE-154,	

Hydrocarbons, Petrochemicals, Organochlorines

PCBs, PCT, PBB, PBT, Anthracene, Pentachlorophenol, Benzo(g,h,i)perylene, Benzene, Benzene, C14-C24-branched, Polyethylbenzene residue, Octane, Hexachlorobenzene, Ethylbenzene,

Chlorinated Benzenes, Naphtha (petroleum), turpentine-oil, Hydrotreated kerosene, Hydrocarbon oils, Hydrocarbons, C10 and C12, Distillates (petroleum), Fuel oil, Creosols, P-Cresol, O-Cresol,

2-(2H-Benzotriazol-2-yl)-p-cresol, Hexachlorobutadiene, N-Nitrosodimethylamine, Toxaphene, Trichloroethane, Tetrachloroethane, Hexachloroethane, Carbon Tetrachloride, Dichloroethylene, Trichloroethylene, Tetrachloroethylene, Xylene,

Pharmaceuticals

1,7-Dimethylxanthine,
4-Epianhydrochlortetracycline,
4-Epianhydrotetracycline,
4-Epichlortetracycline,
4-Epioxytetracycline,
4-Epitetracycline,
Acetaminophen,
Albuterol,
Anhydrochlortetracycline,
Anhydrotetracycline,
Azithromycin,
Caffeine,
Carbadox,
Carbamazepine,
Cefotaxime,
Chlortetracycline,
Cimetidine,
Ciprofloxacin,
Clarithromycin,
Clinafloxacin,
Cloxacillin,
Codeine,
Cotinine,
Dehydronifedipine,
Demeclocycline,
Digoxigenin,
Digoxin,
Diltiazem,
Diphenhydramine,
Doxycycline,
Enrofloxacin,
Erythromycin-Total,
Flumequine,
Fluoxetine,
Gemfibrozil,
Ibuprofen,
Isochlortetracycline,
Lincomycin,
Lomefloxacin,
Metformin,
Miconazole,
Minocycline,
Naproxen,
Norfloxacin,
Norgestimate,
Ofloxacin,
Ormetoprim,
Oxacillin,
Oxolinic Acid,
Oxytetracycline,
Penicillin G,
Penicillin V,
Ranitidine,
Roxithromycin,
Sarafloxacin,
Sulfachloropyridazine,
Sulfadiazine,
Sulfadimethoxine,
Sulfamerazine,
Sulfamethazine,
Sulfamethizole,
Sulfamethoxazole,
Sulfanilamide,
Sulfathiazole,
Tetracycline,
Thiabendazole,
Triclocarban,
Triclosan,
Trimethoprim,
Tylosin,
Virginiamycin,
Warfarin,

Steroids & Hormones

17 Alpha-Dihydroequilin,
17 Alpha-Estradiol,
17 Alpha-Ethinyl-Estradiol,
17 Beta-Estradiol,
Androstenedione,
Androsterone,
Beta Stigmastanol,
Campesterol,
Cholestanol,
Cholesterol,
Coprostanol,
Desmosterol,
Epicoprostanol,
Equilenin,
Ergosterol,
Estriol,
Estrone,
Ethinylestradiol,
Norethindrone,
Norgestrel,
Progesterone,
Stigmasterol, Sitostanol,
Beta-Estradiol 3-Benzoate,
Beta-Sitosterol,
Equilin,
Testosterone,

"Acceptable" levels of exposure to sewage sludge contaminants are based on obsolete and faulty scientific data and processes. In 2002 and 2010, the National Academy of Sciences and National Institutes of Health established those facts [3, 1].

The risk assessments upon which these levels are based neglected dietary impacts on children; multi-pathway exposure; synergistic impacts; infectious organism exposure; ecological, wildlife, food chain, soil microorganism & forest soil impacts; long-term heavy metal accumulation; and used a cancer risk safety factor 100 times less protective than used for air and water pollution.

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Compiled 12-29-10 by
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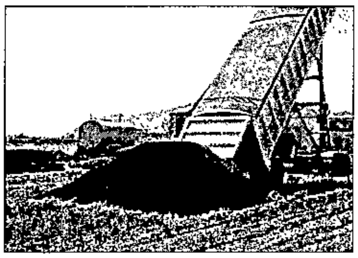
Attachment 2

In Summary

Biosolids Applied to Land: Advancing Standards and Practices
Board on Environmental Studies and Toxicology



For several decades the wastewater treatment industry has recycled sewage sludge by applying a treated form of it (often referred to as biosolids) to agricultural or other lands in order to improve the properties of the soil. The practice offers an alternative to disposal options such as landfilling or incineration, and its use has increased since disposal of sewage sludge in oceans was prohibited in 1992. Today, roughly 60% of the 5.6 million dry tons of sewage sludge disposed of annually is used for land application in the United States.

Biosolids are complex mixtures that can contain pollutants from household, commercial and industrial wastewaters with organic contaminants (such as pharmaceuticals), inorganic contaminants (metals and trace elements) and pathogens (bacteria, viruses and parasites). Depending on the extent of treatment, biosolids may be applied on areas with limited public exposure such as farms, or with more treatment on public sites such as parks, golf courses, lawns and home gardens.

In 1993, EPA established a regulation governing land application of sewage sludge under the Clean Water Act with the intent to protect public health and the environment from reasonably anticipated adverse effects. The regulation (Code of Federal Regulations Title 40, Part 503, commonly referred to as the Part 503 rule) sets chemical pollutant limits, operational standards designed to reduce pathogens and the attraction of disease vectors (such as insects), and management practices.

Public health concerns regarding the use of biosolids are growing, especially from citizens living near application sites. The EPA asked the National Academies to convene a committee to conduct an independent evaluation of the technical methods and approaches used to establish the chemical and pathogen standards for biosolids, focusing specifically on human health protection. The committee was not asked to determine whether EPA should continue to promote land application of biosolids or to judge the adequacy of the individual standards in protecting human health, but rather to reassess the scientific basis of the Part 503 rule.

Overarching Recommendations

There is uncertainty about the potential for adverse human health effects from exposure to biosolids. To assure the public and to protect public health, there is a need to update the scientific basis of the Part 503 rule. The committee identified several data gaps and issues in management practices that should be addressed including:

- *A lack of exposure and health information on exposed populations.* The committee recommends implementing human health studies, including short-term investigations of unusual episodes of release, exposure, or disease, and large-scale preplanned studies of exposures and their association, if any, with disease.
- *Reliance on outdated risk-assessment methods.* Since 1993 when the rule was established, risk-assessment methods have advanced significantly. The committee recommends that new risk assessments be used to update the scientific basis of the chemical limits and the regulatory criteria for pathogens.
- *Reliance on outdated characterization of sewage sludges.* Changes in treatment processes and chemical uses over the last decade have changed the composition of sewage sludges. The committee recommends a new national survey of chemicals and pathogens in sewage sludges and a review of management practices to ensure that risk assessment principles are put into practice.
- *Inadequate programs to ensure compliance with biosolids regulation.* EPA should expand its oversight activities to include procedures to 1) assess the reliability of biosolids treatment processes and effectiveness of management practices, 2) monitor compliance with chemical and pathogen standards, 3) conduct environmental hazard surveillance, and 4) study human exposures and health.
- *Lack of resources devoted to EPA's biosolids program.* More funding and staff resources are needed to implement the recommendations in this report. The committee also recommends that EPA delegate authority to more states to administer the federal biosolids regulation.

Health Effects Recommendations

There are anecdotal reports attributing adverse health effects to biosolids exposures, ranging from relatively mild irritant and allergic reactions to severe and chronic health outcomes. The Committee recommends that the EPA promote and support studies of exposed populations in order to document whether any health effects can be linked to biosolids exposure through the following types of studies:

- Studies in response to unusual exposures and unusual occurrences of disease.

- Preplanned assessment studies to characterize exposures of workers and the general public who come into contact with biosolids.
- Complete epidemiological studies, for example, evaluating health effects in a group of biosolids appliers.

Chemical Standards Recommendations

In developing the 1993 Part 503 rule, the EPA relied heavily on its 1988-1989 National Sewage Sludge Survey to identify chemicals to regulate, selecting 9 inorganic chemicals (arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc). Risk assessments were conducted on each chemical to establish acceptable concentration limits.

Since 1993, new chemicals of concern have been identified, such as organic compounds used as flame retardants (i.e., brominated diphenyl ethers), pharmaceuticals and odorants. Chemicals eliminated in earlier selection processes because of data gaps might now be reevaluated in light of new data.

To set the 1993 limits for the regulated chemicals, the EPA considered 14 major exposure pathways, nine of which involve exposure to humans. EPA elected to estimate human exposure based on a theoretical, highly exposed individual (HEI), and gave no consideration to aggregate exposure, but rather evaluated each exposure pathway independently.

The Committee made the following recommendations regarding chemical standards:

- A new national survey of chemicals in sewage sludge should be conducted. Data from the survey should be used to determine whether additional chemicals should be considered for regulation.
- Using current risk-assessment practices, EPA should reassess standards for regulated chemicals. Because of the diversity of exposed populations and environmental conditions in the United States, it is important that nationwide chemical regulations be based on the full range of exposure conditions that might occur.
- Conceptual site models should be used to identify major and minor exposure pathways.
- A hypothetical individual with reasonable maximum exposure (RME, such as a farm family living adjacent to an application site), rather than an HEI, should be evaluated for each exposure pathway. If there is likely more than one pathway, exposures should be added across pathways.
- Representatives of stakeholders should be included in the risk-assessment process.

Pathogen Standards Recommendations

EPA considered a spectrum of bacteria, viruses, and parasites in setting its 1993 pathogen standards. No risk assessments were conducted to establish these standards. Instead, EPA established requirements to reduce pathogens by treatment or a combination of treatment and use restrictions. Given the variety of pathogens that have the potential to be present in biosolids, the committee supports this approach. However, the reliability of EPA's treatment techniques should be better documented using current pathogen detection technology, and more research is needed to verify that current management controls are adequate to maintain minimal exposure concentrations over an extended period of time.

The Committee recommends the following:

- EPA should conduct a national survey of pathogen occurrence in raw and treated sewage sludges.
- Quantitative microbial risk assessments (QMRAs) should be developed and used to establish regulatory criteria for pathogens in biosolids. QMRAs should include evaluation of all potential exposure pathways (e.g., transport of bioaerosols, runoff), and the possibility of secondary transmission of disease such as through person-to-person contact.
- EPA should foster development of standardized methods for measuring pathogens in biosolids and bioaerosols.
- EPA should promote research that uses improved pathogen detection technology to better establish the reliability of its prescribed pathogen treatment processes and biosolids-use controls to achieve and maintain minimal exposure over time.

Committee on Toxicants and Pathogens in Biosolids Applied to Land: **Thomas Burke** (*Chair*), Johns Hopkins University, **Lawrence R. Curtis**, Oregon State University, **Charles N. Haas**, Drexel University, **Ellen Z. Harrison**, Cornell University, **William E. Halperin**, New Jersey Medical School, **John B. Kaneene** Michigan State University, **Greg Kester**, Wisconsin Department of Natural Resources, **Stephen P. McGrath**, Institute for Arable Crops Research, **Thomas E. McKone**, University of California, **Ian L. Pepper** University of Arizona, **Suresh D. Pillai**, Texas A&M University, **Frederick G. Pohland**, University of Pittsburgh, **Robert S. Reimers**, Tulane University, **Rosalind A. Schoof**, Gradient Corporation, **Donald L. Sparks**, University of Delaware, **Robert C. Spear**, University of California at Berkeley, **Susan Martel** (Study Director), the National Academies' Board on Environmental Studies and Toxicolgy.

Biosolids Applied to Land: Advancing Standards and Practices is available from the National Academy Press, 2101 Constitution Avenue, N.W., Washington, DC 20055; (800) 624-6242 or (202) 334-3313, or http://www.nap.edu.

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Attachment 3

Case for Caution Revisited: Health and Environmental Impacts of Application of Sewage Sludges to Agricultural Land

Ellen Z. Harrison, retired Director, and Murray McBride, Director, Cornell Waste Management Institute, Dept. of Crop and Soil Sciences, Rice Hall, Cornell University, Ithaca, NY. (cwmi.css.cornell.edu)

Posted at: cwmi.css.cornell.edu/case.pdf

September 2008 (updated March 2009)

Note: Text in this Arial font is written by the authors. Text in this Times New Roman font is quotations and citations.

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Over the past 15 years since the 40CFRPart503 rules were promulgated, there have been many new scientific findings regarding the environmental and health implications of the application of sewage biosolids to agricultural soils. Many of these findings show increased risks, risks that were not assessed as part of the risk assessment that USEPA used as the basis for the standards promulgated in 1993. These new findings support the rational basis for U.S. EPA to revise the federal regulations and for states and municipalities to regulate the application of sewage biosolids in order to protect their citizens and the land-base.

Agricultural soils are a unique and valuable resource. Protecting agricultural soils requires anticipating and avoiding potential harms since once contaminated with persistent pollutants, the damage will remain for the foreseeable future. Once contaminated, stopping the application of pollutants such as metals and many organic chemicals that are in sewage biosolids will not correct the problem. The contamination will remain for decades or centuries. It is thus critical to prevent this essentially permanent degradation.

Current Rules are Based on Outdated and Inadequate Science

As pointed out the by the National Research Council, the risk assessment on which current rules are based was conducted nearly 20 years ago and is outdated. A tremendous amount of new knowledge about the presence and behavior of chemicals and pathogens has been developed in the last decades.

NRC Targets Pathogens in Sludge for Research. Rebecca Renner, 2002.Environmental Science and Technology: Science News - July 24. <http://pubs.acs.org/doi/pdf/10.1021/es022404s>

The U.S. EPA rules for using treated sewage sludge as fertilizer are based on outdated science, according to a report released in July from the National Academies, National Research Council (NRC). The report, which was produced after two years of study, recommends new research to update the rules. In particular, EPA needs to investigate the growing number of complaints about illnesses and even deaths from exposure to Class B sludge.

Under a 1993 Clean Water Act rule, treated sewage sludge, or biosolids, can be applied to land with certain limitations. Pathogen-containing Class B sludge, which makes up the bulk of sludge applied to land, may be used as fertilizer in situations in which public exposure is limited. Class A sludge can be applied on public sites. Of the 5.6 million tons of sewage sludge generated in the United States each year, 60% ends up being applied as fertilizer.

The agency needs to investigate the potential health effects from sludge exposure and find out more about the pathogens in sludge, according to committee chair Thomas Burke, a public health professor at Johns Hopkins University in Baltimore, Md. There is a serious lack of health-related information about populations exposed to treated sludge, adds Burke.

The NRC report also recommends a new national sludge survey to measure sludge contaminants, which would update the previous 1988 survey. This earlier study was unreliable and needs to include newly recognized chemicals of potential concern, including polybrominated biphenyl ether flame retardants, pharmaceuticals, and personal care products such as shampoos and soaps, says the NRC committee. EPA also needs to redo its assessment of the human health risks posed by metals in sludge. The revised risk assessments should reflect the potential for variations in climate, water flow, and sludge characteristics. The report also notes that more rigorous enforcement of the current standards is needed."

Targeted National Sewage Sludge Survey Report Released in 2009. USEPA, <http://earth1.epa.gov/waterscience/biosolids/tnsss-overview.html>

The last EPA survey of sewage sludges nationally occurred in 1988. The EPA 503 rule was based in large part on the levels of contaminants detected in that survey. Many contaminants have emerged since then as being potentially harmful in the environment. This new survey by

EPA provides much-needed information on chemicals likely to be found in sewage sludges across the country.

In 2006 and 2007, the USEPA collected samples of sewage sludge from 74 randomly-chosen wastewater treatment facilities in 35 states. The sampled facilities are considered to be representative of the nation's 3,337 largest treatment facilities. The samples were tested for 145 chemicals, including metals, PAHs, nitrogen, phosphorus, flame retardants (PDBEs), pharmaceuticals, hormones, and steroids.

It is notable that, while the median concentrations of toxic metals, trace elements, and organic chemicals were generally many times lower than the highest concentrations observed, quite high concentrations of one or more chemicals were measured in a substantial fraction of the 74 treatment plants. This survey, while quite informative, is not able to assess variability of sludge composition over time, as the sewage sludge was sampled at a single time point. The survey showed some very high concentrations of specific chemicals at one or more treatment plants, with peak concentration for the following elements being:

Barium	3,460 mg/kg		Mercury	8.26 mg/kg
Fluoride	234 mg/kg		Nickel	526 mg/kg
Molybdenum	132 mg/kg		Copper	2,580 mg/kg
Silver	856 mg/kg		Tin	522 mg/kg
Cobalt	290 mg/kg		Vanadium	617 mg/kg
Iron	299,000 mg/kg		Zinc	8,550 mg/kg
Lead	450 mg/kg			

This list is only a sampling of the inorganic contaminants reported in the survey.

In many cases, the highest contaminant concentrations were found in the smallest wastewater treatment plants included in the survey (1-10 MGD plant). The very high Fe sludge (reported in the list above) also had very high phosphorus, attributable to a tertiary treatment process using iron salts to remove P from wastewater. As tertiary treatment to lower P in treated water is likely to increase in the future, we can perhaps expect to see more sewage sludges with very high Fe content. Although ferric iron is not a toxic metal when mixed into soil, it has been known to be toxic to cattle where sludge was applied directly to pasture.

The high levels of several unregulated or inadequately regulated and potentially toxic metals (e.g., silver, molybdenum, tin) are a concern for land application. It should also be of great concern for land application that the measured concentrations of persistent organic pollutants (POPs), including the brominated fire retardants (PBDEs), and the antimicrobial chemicals (triclosan and triclocarban) are so high in some sludges. These POPs are likely to build up in soils with repeated application, and have the potential to bioconcentrate in foraging animals and therefore in meat and milk. One of the eleven PBDE congeners measured (BDE 209) reached a concentration of 17,000 μg/kg in one sludge, and the highly bioaccumulative BDEs 47 and 99 reached levels as high as 5,000 μg/kg. Triclocarban and triclosan had peak concentrations of 441,000 and 133,000 μg/kg in separate sludges. The impact of these persistent chemicals on soil organisms, the safety of food crops, and the environment is not known at this time because of very limited research on their behavior and toxicity in soil.

The prevalence of a wide array of pharmaceuticals, steroids and hormones, as summarized in the EPA report, is a clear indication that the sewage treatment process does not degrade these organic chemicals effectively, and sewage sludge therefore becomes the repository for a large fraction of the chemicals used commercially and domestically.

New information on the impacts of the regulated contaminants

Endocrine Disruption

New information indicates that some of the handful of metals that are regulated under Part 503 pose risks that were not evaluated in the risk assessment upon which the Part 503 USEPA rules are based. The whole subject of endocrine disruption due to exposure to chemicals in the environment (i.e. our knowledge regarding the disruption to human and animal hormones and reproductive systems posed by a number of chemicals) has developed since those rules were promulgated.

Examples of several of the regulated metals for which new risks have been identified are lead and cadmium. Recent work shows that lead has a number of effects on sperm and may play a role in the rising infertility that is being observed. Cadmium has been shown to mimic estrogen and may be related to increased breast cancer. These metals are contained in all sewage biosolids. The contaminant limits in Part 503 do not include any recognition of these endocrine-disrupting impacts.

Increased seminal plasma lead levels adversely affect the fertility potential of sperm in IVF. Susan Benoff, Grace M. Centola, Colleen Millan, Barbara Napolitano, Joel L. Marmar and Ian R. Hurley, 2003. Human Reproduction, V. 18, No. 2, 374-383

BACKGROUND: Lead remains in high levels in the environment and is known to reduce fertility in animal models, but a direct link between lead exposures and human infertility has not yet been established. METHODS: In a prospective, double-blind study of the metal ion levels and sperm function, semen was obtained from partners of 140 consecutive women undergoing their first IVF cycle. Lead in seminal plasma was determined by atomic absorption spectroscopy. Motile sperm populations were assessed for surface receptors for mannose binding, and the ability to undergo premature ('spontaneous'), and free mannose-induced acrosome reactions. Fertile donor ($n = 9$) sperm were exposed to exogenous lead during capacitating incubations and then assessed for mannose receptor expression and acrosome loss. RESULTS: Lead levels were negatively correlated with IVF rates. Lead levels were negatively correlated to two of the three sperm function biomarkers (mannose receptors, mannose-induced acrosome reactions). Lead levels positively correlated with the spontaneous acrosome reaction. These findings were mimicked by in-vitro exposure of fertile donor sperm to lead. CONCLUSIONS: Multiple sperm parameters are affected as lead levels rise. Increased lead levels may contribute to the production of unexplained male infertility.

Cadmium mimics the in vivo effects of estrogen in the uterus and mammary gland. Michael D Johnson, Nicholas Kenney, Adriana Stoica, Leena Hilakivi-Clarke, Baljit Singh, Gloria Chepko, Robert Clarke, Peter F Sholler, Apolonio A Lirio, Colby Foss, Ronald Reiter, Bruce Trock, Soonmyoung Paik, and Mary Beth Martin, 2003. Nature Medicine, 9:1081-1084. Letter Published online: 13 July 2003.

Abstract: "It has been suggested that environmental contaminants that mimic the effects of estrogen contribute to disruption of the reproductive systems of animals in the wild, and to the high incidence of hormone-related cancers and diseases in Western populations. Previous studies have shown that functionally, cadmium acts like steroidal estrogens in breast cancer cells as a result of its ability to form a high-affinity complex with the hormone binding domain of the estrogen receptor1, 2. The results of the present study show that cadmium also has potent estrogen-like activity *in vivo*. Exposure to cadmium increased uterine wet weight, promoted growth and development of the mammary glands and induced hormone-regulated genes in ovariectomized animals. In the uterus, the increase in wet weight was accompanied by proliferation of the endometrium and induction of progesterone receptor (PgR) and complement component C3. In the mammary gland, cadmium promoted an increase in the formation of side branches and alveolar buds and the induction of casein, whey acidic protein, PgR and C3. *In utero* exposure to the metal also mimicked the effects of estrogens. Female offspring experienced an earlier onset of puberty and an increase in the epithelial area and the number of terminal end buds in the mammary gland."

Cadmium mimics effects of estrogen. NewScientist.com News Service, 13:44, July 14, 2003.

Cadmium is astonishingly good at mimicking the effects of the female sex hormone estrogen, new research on rats has revealed. The discovery raises concerns that the metal, and others like it, could increase the risk of illnesses like breast cancer in people.

Cadmium is widely used in batteries, and is present in cigarette smoke and sewage sludge spread on agricultural land. It is best known for obvious toxic effects on the liver and kidneys.

But new research by Mary Beth Martin's team at Georgetown University in Washington DC shows that, at much lower doses, cadmium can cause very similar effects as estrogen.

Martin gave cadmium to female rats whose ovaries had been removed, so they could not make estrogen themselves. The animals received doses comparable to the level set by the World Health Organization as a tolerable weekly intake for people. The results were unexpectedly striking, with the effects of the cadmium appearing almost identical to those of estrogen.

Denser tissue

Rats given cadmium rapidly developed heavier wombs, denser mammary glands and thicker womb linings - just as they did when given estrogen itself. They also began to make milk, and two genes usually activated by estrogen were switched on.

And when Martin's team gave cadmium to pregnant rats, their female offspring went through puberty sooner and developed denser mammary gland tissue, again matching the effects of estrogen.

Impacts on livestock

Livestock that graze on sludge-amended pastures ingest biosolids that adhere to the forage plants and also ingest soil directly. Particularly in arid conditions, soil can be up to 18% dry weight of a grazing animal's diet. Even where lesser amounts are ingested, recent research has shown impacts to grazing animals from biosolids additions to soils. These impacts include an accumulation of toxic metals in edible body organs, with implications for the human food chain. Additionally, endocrine disruption (reduced testis size) has been documented, with implications for livestock reproduction. There is now evidence that elements in sludge, particularly molybdenum and sulfur, are readily taken up by forages and can lead to Cu deficiency in livestock.

Accumulation of potentially toxic elements by sheep given diets containing soil and sewage sludge. 1. Effect of type of soil and level of sewage sludge in the diet. Hill, J. B. Stark, J. Wilkinson, M. Curran, I. Lean, J. Hall, C. Livesey, 1998. Animal Science, 67:73-86.

Live weight gain was depressed by the addition of sludge to the diet. Levels of cadmium and lead in liver and kidneys increased, with the lead levels approaching the UK statutory limit for human food.

The long-term effect of sludge application on Cu, Zn, and Mo behavior in soils and accumulation in soybean seeds. B.J. Kim, M.B. McBride, B.K. Richards, T.S. Steenhuis, 2007. Plant and Soil, 299:227-236.

Molybdenum and copper uptake by forage grasses and legumes grown on a metal-contaminated sludge site. M.B. McBride, 2005. Communications in Soil Science and Plant Analysis, 36: 2489-2501.

Molybdenum extractability in soils and uptake by alfalfa 20 years after sewage sludge application. M.B. McBride and B. Hale, 2004. Soil Science, 169:505-514.

Molybdenum, sulfur, and other trace elements in farm soils and-forages after sewage sludge application. M.B. McBride, 2004. Communications in Soil Science and Plant Analysis, 35:517-535.

The EPA 503 rule regulated the loading of only 8 heavy metals on agricultural soils. Molybdenum loading on soils is not limited by the 503 rule even though this trace metal presents a well-documented danger for ruminant animals due to its ready uptake into forage legumes, grasses, soybeans and other crops. The 4 research papers cited above demonstrates that molybdenum in land-applied sewage represents a sustained and long-term risk to livestock health from increased molybdenum in forages and soybeans.

Effects of pasture applied biosolids on performance and mineral status of grazing beef heifers. M.E. Tiffany, L.R. McDowell, G.A. O'Connor, F.G. Martin, N.S. Wilkinson, E.C. Cardoso, S.S. Percival and P.A. Rabiansky, 2000. J. Animal Science, 78:1331-1337.

Effects of residual and reapplied biosolids on performance and mineral status of grazing beef steers. M.E. Tiffany, L.R. McDowell, G.A. O'Connor, F.G. Martin, N.S. Wilkinson, S.S. Percival and P.A. Rabiansky, 2002. J. Animal Science, 80:260-269.

Molybdenum and sulfur in forage crops are known to reduce the availability of copper to ruminant animals, and can lead to severe copper deficiency in livestock.

Studies in Florida have revealed that, while molybdenum applied with sewage sludges on bahiagrass was not taken up by the grass to a significant degree, grazing beef cattle nevertheless developed signs of copper deficiency as confirmed by reductions in liver copper stores. This negative effect of sewage sludge on copper availability to the cattle was attributed to high sulfur concentrations in the sludge-amended pastures. The low uptake of molybdenum by grass in that study can be attributed to the low pH of the pasture soils.

Exposure to pastures fertilised with sewage sludge disrupts bone tissue homeostasis in sheep. P. Monica Lind, M. Gustafsson, S.A.B. Hermsen, S. Larsson, C.E. Kyle, J. Orberg and S.M. Rhind, 2009. Science of the Total Environment, 407:2200-2208.

A recent study has shown that male sheep exposed to low levels of pollutants by grazing on pastures fertilized with sewage sludge developed bone tissue abnormalities.

Cellular and hormonal disruption of fetal testis development in sheep reared on pasture treated with sewage sludge. Catriona Paul, Stewart M. Rhind, Carol E. Kyle, Hayley Scott, Chris McKinnell, and Richard M. Sharpe, 2005. Environmental Health Perspectives, 113(11):1580-1587

Fetuses of pregnant sheep reared on sludge-treated pasture had reduced body weight. Male fetus testis were significantly reduced. "These findings indicate that exposure of the developing male sheep fetus to real-world mixtures of environmental chemicals can result in major attenuation of testicular development and hormonal function, which may have consequences in adulthood." This has the potential for impact on fertility.

Movement to groundwater through facilitated transport

New understanding about the movement of contaminants (both chemicals and pathogenic organisms) through soils into groundwater has been developed in recent years. This includes information showing that contaminants may "piggy-back" on other chemicals that move in water (this is termed "facilitated transport"). Thus a chemical which by itself is relatively immobile in soils (such as many metals), can move rapidly through soils when other chemicals are present (such as organic matter in biosolids). In addition, another mechanism that provides for rapid movement of chemicals through soils is that water and the contaminants carried in it can move through soils along preferential flow paths (such as worm holes, root channels or wetting fingers).

Recent short feature articles on these topics prepared by Cornell include *Colloidal transport: the facilitated movement of contaminants into groundwater* (B.K. Richards, J.F. McCarthy, T.S. Steenhuis, A.G. Hay, Y. Zevi, A. Dathe. 2007. Journal of Soil & Water Conservation 62(3)55A-

56A) and *The unintentional secret.* (B.K. Richards, N. Peranginangin, T.S. Steenhuis and L.D. Geohring. 2003. Journal of Soil & Water Conservation, September-October 2003 59(5):104A-105A). By these mechanisms, contaminants can move through the soil and into groundwater much more quickly than predicted in the very limited risk assessment of groundwater transport potential performed to support the Part 503 rules. The rate of contaminant movement predicted by that risk assessment relied on data from a *single* paper based on *test tube* mobility tests from a *single soil type*. No actual field data were used. Furthermore, the transport models employed by that assessment assumed uniform homogenous soils. The risk assessment thus did not account for these common rapid flow phenomena.

Biosolid colloid-mediated transport of copper, zinc, and lead in waste-amended soils. A.D. Karathanasis, D.M.C. Johnson, and C.J. Matocha, 2005. Journal of Environmental Quality, 34(4):1153-1164

A significant increase in the leaching of metals (up to 10,000 times) was measured in a laboratory experiment as a result of the binding of metals to the organic colloids in sewage sludge. "The findings demonstrate the important role of biosolids colloids as contaminant carriers and the significant risk they pose."

Effect of Mineral Colloids in Virus Transport through Saturated Sand Columns. Yan Jin, Ellen Pratt, and Marylynn V. Yates, 2000. Journal of Environmental Quality, 29(2):532-539

The movement of viruses through soils was facilitated by adsorption on to colloidal particles.

Facilitated Transport of Napropamide by Dissolved Organic Matter in Sewage Sludge-Amended Soil. L. Nelson, W. Farmer, C.J. Williams, and M. Ben-Hur, 1998. Journal of Environmental Quality, 27:1194-1200.

Abstract: The application of sewage sludge to agricultural soils is practiced to minimize landfill disposal. Organic matter amendments to soil are generally thought to improve soil quality, but pesticide application to these soils may lead to groundwater contamination problems. The complexation of pesticides with a water-soluble carrier such as dissolved organic matter (DOM) may facilitate chemical movement through soil. Sewage sludge amendments may lead to greater downward movement of organic chemicals if associated with DOM. Napropamide [2-α-napthoxy)-*N,N*-diethylpropionamide] was applied to a silt loam soil with (SS) and without (NoSS) sewage sludge application. Laboratory batch equilibrium and soil column studies were performed to determine the potential for herbicide complexation with DOM. Over 98% of the herbicide in soil columns followed typical adsorption and transport behavior as the center of mass of the lower organic matter soil (NoSS) moved twice the depth as that of SS. However, napropamide was detected in the initial leachate eluted from repacked soil columns with steps taken to prevent preferential flow. Napropamide concentrations in the initial leachate of SS were twice that from NoSS with <1.5% of the total applied chemical mass eluting from the bottom of each column. A strong positive relationship was found between napropamide concentration and DOM content in soil leachates. Equilibrium dialysis methods were used to determine that napropamide moving through the soil columns was complexed with DOM. The results show that DOM can facilitate herbicide movement through soil and that sewage sludge-derived DOM may lead to enhanced chemical transport in sludge-amended soils.

Enhanced Transport of Pesticides in a Field Trial with Treated Sewage Sludge. E. Grager, I. Dror, F. Bercovich, and M. Rosner, 2001. Chemosphere, 44: 805-811

Pesticide leaching in arid field soils was increased by the application of sewage sludge.

Aerosols and human health effects

Health effects from exposure to sewage sludge during land spreading have been reported frequently, but these reports have been considered anecdotal and not confirmatory evidence that illness can result from aerosols released during application. Few studies have actually addressed symptoms related to land application. A study of people living near application sites compared with a control population showed statistically elevated health-related symptoms in the exposed population. Another study of 48 people located near 10 land application sites indicated that chemical irritants and pathogens in sludge may interact to cause symptoms.

Several recent publications have tracked aerosol emissions from fields during sewage sludge (biosolids) application and tillage. DNA-based microbial tracking has proven that wind is a critical factor in the formation and off-site migration of aerosols. Biosolids aerosols of inhalable size (< 10 μm), containing bacteria such as coliforms and Health survey of residents living near farm fields permitted to receive biosolids.

Health Survey of Residents Living near Farm Fields Permitted to Receive Biosolids. Sadik Khuder, Sheryl A. Milz, Michael Bisesi, Robert Vincent, Wendy McNulty, and Kevin Czajkowski, 2007. Archives of Environmental and Occupational Health, 62(1):5-11.

Abstract: The authors studied the health status of residents living in Wood County, OH, near farm fields that were permitted to receive biosolids. They mailed a health survey to 607 households and received completed surveys from 437 people exposed to biosolids (living on or within 1 mile of the fields where application was permitted) and from 176 people not exposed to biosolids (living more than 1 mile from the fields where application was permitted). The authors allowed for up to 6 surveys per household. Results revealed that some reported health-related symptoms were statistically significantly elevated among the exposed residents, including excessive secretion of tears, abdominal bloating, jaundice, skin ulcer, dehydration, weight loss, and general weakness. The frequency of reported occurrence of bronchitis, upper respiratory infection, and giardiasis were also statistically significantly elevated. The findings suggest an increased risk for certain respiratory, gastrointestinal, and other diseases among residents living near farm fields on which the use of biosolids was permitted. However, further studies are needed to address the limitations cited in this study.

Interactions of pathogens and irritant chemicals in land-applied sewage sludges (biosolids). David L Lewis, David K Gattie, Marc E Novak, Susan Sanchez, and Charles Pumphrey, 2002.

BMC Public Health, 2:11

Background: Fertilisation of land with processed sewage sludges, which often contain low levels of pathogens, endotoxins, and trace amounts of industrial and household chemicals, has become common practice in Western Europe, the US, and Canada. Local governments, however, are increasingly restricting or banning the practice in response to residents reporting adverse health effects. These self-reported illnesses have not been studied and methods for assessing exposures of residential communities to contaminants from processed sewage sludges need to be developed.

Methods: To describe and document adverse effects reported by residents, 48 individuals at ten sites in the US and Canada were questioned about their environmental exposures and symptoms. Information was obtained on five additional cases where an outbreak of staphylococcal infections occurred near a land application site in Robesonia, PA. Medical records were reviewed in cases involving hospitalisation or other medical treatment. Since most complaints were associated with airborne contaminants, an air dispersion model was used as a means for potentially ruling out exposure to sludge as the cause of adverse effects.

Results: Affected residents lived within approximately 1 km of land application sites and generally complained of irritation (e.g., skin rashes and burning of the eyes, throat, and lungs) after exposure to winds blowing from treated fields. A prevalence of *Staphylococcus aureus* infections of the skin and respiratory tract was found. Approximately 1 in 4 of 54 individuals were infected, including 2 mortalities (septicaemia, pneumonia). This result was consistent with the prevalence of *S. aureus* infections accompanying diaper rashes in which the organism, which is commonly found in the lower human colon, tends to invade irritated or inflamed tissue.

Conclusions: When assessing public health risks from applying sewage sludges in residential areas, potential interactions of chemical contaminants with low levels of pathogens should be considered. An increased risk of infection may occur when allergic and non-allergic reactions to endotoxins and other chemical components irritate skin and mucus membranes and thereby compromise normal barriers to infection.

Particulate matter composition and emission rates from the disk incorporation of class B biosolids into soil. Tania Paez-Rubio, Xin Huab, James Anderson, Jordan Peccia, 2006. Atmospheric Environment, 40:7034-7045

Abstract: Biosolids contain metal, synthetic organic compound, endotoxin, and pathogen concentrations that are greater than concentrations in the agricultural soils to which they are applied. Once applied, biosolids are incorporated into soils by disking and the aerosols produced during this process may pose an airborne toxicological and infectious health hazard to biosolids workers and nearby residents. Field studies at a Central Arizona biosolids land application site were conducted to characterize the physical, chemical, and biological content of the aerosols produced during biosolids disking and the content of bulk biosolids and soils from which the aerosols emanate. Arrayed samplers were used to estimate the vertical source aerosol concentration profile to enable plume height and associated source emission rate calculations. Source aerosol concentrations and calculated emission rates reveal that disking is a substantial source of biosolids-derived aerosols. The biosolids emission rate during disking ranged from 9.91 to 27.25 mg s^{-1} and was greater than previously measured emission rates produced during the spreading of dewatered biosolids or the spraying of liquid biosolids. Adding biosolids to dry soils increased the moisture content and reduced the total PM10 emissions produced during disking by at least three times. The combination of bulk biosolids and aerosol measurements along with PM10 concentrations provides a framework for estimating aerosol concentrations and emission rates by reconstruction. This framework serves to eliminate the difficulty and inherent limitations associated with monitoring low aerosol concentrations of toxic compounds and pathogens, and can promote an increased understanding of the associated biosolids aerosol health risks to workers and nearby residents.

Source Tracking Aerosols Released from Land-Applied Class B Biosolids during High-Wind Events. Carolina Baertsch, Tania Paez-Rubio, Emily Viau, and Jordan Peccia, 2007. Applied and Environmental Microbiology, 73:4522-4531

Abstract: DNA-based microbial source tracking (MST) methods were developed and used to specifically and sensitively track the unintended aerosolization of land-applied, anaerobically digested sewage sludge (biosolids) during high-wind events. Culture and phylogenetic analyses of bulk biosolids provided a basis for the development of three different MST methods. They included (i) culture- and 16S rRNA gene-based identification of Clostridium bifermentans, (ii) direct PCR amplification and sequencing of the 16S rRNA gene for an uncultured bacterium of the class Chloroflexi that is commonly present in anaerobically digested biosolids, and (iii) direct PCR amplification of a 16S rRNA gene of the phylum Euryarchaeota coupled with terminal restriction fragment length polymorphism to distinguish terminal fragments that are unique to biosolid-specific microorganisms. Each method was first validated with a broad group of bulk biosolids and soil samples to confirm the target's exclusive presence in biosolids and absence in soils. Positive responses were observed in 100% of bulk biosolid samples and in less than 11% of the bulk soils tested. Next, a sampling campaign was conducted in which all three methods were applied to aerosol samples taken upwind and downwind of fields that had recently been land applied with biosolids. When average wind speeds were greater than 5 m/s, source tracking results confirmed the presence of biosolids in 56% of the downwind samples versus 3% of the upwind samples. During these high-wind events, the biosolid concentration in downwind aerosols was between 0.1 and 2 μg/m 3. The application of DNA-based source tracking to aerosol samples has confirmed that wind is a possible mechanism for the aerosolization and off-site transport of land-applied biosolids.

Off-Site Exposure to Respirable Aerosols Produced during the Disk-Incorporation of Class B Biosolids. Swee Yang Low, Tania Paez-Rubio, Carolina Baertsch, Matthew Kucharski, and Jordan Peccia, 2007. Journal of Environmental Engineering, 133:987-994

Abstract: Field experiments were conducted at a Class B biosolids land application site in central Arizona to measure, model, and source-track the off-site transport of aerosols emitted when biosolids were disk-incorporated into soils. Real-time PM10 monitoring provided time-resolved aerosol information sufficient for verifying both off-site concentration and off-site exposure time model results. Under the conditions considered and at a distance of 165 m from the aerosol source, biosolids disk-incorporation resulted in an intermittent exposure to biosolids-derived aerosol concentration between 15 and 40 μg/m3 and an inhalable biosolids dose between 2 and 8 μg. Transport modeling predicted that these doses will decrease with increasing wind speed. In addition, three DNA sequence-based biosolids source tracking methods were applied to aerosol samples and confirmed the presence of biosolids in aerosols at 5, 65, and 165 m from the aerosol source. Field measurements and modeling indicate that the nature of biosolids-derived aerosol exposure is a series of intermittent high concentration puffs, rather than a continuous low concentration.

Emission Rates and Characterization of Aerosols Produced During the Spreading of Dewatered Class B Biosolids. Tania Paez-Rubio, Abel Ramarui, Jeffrey Sommer, Hua Xin, Hua, James Anderson, and Jordan Peccia, 2008. Environmental Science and Technology, 41(10):3537-3544.

Abstract: This study measured aerosol emission rates produced during the spreading of dewatered class B biosolids onto agricultural land. Rates were determined in multiple independent experimental runs by characterizing both the source aerosol plume geometry and aerosol concentrations of PM10, total bacteria, heterotrophic plate count bacteria (HPC), two types of biosolids indicator bacteria, endotoxin, and airborne biosolids regulated metals. These components were also measured in the bulk biosolids to allow for correlating bulk biosolids concentrations with aerosol emission rates and to produce reconstructed aerosol concentrations. The average emission rates and associated standard deviation for biosolids PM10, total bacteria, HPC, total coliforms, sulfite-reducing Clostridia, endotoxin, and total biosolids regulated metals were 10.1 ± 8.0 (mg/s), $1.98 \pm 1.41 \times 10^9$ (no./s), $9.0 \pm 11.2 \times 10^7$ (CFU/s), $4.9 \pm 2.2 \times 10^3$ (CFU/ s), $6.8 \pm 3.8 \times 10^3$ (CFU/s), $2.1 \pm 1.8 \times 10^4$ (EU/s), and 36.9 ± 31.8 (μg/s) respectively. Based on the land application rates of spreaders used in this study, an estimated 7.6 ± 6.3 mg of biosolids were aerosolized for every 1 kg (dry weight) applied to land. Scanning electron microscopy particle size distribution analysis of the aerosols revealed that greater than 99% of the emitted particles were less than 10 μm and particle size distributions had geometric mean diameters and standard deviations near 1.1 ± 0.97 μm. The demonstrated correlations of bulk biosolids concentrations with aerosol emission rates, and the reconstruction of aerosol concentration based on PM10 and bulk biosolids concentration provide a more fundamental, bulk biosolids based approach for extending biosolids aerosol exposure assessment to different land application scenarios and a broader range of toxins and pathogens.

Non-regulated contaminants and POPs

Only 9 contaminants are regulated under the Part 503 rules. There are many unregulated contaminants present in sewage biosolids. Some were considered when the rules were being developed and EPA decided not to regulate them. Chemicals considered for regulation, but not included in the 503 rules, include both chemicals for which there were insufficient data to evaluate the risks as well as chemicals for which EPA determined the risk was not substantial. There are, however, many other chemicals now in widespread usage that were not even considered when the 503 rules were promulgated. Among those are the brominated flame retardants, antibacterials, wastewater treatment flocculant polymers, organotins, surfactants, fragrance chemicals and pharmaceuticals.

Over 500 different synthetic organic chemicals have been reported in sewage sludges. Concentrations of many exceed Soil Screening levels set by EPA. None are regulated in sewage biosolids in the US. EPA eliminated organic chemicals from regulatory consideration based on insensitive analyses that had high detection limits for most organic chemicals, too high to measure levels that would be of environmental significance.

All sewage biosolids contain an array of synthetic organic chemicals. An array of pharmaceuticals was found in all of the biosolids tested, regardless of the type of treatment. All biosolids are "highly enriched" in organic wastewater contaminants. Some are present in high concentrations in sewage biosolids (up to 1% by dry weight). Some have demonstrated toxicity. Pharmaceuticals are designed to be biologically active at very low concentrations and thus even at trace levels they may impact plants and animals. There is new information showing that antibiotics and other pharmaceuticals have an impact on plants grown in soils containing these chemicals.

The fate of chemicals entering a wastewater treatment plant depends on the chemical and the treatment processes. They may pass through the treatment plant virtually undegraded and travel with the water effluent, they may be sorbed onto the sludge solids, they may volatilize or they may be transformed or degraded in the treatment process. Most organic chemicals tend to sorb onto and thus concentrate in sewage biosolids rather than volatilizing or traveling through the wastewater treatment plant for discharge with the water effluent.

While many organic chemicals are not degraded or transformed by treatment processes (including composting), some compounds are transformed through chemical and biological process, creating daughter products that may be more or less toxic than the original compound. For example, surfactants are a group of chemicals present in large quantities in biosolids. The degradation products of alkyl phenol ethoxylate (APE) surfactants are significantly more toxic than the original compounds and anaerobic digestion processing at wastewater treatment plants promote this transformation, resulting in high concentrations of the recalcitrant and toxic daughter product. This has led to the restriction in use of APEs in Europe. Even compounds that may degrade to less toxic products may be present in such high concentrations in sludges that despite degradation that may take place when the sludge is applied to land, the concentration of the original compound remains at levels of concern. The surfactant LAS is such a compound.

Determination of Anionic and Nonionic Surfactants, Their Degradation Products, and Endocrine-Disrupting Compounds in Sewage Sludge by Liquid Chromatography/Mass Spectrometry. M. Petrovic and D. Barcelo, 2000. Analytical Chemistry, 72: 4560-4567

Surfactants are present in sludges in high concentrations. Degradation may result in more toxic compounds. Aerobic conditions are necessary for more complete degradation of some surfactants to more benign products.

Organic Chemicals in Sewage Sludges. Ellen Z. Harrison, Summer Rayne Oakes, Matthew Hysell, and Anthony Hay, 2006. Science of the Total Environment 367(2-3):481-497.

Abstract: Sewage sludges are residues resulting from the treatment of wastewater released from various sources including homes, industries, medical facilities, street runoff and businesses. Sewage sludges contain nutrients and organic matter that can provide soil benefits and are widely used as soil amendments. They also, however, contain contaminants including metals, pathogens, and organic pollutants. Although current regulations require pathogen reduction and periodic monitoring for some metals prior to land application, there is no requirement to test sewage sludges for the presence of organic chemicals in the U. S. To help fill the gaps in knowledge regarding the presence and concentration of organic chemicals in sewage sludges, the peer-reviewed literature and official governmental reports were examined. Data were found for 516 organic compounds which were grouped into 15 classes. Concentrations were compared to EPA risk-based soil screening limits (SSLs) where available. For 6 of the 15 classes of chemicals identified, there were no SSLs. For the 79 reported chemicals which had SSLs, the maximum reported concentration of 86% exceeded at least one SSL. Eighty-three percent of the 516 chemicals were not on the EPA established list of priority pollutants and 80% were not on the EPA's list of target compounds. Thus analyses targeting these lists will detect only a small fraction of the organic chemicals in sludges. Analysis of the reported data shows that more data has been collected for certain chemical classes such as pesticides, PAHs and PCBs than for others that may pose greater risk such as itrosamines. The concentration in soil resulting from land application of sludge will be a function of initial concentration in the sludge and soil, the rate of application, management practices and losses. Even for chemicals that degrade readily, if present in high concentrations and applied repeatedly, the soil concentrations may be significantly elevated. The results of this work reinforce the need for a survey of organic chemical contaminants in sewage sludges and for further assessment of the risks they pose.

Survey of Organic Wastewater Contaminants in Biosolids Destined for Land Application. C.A. Kinney, E.T. Furlong, S.D. Zaugg, M.R. Burkhardt, S.L. Werner, J.D. Cahill, and G.R. Jorgensen, 2006. Environmental Science and Toxicology, 40(23):7207-7215.

Abstract: In this study, the presence, composition, and concentrations of organic wastewater contaminants (OWCs) were determined in solid materials produced during wastewater treatment. This study was undertaken to evaluate the potential of these solids, collectively referred to as biosolids, as a source of OWCs to soil and water in contact with soil. Nine different biosolid products, produced by municipal wastewater treatment plants in seven different states, were analyzed for 87 different OWCs. Fifty-five of the OWCs were detected in at least one biosolid product. The 87 different OWCs represent a diverse cross section of emerging organic contaminants that enter wastewater treatment plants and may be discharged without being

completely metabolized or degraded. A minimum of 30 and a maximum of 45 OWCs were detected in any one biosolid. The biosolids used in this study are produced by several production methods, and the plants they originate from have differing population demographics, yet the percent composition of total OWC content, and of the most common OWCs, typically did not vary greatly between the biosolids tested. The summed OWC content ranged from 64 to 1811 mg/kg dry weight. Six biosolids were collected twice, 3-18 months apart, and the total OWC content of each biosolid varied by less than a factor of 2. These results indicate that the biosolids investigated in this study have OWC compositions and concentrations that are more similar than different and that biosolids are highly enriched in OWCs (as mass-normalized concentrations) when compared to effluents or effluent-impacted water. These results demonstrate the need to better describe the composition and fate of OWCs in biosolids since about 50% of biosolids are land applied and thus become a potentially ubiquitous nonpoint source of OWCs into the environment.

Organic Contaminants in Canadian Municipal Sewage Sludge. Part II. Persistent Chlorinated Compounds and Polycyclic Aromatic Hydrocarbons. J. Kohli, H.B. Lee and T.E. Peart, 2006. Water Quality Research Journal of Canada, 41: 47-55

PAHs, PCBs, and other persistent organic pollutants are found in essentially all sludges, but at widely varying concentrations depending on the source of sludge.

Persistence of organic contaminants in sewage sludge-amended soil: A field experiment. S.C. Wilson, R. E. Alcock, A.P. Sewart, K.C. Jones, 1997. J. Environ. Qual., 26: 1467-1477.

POPs introduced into soils by sewage sludge incorporation, specifically dioxins and PCBs, persisted in the soil with concentrations unchanged up to 260 days.

Partitioning, persistence, and accumulation in digested sludge of the topical antiseptic triclocarban during wastewater treatment. J. Heidler, A. Sapkota, R.U. Halden, 2006. Environmental Science & Technology, 40, 3634-3639.

Antibacterial chemicals, including triclosan and triclocarban, are common additives in many antimicrobial household products, including soaps and other personal care products. Research now confirms that most of the triclocarban in wastewater sludge is not decomposed during anaerobic digestion in the wastewater treatment plant, with the result that it concentrates to a high degree in sewage sludge.

Bioaccumulation of pharmaceuticals and other anthropogenic waste indicators in earthworms from agricultural soil amended with biosolid or swine manure. C.A. Kinney, E.D. Furlong, D.W. Kolpin, M.R. Burkhardt, S.D. Zaugg, S.L. Werner, J.P. Bossio and M.J. Benotti, 2008. Environmental Science & Technology, 42:1863-1870.

Triclosan has been shown to bioaccumulate in earthworms sampled from an agricultural field amended with sewage sludge.

Fate of higher brominated PBDEs in lactating cows. A. Kierkegaard, L. Asplund , C.A. deWit , M.S. McLachlan , G.O. Thomas, A.J. Sweetman, K.C. Jones, 2007. Environ. Sci. Technol., 41:417-423

Brominated fire retardant chemicals in contaminated feed accumulated in the fat of cows, indicating that meat consumption may be an important human exposure route to higher brominated BDEs. This observation has important implications for pasture and forage land contamination by these chemicals in sewage sludge.

EPA finds record PFOS, PFOA levels in Alabama grazing fields. R. Renner, 2009. Environmental Science & Technology, 43(5):1245-1246.

Scientists with the EPA, USDA and FDA are investigating whether the high levels of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) measured in agricultural soils in Alabama could have entered the food chain through beef cattle grazing on the land. Sewage sludge had been applied to these pasture lands used for grazing over a 12 year period, and is the likely source of these stable perfluorinated chemicals which are possibly carcinogenic.

Removal of Organotins During Sewage Treatment: A Case Study. N. Voulvoulis, M.D. Scrimshaw, and J.N. Lester, 2004. Environmental Technology, 25(6):733-740.

Organotins are highly toxic compounds found in sludges. They do not degrade in the wastewater treatment process.

The potential impact of veterinary and human therapeutic agents in manure and biosolids on plants grown on arable land: a review. Patrick K. Jjemba, 2002. Agriculture, Ecosystems and Environment, 93(1-3):267-278

Substantial quantities of pharmaceuticals are applied to land in sludges and manures. Detrimental impacts of pharmaceuticals on crops is observed with some species of plants.

Bacterial regrowth/viable non-culturable (VNC)

Recent research has demonstrated that sewage biosolids believed to meet Class A or Class B standards were subject to regrowth and reactivation of bacteria. Thus materials have been land applied that contained bacterial levels far above those of Class A or Class B as defined by USEPA under Part 503. Coliform concentrations were found to increase by 100-1000-fold in biosolids and in soil/biosolid mixtures after centrifugation of anaerobically digested biosolids. Coliform concentrations up to 100,000 times those measured by conventional culture methods may be found in thermophilically digested sludges after centrifugation. This results from the presence of viable but non-culturable bacteria.

Increases in Fecal Coliform Bacteria Resulting From Centrifugal Dewatering of Digested Biosolids. Yinan Qi, Steven. K. Dentel, and Diane S. Herson, 2007. Water Research, 41(3):571-580.

Abstract: In many countries, the classification of biosolids for disposal purposes can be based, in part, on fecal coliform levels, with alternative criteria also available based on the stabilization process used, such as anaerobic digestion. The assumption that these alternative criteria provide equivalent protection may be flawed. This paper demonstrates that fecal coliform levels determined after digestion do not always indicate the bacterial levels after the same biosolids have been dewatered by centrifugation. In samples from mesophilic digestion, half had significant increases in coliform numbers ($P<0.05$) with up to one order of magnitude increase during centrifugation, suggesting coliform regrowth. Thermophilically digested samples had significant increases of several orders of magnitude during dewatering, more likely from reactivation of viable but non-culturable coliforms than from regrowth. In other cases, centrifugation induced coliform regrowth or reactivation upon incubation and storage of dewatered samples, but not digested samples. These 2–3 order of magnitude increases occurred with both 25 and 37 °C incubations. Coliform increases continued for up to 5 days, then gradually declined. However, by day 20 coliform numbers were still 2 orders of magnitude greater than when originally sampled. The magnitude of the increases could be due either to regrowth or reactivation, but the nature of the longer-term increases—also seen in biosolids/soil mixtures—suggests regrowth. Differences in numbers between digested and dewatered samples could not be duplicated with high shear processing in lab-scale devices, with nitrogen purging to remove volatile or gaseous constituents, or with redilution using centrate. They could not be attributed to enumeration methods, to interference of Bacillus spp. on apparent coliform counts, or to temperature changes. The increases have practical implications in the use of fecal coliform or alternative criteria to define pathogen content in biosolids.

Reactivation and Growth of Non-Culturable Indicator Bacteria in Anaerobically Digested Biosolids After Centrifuge Dewatering. Matthew J. Higgins, Yen-Chih Chen, Sudhir N. Murthy, Donald Hendrickson, Joseph Farrel, Perry Schafer, 2007. Water Research, 41(3):665-673

Abstract: Recent literature has reported that high concentrations of indicator bacteria such as fecal coliforms (FCs) were measured in anaerobically digested sludges immediately after dewatering even though low concentrations were measured prior to dewatering. This research hypothesized that the indicator bacteria can enter a non-culturable state during digestion, and are reactivated during centrifuge dewatering. Reactivation is defined as restoration of culturability. To examine this hypothesis, a quantitative polymerase chain reaction (qPCR) method was developed to enumerate Escherichia coli, a member of the FC group, during different phases of digestion and dewatering. For thermophilic digestion, the density of E. coli measured by qPCR could be five orders of magnitude greater than the density measured by standard culturing methods (SCMs), which is indicative of non-culturable bacteria. For mesophilic digestion, qPCR enumerated up to about one order of magnitude more E. coli than the SCMs. After centrifuge dewatering, the non-culturable organisms could be reactivated such that they are enumerated by SCMs, and the conditions in the cake allowed rapid growth of FCs and E. coli during cake storage.

Antibiotic resistance in sludge bacteria

Recent studies have confirmed that the use of antimicrobials had created a large pool of antibiotic-resistance genes in bacteria that are detected in sewage sludge and effluent from sewage treatment plants. Antibiotic resistant bacteria were found in higher numbers downstream of sludge-treated farmland as compared to upstream.

Increased Frequency of Drug-resistant Bacteria and Fecal Coliforms in an Indiana Creek Adjacent to Farmland Amended with Treated Sludge. Shivi Selvaratnam and David J. Kunberger, 2004. Canadian Journal of Microbiology, 50(8):653-656

Abstract: Many studies indicate the presence of human pathogens and drug-resistant bacteria in treated sewage sludge. Since one of the main methods of treated sewage disposal is by application to agricultural land, the presence of these organisms is of concern to human health. The goal of this study was to determine whether the frequency of drug resistant and indicator bacteria in Sugar Creek, which is used for recreational purposes, was influenced by proximity to a farmland routinely amended with treated sludge (site E). Surface water from 3 sites along Sugar Creek (site E, 1 upstream site (site C) and 1 downstream site (site K)) were tested for the presence of ampicillin-resistant (AmpR) bacteria, fecal and total coliforms over a period of 40 d. Site E consistently had higher frequencies of AmpR bacteria and fecal coliforms compared with the other 2 sites. All of the tested AmpR isolates were resistant to at least 1 other antibiotic. However, no isolate was resistant to more than 4 classes of antimicrobials. These results suggest that surface runoff from the farmland is strongly correlated with higher incidence of AmpR and fecal coliforms at site E.

Potential ecological and human health impacts of antibiotics and antibiotic-resistant bacteria from wastewater treatment plants. S. Kim and D.S. Aga, 2007. Journal of Toxicology and Environmental Health-Part B-Critical Reviews, 10:559-573.

Abstract: The occurrence of antibiotics and other pharmaceuticals in the environment has become an increasing public concern as recent environmental monitoring activities reveal the presence of a broad range of persistent pharmaceuticals in soil and water. Studies show that municipal wastewater treatment plants (WWTPs) are important point sources of antibiotics and antibiotic-resistant bacteria in the environment. The fate of antibiotics and other pharmaceuticals in WWTPs is greatly influenced by the design and operation of treatment systems. Because knowledge on the fate of antibiotics and resistant bacteria in WWTPs is important in estimating their potential impacts on ecology and human health, investigations on occurrence, treatment, and observed effects are reviewed in this article. In addition, human health risk assessment protocols for antibiotic and resistant bacteria are described. Although data on other pharmaceutical compounds are also presented, discussion is focused on antibiotics in the environment because of the potential link to increased emergence of resistance among pathogenic bacteria. The applications of modern analytical methods that facilitate the identification of novel transformation products of pharmaceuticals in environmental matrices are also included to illustrate that the disappearance of the parent pharmaceuticals in WWTPs does not necessarily equate to their complete removal.

Effect of wastewater treatment on antibiotic resistance in Escherichia coli and Enterococcus sp. S. Garcia, B. Wade, C. Bauer, C. Craig, K. Nakaoka, and W. Lorowitz, 2007.Water Environment Research, 79:2387-2395

Abstract: The effects of wastewater treatment on the proportion of Escherichia coli and Enterococcus sp. resistant to specific antibiotics were investigated at two facilities in Davis

County, Utah, one of which received hospital waste. Samples were taken from the influent, effluent before disinfection, and secondary anaerobic sludge digester effluent. There was very little difference in antibiotic resistance among E. coli in the inflow waters of the plants but the plant receiving hospital waste had a significantly higher proportion of antibiotic resistant Enterococcus. The effect of wastewater treatment on antibiotic resistance was more pronounced on enterococci than E. coli. Although some increases in antibiotic resistance were observed, the general trend seemed to be a decrease in resistance, especially in the proportion of multidrug resistant Enterococcus sp.

Antimicrobial resistance in Enterococcus spp. isolated in inflow, effluent and sludge from municipal sewage water treatment plants. P.M. Da Costa, P. Vaz-Pires, and F. Bernardo, 2006. Water Research, 40:1735-1740

Abstract: Antimicrobial resistance of enterococci was investigated in 42 samples of crude inflow, treated effluent and sludge collected in 14 municipal sewage treatment plants of Portugal. A total of 983 enterococci were recovered and tested, using the diffusion agar method, regarding their sensitivity to 10 different antimicrobial drugs. Multidrug resistance was present in 49.4% of the isolates. Only 3.3% and 0.6% of the investigated strains were resistant to ampicillin and vancomycin, respectively. Resistances found against rifampicin (51.5%), tetracycline (34.6%), erythromycin (24.8%) and nitrofurantoin (22.5%), are causes for substantial concern. Almost 14% of isolates were resistant to ciprofloxacin. Wastewater treatment resulted in enterococci decrease between 0.5 and 4log; nevertheless, more than 4.4 x 10(5) CFU/100ml were present in the outflow of the plants. Our data indicate that the use of antimicrobials had created a large pool of resistance genes and that sewage treatment processes are unable to avoid the dissemination of resistant enterococci into the environment.

Prions

The potential for prions that might be present in wastewater to accumulate in sludges and to persist through treatment is a concern.

Persistence of Pathogenic Prion Protein during Simulated Wastewater Treatment Processes. G.T. Hinckley, C.J. Johnson, K.H. Jacobson, C. Bartholomay, K.D. McMahon, D. McKenzie, J.M. Aiken, and J.A. Pederson, 2008. Environmental Science and Technology, 42(14):5254-5259.

Abstract: Transmissible spongiform encephalopathies (TSEs, prion diseases) are a class of fatal neurodegenerative diseases affecting a variety of mammalian species including humans. A misfolded form of the prion protein (PrPTSE) is the major, if not sole, component of the infectious agent. Prions are highly resistant to degradation and to many disinfection procedures suggesting that, if prions enter wastewater treatment systems through sewers and/or septic systems (e.g., from slaughterhouses, necropsy laboratories, rural meat processors, private game dressing) or through leachate from landfills that have received TSE-contaminated material, prions could survive conventional wastewater treatment. Here, we report the results of experiments examining the partitioning and persistence of PrPTSE during simulated wastewater treatment processes including

activated and mesophilic anaerobic sludge digestion. Incubation with activated sludge did not result in significant PrPTSE degradation. PrPTSE and prion infectivity partitioned strongly to activated sludge solids and are expected to enter biosolids treatment processes. A large fraction of PrPTSE survived simulated mesophilic anaerobic sludge digestion. The small reduction in recoverable PrPTSE after 20-d anaerobic sludge digestion appeared attributable to a combination of declining extractability with time and microbial degradation. Our results suggest that if prions were to enter municipal wastewater treatment systems, most would partition to activated sludge solids, survive mesophilic anaerobic digestion, and be present in treated biosolids.

Ecological impacts

Soil microorganisms play a critical role in the functions of soil as a source of plant nutrition and in the cycling of nutrients. Recent research shows that sludge application changes the soil microbial community and decreases its diversity. A number of human-use compounds (such as triclosan found in many personal care products such as antibacterial soaps) bioconcentrate in earthworms where soil has been amended with sewage sludges.

Computational Improvements Reveal Great Bacterial Diversity and High Metal Toxicity in Soil. Jason Gans, Murray Wolinsky, and John Dunbar, 2005. Science, 309:1387-1390.

Sewage sludge greatly reduced the diversity of bacterial species in soils.

Parallel Shifts in Plant and Soil Microbial Communities in Response to Biosolids in a Semi-Arid Grassland. Tarah S. Sullivan, Mary E. Stromberger, and Mark W. Paschke, 2006. Soil Biology and Biochemistry, 38 449-459.

Abstract: Approximately 70,150 dry Mg of biosolids from over 450 wastewater treatment facilities are applied to the semi-arid rangelands of Colorado every year. Research on semi-arid grassland responses to biosolids has become vital to better understand ecosystem dynamics and develop effective biosolids management strategies. The objectives of this study were to determine the long-term (~12 years) effects of a single biosolids application, and the short-term (~2 years) effects of a repeated application, on plant and microbial community structure in a semi-arid grassland soil. Specific attention was paid to arbuscular mycorrhizal fungi (AMF) and linkages between shifts in plant and soil microbial community structures. Biosolids were surface applied to experimental plots once in 1991 (long-term plots) and again to short-term plots in 2002 at rates of 0, 2.5, 5, 10, 21, or 30 Mg ha^{-1}. Vegetation (species richness and above-ground biomass), soil chemistry (pH, EC, total C, total N, and extractable P, NO_3-N, and NH_4-N), and soil microbial community structure [ester-linked fatty acid methyl esters (EL-FAMEs)], were characterized to assess impacts of biosolids on the ecosystem. Soil chemistry was significantly affected and shifts in both soil microbial and plant community structure were observed with treatment. In both years, the EL-FAME biomarker for AMF decreased with increasing application rate of biosolids; principal components analysis of EL-FAME data yielded shifts in the structure of the microbial communities with treatment primarily related to the relative abundance of the AMF specific biomarker. Significant (p%0.05) correlations existed among biomarkers for Gram-negative and

Gram-positive bacteria, AMF and specific soil chemical parameters and individual plant species' biomass. The AMF biomarker was positively correlated with biomass of the dominant native grass species blue grama (Bouteloua gracilis [Willd. ex Kunth] Lagasca ex Griffiths) and was negatively correlated with western wheatgrass (Agropyron smithii Rydb.) biomass. This study demonstrated that applications of biosolids at relatively low rates can have significant long-term effects on soil chemistry, soil microbial community structure, and plant community species richness and structure in the semi-arid grasslands of northern Colorado. Reduced AMF and parallel shifts in the soil microbial community structure and the plant community structure require further investigation to determine precisely the sequence of influence and resulting ecosystem dynamics.

Bioaccumulation of Pharmaceuticals and Other Anthropogenic Waste Indicators in Earthworms from Agricultural Soil Amended With Biosolid or Swine Manure. C.A. Kinney, E.T. Furlong, D.W. Kolpin, M.R. Burkhardt, S.D. Zaugg, S.L. Werner, J.P. Bossio and M.J. Benotti, 2008. Environmental Science and Technology, 42:1863-1870.

Abstract: Analysis of earthworms offers potential for assessing the transfer of organic anthropogenic waste indicators (AWIs) derived from land-applied biosolid or manure to biota. Earthworms and soil samples were collected from three Midwest agricultural fields to measure the presence and potential for transfer of 77 AWIs from land-applied biosolids and livestock manure to earthworms. The sites consisted of a soybean field with no amendments of human or livestock waste (Site 1), a soybean field amended with biosolids from a municipal wastewater treatment plant (Site 2), and a cornfield amended with swine manure (Site 3). The biosolid applied to Site 2 contained a diverse composition of 28 AWIs, reflecting the presence of human-use compounds. The swine manure contained 12 AWIs, and was dominated by biogenic sterols. Soil and earthworm samples were collected in the spring (about 30 days after soil amendment) and fall (140-155 days after soil amendment) at all field sites. Soils from Site 1 contained 21 AWIs and soil from Sites 2 and 3 contained 19 AWIs. The AWI profiles at Sites 2 and 3 generally reflected the relative composition of AWIs present in waste material applied. There were 20 AWIs detected in earthworms from Site 1 (three compounds exceeding concentrations of 1000 μg/kg), 25 AWIs in earthworms from Site 2 (seven compounds exceeding concentrations of 1000 μg/ kg), and 21 AWIs in earthworms from Site 3 (five compounds exceeding concentrations of 1000/μg/kg). A number of compounds that were present in the earthworm tissue were at concentrations less than reporting levels in the corresponding soil samples. The AWIs detected in earthworm tissue from the three field sites included pharmaceuticals, synthetic fragrances, detergent metabolites, polycyclic aromatic hydrocarbons (PAHs), biogenic sterols, disinfectants, and pesticides, reflecting a wide range of physicochemical properties. For those contaminants detected in earthworm tissue and soil, bioaccumulation factors (BAF) ranged from 0.05 (galaxolide) to 27 (triclosan).Thisstudydocuments that when AWIs are present in source materials that are land applied, such as biosolids and swine manure, AWIs can be transferred to earthworms.

International Standards for Heavy Metals

The USEPA standards for sewage biosolid contaminant concentrations (standards are set for 9 metals) are higher than those in other developed countries and higher than recommendations of scientists in the northeastern U.S. Switzerland has banned sludge application.

Since the 503 rule was promulgated by USEPA, there has been no reassessment of the heavy metal loading limits on agricultural soils set at that time. In fact, there has been no significant research effort in the US to test the assertion by EPA that the very high metal loading limits (by international standards) of the 503 rule have a high safety margin in protecting soil productivity and crop quality.

Two recent large multi-site field investigations measuring the long-term impacts of sludge metals on soil health and crop quality were undertaken independently in Australia and the UK. In the absence of a comparable study of this scale or longevity in the US, the results of the Australian and UK studies are highly useful in developing guidelines for heavy metals in the US.

The Australian study addressed the impact of Cd loading on food crop quality (levels of Cd in edible crops), and Cu and Zn impacts on crop production (phytotoxicity) and soil health (microbial processes). The recommended limits are much lower for most soils than the allowed soil concentrations of Cd, Zn and Cu based on metal loadings permitted by the USEPA 503 rule. However, the study revealed the high sensitivity of harmful metal effects in soils on soil properties such as pH, clay content and organic matter content. Therefore, the recommended limits for the heavy metals vary greatly by soil type, with acid sandy soils being the most sensitive soils to metal additions.

Ban on the Use of Sludge as a Fertiliser. Switzerland: Federal Office for the Environment, 2003. http://www.bafu.admin.ch/dokumentation/medieninformation/00962/index.html?lang=en&msg-id=1673.

Bern, 26.03.2003 – The use of sludge as a fertiliser is to be banned throughout Switzerland; in the future sludge will have to be incinerated using an environmentally friendly method. The Swiss Federal Council will modify the Ordinance on Materials accordingly on 1 May 2003. The ban will be introduced in stages: from May this year, sludge may no longer be used in the production of fodder crops and vegetables. A period of transition lasting until 2006 at the latest has been accorded for other types of cultivation which until now have been fertilised using sludge; in individual cases the cantonal authorities may extend this period until 2008. This decision is part of the Federal Council's implementation of precautionary provisions for the protection of soils and public health.

Although sludge contains plant nutrients such as phosphorus and nitrogen it also comprises a whole range of harmful substances and pathogenic organisms produced by industry and private households. For this reason, most farmers already avoid using sludge as a fertiliser since they are aware of the risk of irreversible damage to the soil, the danger to public health and possible negative effects on the quality of the food they produce."

Australian recommendations on soil limits for cadmium, zinc and copper

Recommendations of the Australian National Biosolids Research Program on Biosolids Guidelines. Michael Warne, Mike McLaughlin, Diane Heemsbergen, Mike Bell, Kris Broos, Mark Whatmuff, Glenn Barry, David Nash, Deb Pritchard, Daryl Stevens, Grant Pu, and Craig Butler, 2007. Draft Position Paper.

Executive Summary: A set of soil specific maximum limits for copper and zinc in soils that have received biosolids were derived. These recommended limits state the amount of copper or zinc that can be added to a soil. In acidic, low carbon soils (pH 5, OC 1%) the recommended limit is 25 mg/kg added copper, which increases to 245 mg/kg added copper in alkaline soils (pH 8) irrespective of the organic carbon content. The recommended limits are, depending on the soil properties at a site, considerably smaller to considerably larger than the current limits of 100 – 200 mg/kg total copper. In acidic, low cation exchange capacity (CEC) soils (pH 5, CEC 3 cmolc/kg) the recommended limit for zinc in soils that have received biosolids is 20 mg/kg added zinc, which increases to 300 mg/kg added zinc when the soil pH is greater than or equal to 7.5 irrespective of the cation exchange capacity. Thus, the recommended limits can be considerably lower to marginally higher than the current limits of 200 – 250 mg/kg total zinc, depending on the properties of the soils at sites. Critical soil concentrations of cadmium that would lead to exceedance of the Food Standards Australian New Zealand (FSANZ) standard (0.1 mg/kg) for human consumption were determined across all NBRP sites. The critical values were affected by soil properties, principally soil pH and clay content. A set of recommended soil specific maximum cadmium concentrations in soils that have received biosolids were developed. The recommended limit for total cadmium at a soil pH of 5.5 is 0.6 mg/kg in sandy soils (5% clay or less). In alkaline (pH 7.5 or greater) and clayey soils (25% or greater) the recommended limit for total cadmium in soil is approximately 1 mg/kg or greater. Thus depending on the soil properties at a site the recommended cadmium soil concentration is considerably smaller to considerably greater than the value of 1 mg/kg previously recommended by the National Cadmium Management Committee. From the above recommended limits for cadmium, copper and zinc it is apparent that soils that are acidic combined with either low organic carbon, low clay content or low cation exchange capacity have low critical soil metal concentrations. The critical soil concentrations increased as the pH, organic carbon content, clay content or cation exchange capacity of soils increased. Based on the recommended soil limits, typical metal concentrations in biosolids and current land application practices example masses of biosolids that could be applied cumulatively to land were calculated. For high risk sites as little as 40 to 90 tonnes in total may be added, while at low risk sites between 280 and 970 tonnes in total may be applied. At typical current agronomic application rates of 10 t/ha this translates to 4 to 98 applications.

UK findings on the effect of sewage sludge metals on soil health

The UK study also addressed the impact of Cd loading on food crop quality (levels of Cd in edible crops), and Cu and Zn impacts on soil health (microbial biomass, rhizobium numbers, and microbial respiration). The results suggest that Zn is the metal responsible for the decrease in rhizobial population. It is important to stress that this study was designed to test the adequacy of existing UK limits for Cd, Zn and Cu in agricultural soils (e.g., 200-300 mg/kg for Zn). As some important detrimentral effects are being seen, at least in the early years of this long-term study, it is possible that UK limits for these metals will be adjusted lower. The present UK limits are well below those permitted in the US under the 503 rule.

Effects of Sewage Sludge Applications to Agricultural Soils on Soil Microbial Activity and the Implications for Agricultural Productivity and Long-Term Soil Fertility: Phase III, ADAS, Rothamsted Research, Water Research Centre (WRc), 2007.

Project synthesis: During the four years (2002-2006) of this project, significant ($P < 0.05$) responses in soil microbial properties (i.e. rhizobia numbers and microbial biomass size) and agricultural crop quality (i.e. grain Cd concentrations) were measured following the application of metal-rich sludge cakes and metal-amended liquid sludges during Phase I (1994-1997). The soil samples taken in spring 2003 and 2005 at all nine sites in Britain (and additionally in 1999 and 2001 during Phase II of the project) showed significant ($P < 0.05$) responses in rhizobia numbers on the Zn sludge cake treatments, and in soil microbial biomass size on the Zn and Cu sludge cake treatments. Further soil sampling and measurements during future years of this long term study will help to establish whether the effects measured so far are permanent and consistent over time.

Northeastern U.S. application guidelines

A review of published research by 9 scientists from 5 Northeastern states produced recommended limits for heavy metals that are substantially lower than those permitted under the USEPA 503 rule.

Guidelines for Application of Sewage Biosolids to Agricultural Lands in the Northeastern U.S., Ellen Z. Harrison and Uta Krogmann (Eds.), 2007. New Jersey Agricultural Experiment Station, Rutgers Cooperative Extension Bulletin, 36 pp.

Maximum recommended cumulative soil trace element concentration limits for sites to which sewage biosolids are applied are intended to address and protect the agricultural productivity under Northeast soil conditions and for Northeast farming practices and demographics some of which are unique to this region (Table 3).

Table 3. Recommended Maximum Soil Trace Element Concentrations for the Northeast US

Metal	Recommended Maximum Soil Concentration (mg/kg)		
	Sand to loamy sand	Sandy loam to silt loam	Silt to clay
cadmium	1.2	2	3
copper	50	75	120
nickel	30	40	60
lead	120	120	120
zinc	90	150	230

New Technologies as Alternative Beneficial Uses

Application of sewage biosolids is not the only option for recycling this material. New energy recovery technologies make use of the energy embedded in the sludge. Other technologies are in place to make construction material out of sludges.

***Emerging Technologies for Biosolids Management*, US EPA, 2006.**
http://www.epa.gov/OW-OWM.html/mtb/epa-biosolids.pdf

Preface: The U.S. Environmental Protection Agency (U.S. EPA) is charged by Congress with protecting the nation's land, air, and water resources. Under a mandate of environmental laws, the Agency strives to formulate and implement actions leading to a balance between human activities and the ability of natural systems to support and sustain life. To meet this mandate, the Office of Wastewater Management (OWM) provides information and technical support to solve environmental problems today and to build a knowledge base necessary to protect public health and the environment well into the future.

This publication has been produced under contract to the U.S. EPA by Parsons Corporation and provides information on the current state of development as of the publication date. It is expected that this document will be revised periodically to reflect advances in this rapidly evolving area. Except as noted, information, interviews and data development were conducted by the contractor. It should be noted that neither Parsons nor U.S. EPA has conducted engineering or operations evaluations of the technologies included. Some of the information, especially related to embryonic technologies, was provided by the manufacturer or vendor of the equipment or technology and could not be verified or supported by full-scale case study. In some cases, cost data were based on estimated savings without actual field data. When evaluating technologies, estimated costs, and stated performance, efforts should be made to obtain current information.

The mention of trade names, specific vendors, or products does not represent an actual or presumed endorsement, preference, or acceptance by the U.S. EPA or the Federal government. Stated results, conclusions, usage, or practices do not necessarily represent the views or policies of the U.S. EPA.

Energy alternatives

Combustion and Land Application Can Both be Beneficial? Roger Tim Haug, Deputy City Engineer City of Los Angeles, F. Michael Lewis, PE, Peter Brady, BE MIEI

Abstract: Both combustion and land application have played important roles in biosolids management practices for many decades. Land application in almost all of its forms has been proclaimed as beneficial use. By contrast, many have viewed combustion as a "disposal only" option, even if energy is recovered in the process and the resulting ash reused. These views and opinions are often proclaimed with no basis or criteria to support the conclusion. Five criteria are presented in this paper for judging whether a management practice is beneficial or not. When judged by these criteria, one can conclude that many combustion installations are beneficial. One can also conclude that land application is beneficial in most, but perhaps not all, installations."

__Gasification presents an opportunity that EPA is promoting.__

U.S. Environmental Protection Agency

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Environmental Issue:

Two significant environmental problems lead us to explore the environmental benefits of using waste as a source for energy:

First, one of the most challenging issues faced by the municipalities and industry is the sustainable management of wastes and residues generated by our society. The U.S. produces 1.4 Billion Tons of wastes and residue materials per year, impacting air and water quality, decreasing land values, limiting future use of land, and increasing costs to municipalities, industry, and ultimately the consumer. Municipalities, industrial facilities, and universities are particularly challenged in managing the increasing volumes of all kinds of wastes. This is particularly exacerbated in geographic areas experiencing rapid population growth and industrial productivity. In addition, some sectors have unique waste management problems for which the current waste infrastructure does not readily address. Several of these waste related problems were identified in response to EPA's Environmental Technology Council solicitation, such as residues from meat packing and confined animal feeding operations. Several waste to energy technologies, such as various kinds of waste gasification, hold promise for addressing many of these problems. This action team will explore the technical & economic feasibilities and barriers of applying existing and emerging technologies, as well as identify potential research & development to develop new technologies, to help address these problems.

The second challenge lies with our increasing demand for primary energy leading to the depletion of natural resources, the degradation of ecosystems, and generation of significant amounts of solid waste, water pollution, and atmospheric pollution. With U.S. consumption of primary energy increasing at an annual average rate of 2.4%, we will continue to see increasing rates of pollution and environmental degradation, if new technologies are not pursued. The production of energy products permanently consumes coal, natural gas and petroleum resources. The Energy Information Agency predicts that the U.S. domestic supply of natural gas will be exhausted in 50 years while the coal supply will be spent in 250 years. Conservation of these resources is prudent to assure future generations have a source of energy while alternative methods are developed to take the place of these resources in the production of goods and commodities. Residues materials generated in the United States have the potential for supplying 97 Quads of clean domestic renewable energy for use in the United States. The recovery of this untapped source of energy can have a significant impact on the development of sustainable energy production in the United States, while positively impacting the quality of our air, water, and land.

__Converting Biosolids to a Renewable Fuel.__ Michael Moore, Layne Baroldi, Deirdre Bingman, Ray Kearney, 2006. BioCycle, 47(10):32-35.

Orange County CA is working with EnerTech Environmental Inc on a facility to convert 1/3 of their biosolids to energy. The E-fuel is certified as a renewable fuel by CA Energy Commission.

Turning trash into energy in St. Lucie County. TCPalm newspaper editorial, December 1, 2006.

St Lucie County, FL is proceeding with plans to have Geoplasma INC build a plasma arc facility to deal with trash and sludge.

Green Production of Hydrogen from Excess Biosolids Originating from Municipal Waste Water Treatment. B. Bagchi, J. Rawlston, R.M. Counce, J.M. Holmes, and P.R. Bienkowski, 2006. Separation Science and Technology, 41:2613-2628

Rialto, CA OKs Energy Plant at Landfill Site. National Biosolids Partnership. 3/1/06 Weekly Biosolids Update. http://www.biosolids.org/news_weekly.asp?id=1911

Sewage turned into hydrogen fuel. NewScientist.com News Service, April 29, 2002.

RENEWABLE ENERGY: They hope to turn an array of biomass material into fuels by early 2008. John Welsh. The Press-Enterprise, Sept 14, 2006.

Bricks and glass

Sludge can be used to make construction materials including brick and aggregate.

Lightweight aggregate made from sewage sludge and incinerated ash. Ing-Jia Chiou, Kuen-Sheng Wang, Ching-Ho Chen, and Ta-Ting Lin, 2006. Waste Management, 26:1453-1461

Sewage sludge bulks up house bricks. Andy Cohlan, August 31, 2002. New Scientist

Advances in Envir Research. Chih-Huang Wend, I-Shou U in Kachsiung Co Taiwan.

Sewage vitrification. The Illinois North Shore Sanitary District has a new sludge recycling facility that is the first in the world to convert municipal biosolids into a reusable glass aggregate. Each day, up to 200 tons of municipal biosolids are transformed into 7.5 tons of glass.

Biosolids Reuse as Clear as Glass, 2006. Water Environment Federation, 18(11). http://www.wef.org/ScienceTechnologyResources/Publications/WET/06/06Nov/06NovemberProblemSolvers.htm

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Town of Wheatfield Supplemental Response to
Preliminary AML 305-a(1) Opinion re
Town of Wheatfield Biosolids Law

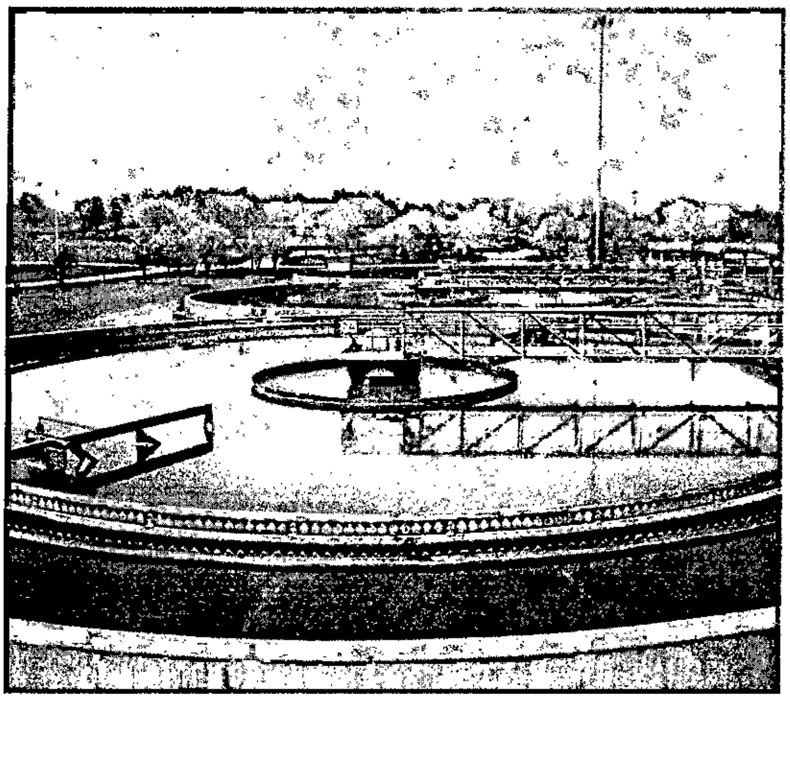
Attachment 4

U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF INSPECTOR GENERAL

More Action Is Needed to Protect Water Resources From Unmonitored Hazardous Chemicals

Report No. 14-P-0363 September 29, 2014



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Abbreviations

CFR	Code of Federal Regulations
CWA	Clean Water Act
DMR	Discharge Monitoring Report
EPA	U.S. Environmental Protection Agency
NPDES	National Pollutant Discharge Elimination System
OIG	Office of Inspector General
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
TRI	Toxics Release Inventory
WET	Whole Effluent Toxicity

Cover photo: Stickney Water Reclamation Plant, Cicero, Illinois. (EPA OIG photo)

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U.S. Environmental Protection Agency
Office of Inspector General

14-P-0363
September 29, 2014

At a Glance

Why We Did This Review

We evaluated the effectiveness of the U.S. Environmental Protection Agency's (EPA's) programs in preventing and addressing contamination of surface water from hazardous chemicals passing through publicly owned treatment works (hereafter "sewage treatment plants"). Hazardous wastes, regulated by the EPA, may be harmful to human health or the environment. Sewage treatment plants receive permits, from the EPA or states, for discharges to surface waters that establish pollutant monitoring requirements. However, hazardous chemicals discharged to sewers are not regulated under EPA hazardous waste regulations. Rather, they are regulated under the Clean Water Act, which focuses on a list of 126 priority pollutants that does not include many hazardous chemicals.

This report addresses the following EPA goals or cross-agency strategies:

- *Protecting America's waters.*
- *Ensuring the safety of chemicals and preventing pollution.*
- *Protecting human health and the environment by enforcing laws and assuring compliance.*

Send all inquiries to our public affairs office at (202) 566-2391 or visit www.epa.gov/oig.

The full report is at: www.epa.gov/oig/reports/2014/20140929-14-P-0363.pdf

More Action Is Needed to Protect Water Resources From Unmonitored Hazardous Chemicals

What We Found

EPA does not have mechanisms to address discharge of hazardous chemicals into water resources.

Management controls put in place by the EPA to regulate and control hazardous chemical discharges from sewage treatment plants to water resources have limited effectiveness. The EPA regulates hazardous chemical discharges to and from sewage treatment plants, but these regulations are not effective in controlling the discharge of hundreds of hazardous chemicals to surface waters such as lakes and streams. Sewage treatment plant staff do not monitor for hazardous chemicals discharged by industrial users. This is due to a general regulatory focus on the priority pollutants list that has not been updated since 1981, limited monitoring requirements, limited coordination between EPA offices, a lack of tracking hazardous waste notifications required for submittal by industrial users, or a lack of knowledge of discharges reported by industrial users under the Toxics Release Inventory. Except for EPA Region 9, sewage treatment plant permits generally include very few monitoring requirements or effluent limits, which can limit enforcement actions.

The EPA developed whole effluent toxicity test results as a mechanism to identify toxic chemicals such as hazardous discharges to sewage treatment plants. However, these are not required for all permits, and are not tracked by the EPA to verify that sewage treatment plants are reporting results as required. Moreover, exceedances of chemical limits in permits and toxicity tests do not trigger notification to enforcement programs. Consequently, the EPA may not be aware of chemical discharge or toxicity exceedances that should be addressed to minimize potentially harmful contamination of water resources.

Recommendations and Planned Agency Corrective Actions

We recommend that the EPA develop a format for sharing annual Toxics Release Inventory data, develop a list of chemicals beyond the priority pollutants list for inclusion in permits, confirm compliance with the hazardous waste notification requirement, and track required submittals of toxicity tests and violations. The agency suggested a change to one recommendation, which the OIG accepted. All recommendations are resolved.

Noteworthy Achievements

The EPA has designed the Discharge Monitoring Report Pollutant Loading Tool to provide access to surface water discharge and other data.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

THE INSPECTOR GENERAL

September 29, 2014

MEMORANDUM

SUBJECT: More Action Is Needed to Protect Water Resources From Unmonitored Hazardous Chemicals
Report No. 14-P-0363

FROM: Arthur A. Elkins Jr.

TO: Ken Kopocis, Deputy Assistant Administrator
Office of Water

This is our report on the subject evaluation conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). This report contains findings that describe the problems the OIG has identified and corrective actions the OIG recommends. This report represents the opinion of the OIG and does not necessarily represent the final EPA position. Final determinations on matters in this report will be made by EPA managers in accordance with established audit resolution procedures.

The EPA office having primary jurisdiction over the issues evaluated in this report is the Office of Water's Office of Wastewater Management.

Action Required

You are not required to provide a written response to this final report, because you agreed to all recommendations and provided corrective actions and completion dates that meet the intent of the recommendations. All recommendations are resolved and open with corrective actions ongoing.

Should you choose to provide a response to this final report, we will post your response on the OIG's public website, along with our memorandum commenting on your response. You should provide your response as an Adobe PDF file that complies with the accessibility requirements of Section 508 of the Rehabilitation Act of 1973, as amended. The final response should not contain data that you do not want to be released to the public; if your response contains such data, you should identify the data for redaction or removal along with corresponding justification.

We will post this report to our website at http://www.epa.gov/oig.

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Chapters

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Chapter 1
Introduction

Purpose

The purpose of this evaluation was to determine the effectiveness of the U.S. Environmental Protection Agency's (EPA's) programs in preventing and addressing contamination of surface water from hazardous wastes passing through publicly owned treatment works (POTWs – hereafter also referred to as sewage treatment plants[1]). This included examining the EPA's role and oversight of hazardous chemical[2] discharges to sewage treatment plants, and determining the effectiveness of the EPA's management controls in regulating hazardous chemical discharges from sewage treatment plants to surface water. We asked the following questions:

- Does the EPA regulate hazardous chemical discharges to and from sewage treatment plants?
- Do sewage treatment plants monitor discharges for hazardous chemicals?
- Has the EPA taken actions to address discharges of hazardous chemicals to and from sewage treatment plants?

Background

Hazardous waste has properties that make it dangerous or capable of having a harmful effect on human health and the environment. Hazardous wastes are regulated by the EPA under the Resource Conservation and Recovery Act (RCRA). RCRA Subtitle C regulations address the generation, transportation, and treatment, storage, or disposal of hazardous wastes. However, under the RCRA domestic sewage exclusion, hazardous wastes discharged to sewage treatment

[1] The EPA defines a POTW as a treatment works owned by a state or municipality. This definition includes systems used in the storage, treatment, recycling, and reclamation of municipal sewage or industrial wastes of a liquid nature. In their technical comments on the draft report, the EPA states that the term publicly owned treatment works "is specifically defined at 40 CFR 403.3(q) and section 212 of CWA as a treatment works which is owned by a State or municipality. This term specifically includes the sewers, pipes, and conveyance system if and only if they convey wastewater to a POTW Treatment Plant." They also point out that NPDES regulations at 40 CFR 122.2 do not contain the term "sewage treatment plant." We use the term "sewage treatment plant" in this report in place of "publicly owned treatment works" because we believe it is more understandable to a non-technical reader.

[2] The term "hazardous chemical" is used in this report to refer to chemicals that, if managed under the EPA hazardous waste program, would be considered hazardous waste. Because hazardous waste discharged to sewage treatment plants is no longer considered hazardous waste, this term is used minimally in this report.

plants are not regulated by RCRA once they enter the sewer. Rather, they are regulated under the Clean Water Act (CWA).

The CWA was passed in 1972 to restore and maintain the chemical, physical and biological integrity of the nation's waters. The goals of the CWA are to eliminate the introduction of pollutants into the nation's waters and to achieve fishable and swimmable water quality. The CWA's National Pollutant Discharge Elimination System (NPDES) program represents one of the key components established to accomplish the goals of the CWA. This program requires that direct dischargers[3] to surface waters such as streams, lakes, and oceans obtain an NPDES[4] permit (hereafter "discharge permit").

A sewage treatment plant is generally designed to treat typical household waste, biodegradable commercial waste, and biodegradable industrial waste. However, all users may also discharge toxic or non-conventional pollutants that the sewage treatment plant is neither designed for nor able to remove. To ensure the goals of the CWA are met, industrial and commercial users are required to comply with pretreatment standards. Sewage treatment plants that discharge to the waters of the United States must obtain a discharge permit. These permits include requirements for discharge monitoring for specific chemicals, monitoring frequency, effluent limits, and discharge toxicity tests. The sewage treatment plant regulates discharges of industrial users through the CWA pretreatment program. The CWA established the National Pretreatment Program to address discharges from industrial users to sewage treatment plants. Figure 1 (next page) illustrates the discharges of the industrial users to the sewage treatment plant, and discharges of the sewage treatment plant to surface waters, and also identifies some permitting and reporting requirements.

EPA guidance defines pretreatment as "The reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater before or in lieu of discharging, or otherwise introducing, such pollutants into a POTW." EPA guidance from 2004 states that, as part of their implementation of the industrial pretreatment program, municipal officials should ensure that industrial users control and properly manage their hazardous waste. This guidance further states that hazardous wastes discharged to sewers are "subject to the CWA, must be reported to the POTW, and should meet all applicable categorical and local discharge limits."

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[3] According to the EPA, a direct discharger is "A point source that discharges a pollutant(s) to waters of the United States, such as streams, lakes, or oceans," and includes sewage treatment plants. EPA considers indirect dischargers "facilities that discharge their wastewaters to a POTW."

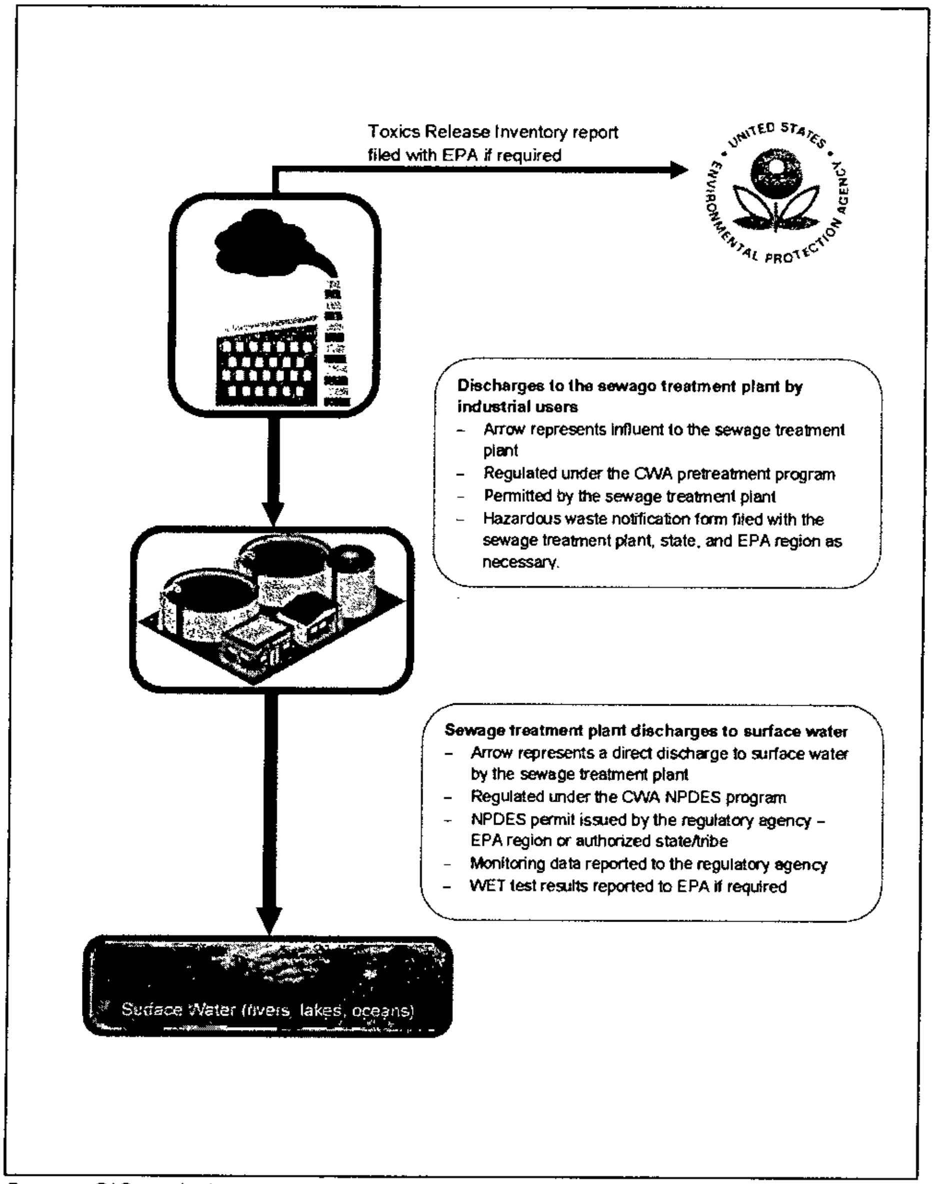
[4] According to the EPA, the NPDES is the national program for issuing, modifying, revoking, reissuing, terminating, monitoring, and enforcing discharge permits from point sources to waters of the United States, and imposing and enforcing pretreatment requirements under the CWA. In this report, we use the term "discharge permit" instead of "NPDES permit" except in direct quotes.

The general pretreatment regulations establish responsibilities among federal, state, and local government; industry; and the public to implement pretreatment standards to control pollutants that pass through or interfere with sewage treatment plant treatment processes or that can contaminate sewage sludge. The pretreatment program focuses on 126 priority pollutants with defined test methods. According to EPA regulations[5], all major sewage treatment plants (sewage treatment plants with a design flow rate equal to or greater than one million gallons per day) and sewage treatment plants with approved or developing pretreatment programs are required to submit the results of a monitoring scan for a modified list of the priority pollutants at least once every 5 years when the sewage treatment plant's permit is renewed.

Thirty six states have an approved State Pretreatment Program.

[5] 40 CFR 122.21(j)(4)(A) and (B).

Figure 1: Diagram of industrial discharges to and from sewage treatment plants



Source: OIG analysis.

The EPA's 1986 *Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works* clarified that the basis of the domestic sewage exclusion is not that hazardous wastes discharged to sewer are rendered harmless, but rather that sufficient regulatory controls existed through the CWA pretreatment program. The report emphasized four recommendations:

1. Additional research, data collection, and analysis are necessary to fill information gaps on sources and quantities of hazardous wastes, their fate and effects in sewage treatment systems and the environment, and the design of any additional regulatory controls which might be necessary.

2. Improvements could be made to standards and pretreatment controls of hazardous wastes discharges to sewage treatment plants.

3. EPA should utilize existing water programs to improve control of hazardous wastes discharged to sewage treatment plants.

4. RCRA, the Comprehensive Environmental Response, Compensation and Liability Act, and the Clean Air Act should be considered along with the CWA to regulate hazardous waste discharges to sewage treatment plants if the studies in recommendation 1 indicate problems.

The EPA developed regulations[6] in accordance with the 1986 Report to Congress, "to improve control of hazardous wastes introduced into POTWs under the Domestic Sewage Exclusion." These regulations included various restrictions on discharges by industrial users to sewage treatment plants as well as various permitting and reporting requirements for industrial users and sewage treatment plants. These regulations also included a notification provision:[7] "The Industrial User shall notify the POTW, the EPA Regional Waste Management Division Director, and State hazardous waste authorities in writing of any discharge into the POTW of a substance, which, if otherwise disposed of, would be a hazardous waste under 40 CFR part 261." An industrial user is required to submit a one-time notification for discharges of more than 15kg of hazardous waste in any month, or any amount of acute hazardous waste[8]. If the discharge exceeds 100kg in any month, the notification should include the hazardous constituents, the constituent mass, and an estimate of the discharge for the next 12 months.

Information on some hazardous chemical discharges to sewage treatment plants is available from the EPA's Toxics Release Inventory (TRI). Information on discharges from sewage treatment plants is available from the EPA's Discharge Monitoring Report (DMR) Pollutant Loading Tool. The TRI program tracks the management of certain toxic chemicals that may pose a threat to human health and the environment. U.S. facilities in different industry sectors must report annually how much of each chemical is released to the environment and/or managed through recycling, energy recovery and treatment. A "release" of a chemical means that it is emitted to the air or water, or placed in some type of land disposal. In general, chemicals covered by the TRI Program are those that cause chronic or acute human health effects or significant adverse environmental effects. The TRI Program currently covers 683 chemicals and chemical categories including many, but not all, hazardous chemicals[9]. TRI filers are required to

[6] Federal Register Vol. 55, No. 142, July, 24, 1990.

[7] 40 CFR Part 403.12(p).

[8] Acute hazardous waste contains such dangerous chemicals that it could pose a threat to human health and the environment even when properly managed.

[9] TRI chemicals also include many chemicals not listed as hazardous waste.

report the chemicals that are released or transferred from their facility. The information submitted by facilities is compiled in the TRI.

According to the EPA, the DMR Pollutant Loading Tool[10] is designed to determine "who is discharging, what pollutants they are discharging and how much, and where they are discharging." Data are currently available for the years 2007 through 2011. Individuals using the tool can identify sewage treatment plants using a name or partial name, and download data on toxic pollutant loadings for all sewage treatment plants for which data has been entered.

The following offices are responsible for EPA programs related to the evaluation of hazardous discharges by sewage treatment plants:

- The Office of Wastewater Management in the Office of Water oversees a range of programs contributing to the well-being of the nation's waters and watersheds.

- The Office of Resource Conservation and Recovery in the Office of Solid Waste and Emergency Response implements RCRA.

- The Office of Information Analysis and Access in the Office of Environmental Information oversees the TRI program.

- The Office of Civil Enforcement in the Office of Enforcement and Compliance Assurance develops and prosecutes administrative civil and judicial cases and provides legal support for cases and investigations initiated in EPA regions.

- The Office of Compliance in the Office of Enforcement and Compliance Assurance manages the ICIS-NPDES data system and the DMR Pollutant Loading Tool.

- The Office of Criminal Enforcement, Forensics and Training investigates violations of environmental laws and provides a broad range of technical and forensic services for civil and criminal investigative support and council on legal and policy matters.

Scope and Methodology

We conducted our work from March 2013 to June 2014. We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and

[10] This tool is available to the public at http://cfpub.epa.gov/dmr/index.cfm. The tool uses DMR data from EPA's Integrated Compliance Information System for the National Pollutant Discharge Elimination System (ICIS-NPDES) to calculate pollutant discharge amounts.

conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We interviewed EPA headquarters staff, in the Office of Resource Conservation and Recovery in the Office of Solid Waste and Emergency Response, the Toxics Release Inventory Program Division in the Office of Environmental Information, the Office of Wastewater Management in the Office of Water, and the Office of Enforcement and Compliance Assurance. We also interviewed regional Pretreatment Coordinators and staff in EPA Regions 2, 3, 5, 6 and 9 about specific discharges to and from sewage treatment plants. We analyzed regional data on specific discharges not tracked through the (NPDES) discharge permit monitoring using TRI and the Discharge Monitoring Report Pollutant Loading Tool.

To analyze hazardous chemical discharges to sewage treatment plants, we obtained quantitative data for discharges of hazardous chemicals to all sewage treatment plants reported in the 2011 EPA TRI. TRI data from 2011 were the most current data available when we performed the analyses. We identified the largest dischargers of hazardous chemicals from 2011 TRI data. We then used the TRI forms to identify the receiving sewage treatment plant, and determined if the hazardous chemicals were monitored in the sewage treatment plant's (NPDES) discharge permit by analyzing permit data from the EPA's Discharge Monitoring Report Pollutant Loading Tool.

We reviewed EPA programs, regulations, and guidance documents related to industrial dischargers and sewage treatment plants, the CWA and its implementing regulations, RCRA Codes and Domestic Sewage Exclusion, (NPDES) discharge permit and listed chemicals, and the EPA's local limits guidance. We reviewed 2011 TRI hazardous chemical discharges to sewage treatment plants for the selected regions to determine whether EPA/regions/states/sewage treatment plant staff are aware of these discharges and if these are monitored and tracked. In our interviews with EPA and state staff in the offices mentioned above, we asked targeted questions regarding sewage treatment plant monitoring, priority pollutants, whole effluent toxicity tests, hazardous waste notification forms, and enforcement actions on exceedances.

Prior Evaluation Coverage

The following EPA Office of Inspector General (OIG) reports addressed issues related to pretreatment and TRI reporting:

- Report No 2004-P-00030, *EPA Needs to Reinforce Its National Pretreatment Program,* issued September 28, 2004.

- Report No 2004-P-00004, *EPA Should Take Steps to Improve Industrial Reporting to the Toxics Release Inventory System,* issued February 2, 2004.

Chapter 2
EPA Has Not Taken Actions to Address Discharges of Hundreds of Hazardous Chemicals From Sewage Treatment Plants

The EPA regulates discharges to and from sewage treatment plants, but these regulations are not effective in controlling the discharge of hundreds of hazardous chemicals to surface waters such as lakes and streams. Sewage treatment plant staff do not monitor for hazardous chemicals discharged by industrial users. This is the result of factors we observed, including a general regulatory focus on the priority pollutants list that has not been updated since 1981, limited monitoring requirements, limited coordination between EPA offices, a lack of tracking hazardous waste notifications required for submittal by industrial users, or a lack of awareness of discharges reported by industrial users under the Toxics Release Inventory. Except for EPA Region 9, sewage treatment plant permits generally include very few monitoring requirements, which can limit enforcement actions. Whole effluent toxicity tests were developed by the EPA as a mechanism to identify toxic chemicals such as hazardous waste. However, these toxicity tests are not be required for all permits, and are not tracked by the EPA to verify that sewage treatment plants are reporting results as required. Moreover, exceedances of chemical limits in permits and toxicity tests do not trigger notification to enforcement programs. Consequently, the EPA may not be aware of exceedances that should be addressed to minimize potentially harmful contamination of water resources.

EPA Does Not Clearly Identify and Regulate Hazardous Chemical Discharges From Sewage Treatment Plants

Priority Pollutants List Not Updated Since 1981

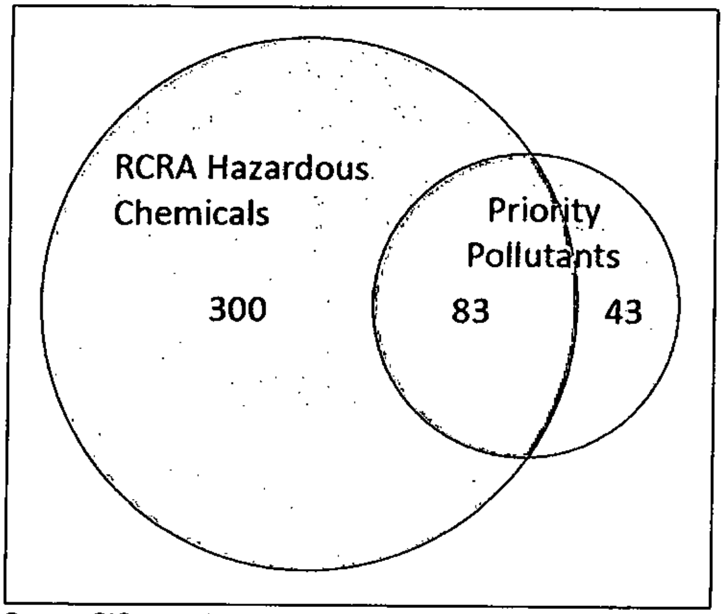
As a result of a suit filed by several environmental groups against the EPA in 1975, the EPA agreed to regulate the discharge of 65 categories of pollutants comprising 126 priority pollutants from 21 industrial categories. Despite changes in the list of regulated industrial categories and the number of pollutants discharged, the EPA has not updated the list of 126 priority pollutants since 1981.

Hundreds of RCRA Hazardous Chemicals are Not Listed as Clean Water Act Priority Pollutants

Figure 2 compares the RCRA hazardous chemicals with those on the CWA priority pollutants list. There are 83 RCRA hazardous chemicals that are also included on the CWA priority pollutants list. However, there still remain about 300 RCRA hazardous chemicals not included on the CWA priority pollutants list.

This illustrates the large number of RCRA hazardous chemicals not monitored by sewage treatment plants in their discharge permits, including many acute hazardous wastes such as pesticides, metals and organic solvents.

Figure 2: RCRA hazardous chemicals overlap with CWA priority pollutants listed chemicals[11]



Source: OIG analysis.

Agency Staff Uncertain About Regulating Beyond 33-Year Old Clean Water Act Priority Pollutants

The CWA gives the EPA authority to regulate "any pollutant" through a discharge permit. At the same time, the CWA incorporates the priority pollutants list into law and requires that effluent limitations be promulgated for the chemicals on the list. This has created a focus on the CWA priority pollutants list for discharge permits.

Some EPA staff, including enforcement staff, stated that the EPA has the authority to regulate any chemical necessary to achieve water quality standards. However, other staff within the EPA and states expressed different opinions about regulating chemicals beyond the list of priority pollutants. For example:

- Monitoring for specific chemicals by a sewage treatment plant is not required because the chemicals are not on the list of priority pollutants.

- Monitoring for specific chemicals is not required because the chemicals are not on the state list of chemicals identified for monitoring.

[11] The number of RCRA hazardous waste chemicals in this diagram includes chemicals specifically listed by EPA as hazardous wastes or acute hazardous wastes.

- Chemicals cannot be in a discharge permit if they are not on the list of priority pollutants.

- Discharge permits are designed to primarily regulate chemicals on the list, although programs do have the authority to regulate beyond the list.

- Sewage treatment plants probably focus on priority pollutants because the state and EPA focuses on them.

According to the CWA, discharge permits may be issued for a term of up to 5 years. According to EPA staff, as part of the renewal application process, sewage treatment plants screen for the 126 priority pollutants. Based on the data submitted, the permit writer then determines whether there is a reasonable potential for any of the pollutants to impact the water quality of the receiving water body. Only those pollutants identified as a concern are put in the permit either with limits or for monitoring only. Thus, discharge permits remain more focused on the priority pollutants list than on the CWA's broader authority to regulate any pollutant that impairs water quality. As a result, other chemical discharges not included on the priority pollutants list, such as many RCRA hazardous wastes, are not monitored. Lack of monitoring or limits for these chemicals may result in contamination of surface waters.

Industrial Users' Hazardous Waste Discharge Reports May Not Have Been Submitted as Required

Under the general pretreatment regulations, industrial users are required to notify the sewage treatment plant, the EPA Regional Waste Management Division Director, and state hazardous waste authorities in writing of any discharge into the sewage treatment plant of a substance, which, if otherwise disposed of, would be a hazardous waste. This refers to RCRA hazardous wastes. However, when we asked EPA staff about these notifications, there was a general lack of awareness of the requirement.

During interviews with EPA staff in headquarters, and Regions 2, 3, 5, 6 and 9, as well as state staff, we asked if the hazardous waste notifications had been submitted as required and if they were tracked. We received various responses, including:

- EPA regional and sewage treatment plant staff stated that the discharges are not considered hazardous waste so this notification was not required.

- One EPA region believed that based on information available through the pretreatment program, the notification did not have to be submitted. The region also stated that failure to notify, or to discharge hazardous wastes would be met with enforcement action, and that is the deterrent.

- The pretreatment coordinator of another EPA region noted that he had seen the notification forms some time ago and that they perform annual archives of the sewage treatment plant files.

- Two states in one EPA region with authorized state programs informed us that the discharger files the hazardous waste discharge notification. However, one of the states indicated the notifications do not go to the region, but rather to the state hazardous waste office and the sewage treatment plant.

- One EPA region was unfamiliar with the notification requirements and had not seen notifications from industrial users for discharging hazardous waste to sewage treatment plants.

In the 1990 final rule that established the notification requirement, the EPA noted that "There is currently no regulatory requirement that industrial users report the discharge of all hazardous wastes to sewers." The final rule further stated that the information provided by the hazardous waste notification "is needed for the ultimate development by POTWs of controls to prevent pass through and interference." In addition, the rule indicated the agency was considering the development of a database of notification information that would make the information available in a usable format for interested parties. Based on our interviews with the EPA and states, the notification is not providing information to the sewage treatment plants as intended. Not only is there no database of the information, we found that no compilation of the notification forms was available in the regions and states we interviewed. Further, there is a general lack of knowledge of the requirement, and no reliance upon or use of the notifications by the sewage treatment plants to manage the discharge of hazardous wastes.

Sewage Treatment Plants Monitor for Few Toxic Chemicals

Number of Chemicals Monitored by EPA Regions Varies Widely

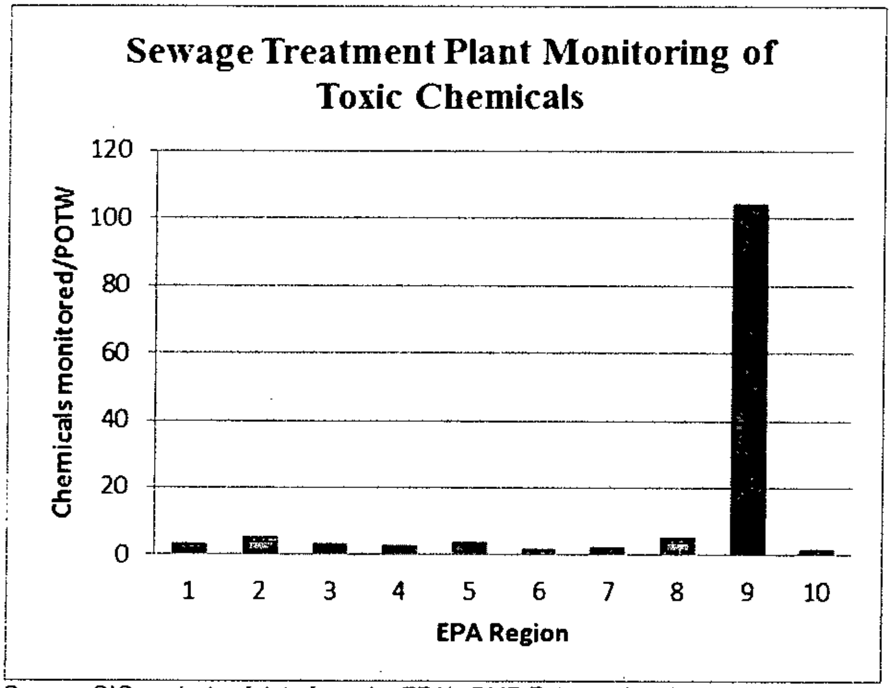
According to EPA staff, while sewage treatment plants are required to perform a monitoring scan for all 126 CWA priority pollutants once every 5 years, the EPA does not require that all 126 priority pollutants be included on a sewage treatment plant's DMR. Analysis of DMR data reported to the EPA reveals large regional differences in the number of chemicals[12] monitored and reported on the DMR. Sewage treatment plant discharge permits within Region 9 require monitoring for many more toxic chemicals as compared to other regions. For example acrolein, which is an acute RCRA hazardous waste and is also a priority pollutant, is monitored by a total of 194 sewage treatment plants nationwide. Of these sewage treatment plants, 193 are in Region 9. Region 9 stated that monitoring can assist

[12] These are chemicals for which the EPA has developed a toxicity weighting factor in the Discharge Monitoring Report Pollutant Loading Tool, which includes many hazardous waste chemicals.

with identifying chemicals that need a limit set during the next discharge permit term.

The extent of the disparity of regional discharge monitoring requirements and reporting is illustrated in Figure 3. Region 9's states require an average of more than 104 chemicals/sewage treatment plant, while other regions require an average of fewer than four chemicals/sewage treatment plant.

Figure 3: Number of toxic chemicals monitored per sewage treatment plant by EPA region



Source: OIG analysis of data from the EPA's DMR Pollutant Loading Tool.

Lack of Data in Discharge Permits Can Hamper Enforcement

Enforcement actions against a sewage treatment plant due to pass through of chemicals from the sewage treatment plant into the receiving water body can be taken when there is a violation of any requirement of the sewage treatment plant's discharge permit. According to the Code of Federal Regulations (CFR) in 40 CFR §403.3(p), "The term *Pass Through* means a Discharge which exits the POTW into waters of the United States in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation)." As a result, enforcement action relies on pollutants and limits documented in a discharge permit. Without monitoring or limits in place, certain pollutants may be discharged by the sewage treatment plant and potentially harm human health and the environment.

Region 9 staff did not have an explanation for the additional monitoring performed by sewage treatment plants in their region. We did find examples of additional monitoring of chemicals by sewage treatment plants outside of Region 9 states, but the monitoring results were not included in the DMRs. Staff in one EPA region stated that information on chemicals not reported in the DMRs are available in annual sewage treatment plant reports. However, including monitoring data in discharge permits, as Region 9 does, provides regulators with the ability to readily identify chemicals in need of discharge limits and identify and enforce pass through violations. Further, the discharge permits for Region 9 states' sewage treatment plants include more hazardous chemicals than the sewage treatment plant discharge permits in other states.

Discharge Permit and Pretreatment Programs Do Not Always Coordinate

EPA regions directly implement discharge permit programs in the four states that have not received program authorization. EPA still retains oversight authority for states with authorized programs. Pretreatment programs may also be authorized to states; however some states have been authorized to implement the discharge permit program but not the pretreatment program. In some cases, this has resulted in separate organizations managing the discharge permit and pretreatment programs. In these cases the pretreatment programs may not provide input to identify the chemicals that should be included for monitoring in the discharge permits.

EPA Office of Water staff stated that the pretreatment and discharge programs do not necessarily coordinate efforts during the discharge permit application review and issuance process. Staff in the Office of Water noted that the pretreatment coordinators do not appear to have the role they should during the permit writing process and acknowledged that there is an issue with coordinated efforts between the programs for permit quality review. As a result, the pretreatment program staff may not have been included in determining which chemicals should be included in the sewage treatment plant discharge permits. This could result in the absence of pretreatment controls in the discharge permits, which impacts what is or is not being monitored for by sewage treatment plants in their discharge permits. Pretreatment enforcement staff in one region specifically noted that they did not have the opportunity to review the draft discharge permits before they were issued.

Whole Effluent Toxicity Test Not Effectively Used for Monitoring and Enforcement

In the 1980s, the EPA recognized that some sewage treatment plant discharges remained toxic despite pretreatment programs which were designed to prevent pass through of specific chemicals. As a result, the EPA developed a control to reduce or eliminate toxic discharges based on whole effluent toxicity (WET) testing. According to EPA regulations[13], sewage treatment plants with flow rates equal to or greater than one million gallons per day, or sewage treatment plants with pretreatment program requirements, must submit three WET test results taken within a four and one-half year period prior to the date of the discharge permit application. EPA staff stated that WET test results are an integral tool in the assessment of water quality. When a WET test exceedance is encountered, the sewage treatment plant conducts a series of additional tests to identify the toxic pollutants and their source so pass through can be eliminated.

During our interviews, EPA staff repeatedly stated that the WET tests provide a suitable backup mechanism for identifying possible discharges of hazardous waste. However, according to data supplied by EPA[14] we found that WET test reporting requirements and tracking of the results do not provide backup for possible discharges (Figure 4):

- Not all sewage treatment plants are required to report– According to the EPA, during 2011 there were 14,241 active sewage treatment plants nationwide. However, only 4,399 (31 percent) of these were required to report WET test results. Reporting was not required for 9,842 (69 percent) of the sewage treatment plants, which significantly restricts any use of the WET test as a backup mechanism to identify hazardous chemical discharges.

- Only about half of the sewage treatment plants report as required – Of the 4,399 required to report, only 1,992 (45 percent) submitted WET test results. According to EPA staff, not all data may be entered into the data system. Therefore, more sewage treatment plants may have completed the required WET test, and 1,992 reflects those WET test submittals entered.

- No system controls automatically track required submittals or exceedances – According to EPA staff, there are no mechanisms for the automatic identification, tracking, and follow-up of required WET test submittals or exceedances. This limits the effectiveness of WET test in identifying releases of unidentified chemicals such as hazardous waste.

According to the Office of Water, the permitting authority determines the WET test requirements and frequency. Office of Water staff also acknowledged that monitoring is important as it improves the chances of identifying toxic chemicals such as hazardous wastes. The lack of regular reporting, tracking, and follow-up on WET test exceedances limits the ability of WET tests to provide a mechanism to identify discharges of hazardous chemicals that may not otherwise have been identified by the sewage treatment plant.

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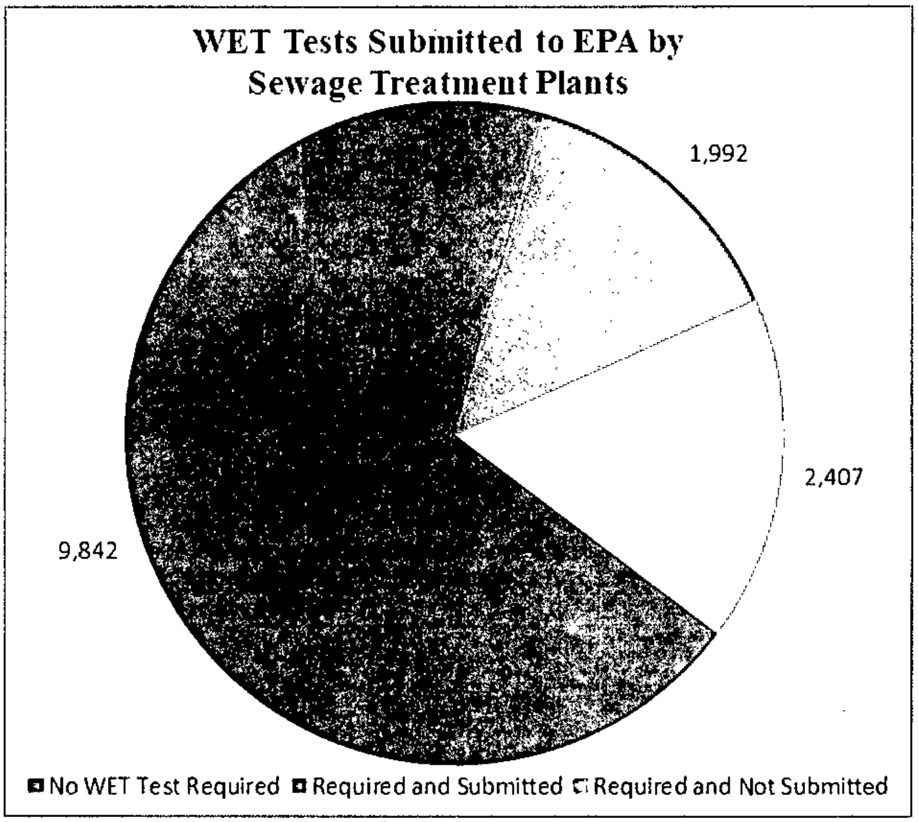
[13] 40 CFR 122.21(j)

[14] Data were from EPA's ICIS-NPDES database.

Figure 4: WET Test Results



Source: OIG analysis of data supplied by EPA staff.

Hazardous Chemical Sewage Treatment Plant Discharges Identified in TRI Not Monitored

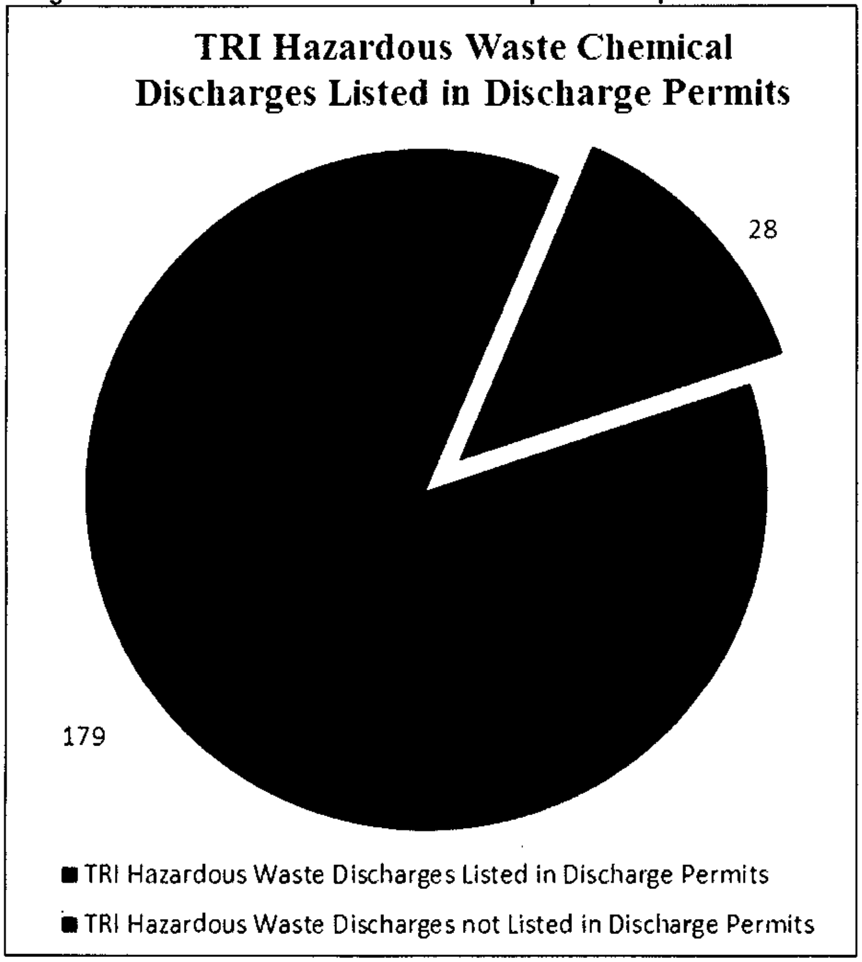
Although TRI reporting does not include all industrial users discharging to sewage treatment plants or all hazardous chemicals, it is a source of data readily available to identify discharges of hazardous wastes to sewage treatment plants. We used 2011[15] TRI data to query EPA regions, states, and/or sewage treatment plants to determine their awareness and management of TRI hazardous chemical discharges. We identified hazardous chemicals discharged by TRI reporters to sewage treatment plants. We initially identified 731 discharges of hazardous chemicals, and narrowed this list down to 207 discharges by eliminating TRI reporters with small volume discharges. We found that sewage treatment plants monitor for few of the chemicals. Of the 207 discharges identified, only 28

[15] At the time of our analysis, data from 2011 were the most current available from TRI and the Discharge Monitoring Report Pollutant Loading Tool.

(14 percent) were chemicals monitored on the sewage treatment plants' discharge permits (Figure 5).

We further analyzed data for a small number of sewage treatment plants to examine reasons hazardous chemicals are not monitored. We selected eight sewage treatment plants for additional follow-up based on the high TRI discharge volume and number of TRI hazardous chemicals that were not monitored in their

Figure 5: TRI hazardous waste chemicals present in permits



Source: OIG analysis of data from TRI and the EPA's DMR Pollutant Loading Tool.

discharge permits. We had discussions with the EPA region, authorized state, and/or the sewage treatment plant to determine if they were aware of the TRI discharges and determine why the chemicals were not included in the discharge permits. We found the eight sewage treatment plants did monitor for 14 of the 50 (28 percent) chemicals identified. However, the monitoring was not required by the sewage treatment plant discharge permits, and was not reported to EPA.

More importantly, the eight sewage treatment plants did not monitor for 36 of the 50 (72 percent) hazardous chemicals identified, which included some acute hazardous chemicals. We received a range of responses for the sewage treatment plants' lack of monitoring, including:

- Monitoring of the chemicals was not necessary because the chemicals in question should be metabolized and rendered harmless in the sewage treatment process.

- Monitoring of the chemicals was not required because the chemicals had been monitored in past years and the discharges were inconsequential. In some cases this was between 7 and 24 years ago.

- No response for why specific chemicals were not monitored.

- Chemicals were not monitored because they were not on the list of priority pollutants or a state list.

- Data were submitted on an annual report to the state.

- Discharges from the sewage treatment plant were not monitored because the influent from the industrial users was monitored.

These responses indicate that sewage treatment plants are not always monitoring chemical discharges, which could result in their release to the environment and impair appropriate enforcement. The sewage treatment plants did not routinely review the TRI data to ensure complete knowledge of the discharges from their respective industrial users. Although there is no requirement that sewage treatment plants use TRI data, we believe these data could provide a useful resource. Discharge permit writers, pretreatment authorities and sewage treatment plants could utilize TRI data to enhance their knowledge of all industrial user discharges. This would help ensure that permits accurately represent known discharges, mitigating the risk of potential release of these chemicals into the environment.

Exceedances in Discharge Monitoring Reports Do Not Automatically Trigger Follow-up

Although sewage treatment plants report annual monitoring data in Discharge Monitoring Reports, there is no automatic trigger in EPA information systems to notify enforcement staff of chemical exceedances. According to the EPA, to identify exceedances in violation of discharge permit limits, an exceedance report from the Discharge Monitoring Report must be manually generated. Thus, enforcement and oversight of chemical exceedances rely on the individual review of exceedance reports by states or the EPA. As a result, exceedances of discharge permit limits may not be identified or reviewed. This could result in the potential undetected discharge of chemicals beyond their defined maximum levels.

Conclusions

Management controls put into place by the EPA to regulate and control hazardous chemical discharges from sewage treatment plants to water resources are not always effective. According to interviews with the EPA's enforcement and permitting staff, states and sewage treatment plant operators, all parties are not always aware of all hazardous chemical discharges flowing into and out of the sewage treatment plant. In addition, most hazardous chemical discharges we identified in selected sewage treatment plants are not monitored by the sewage treatment plants. As a result, sewage treatment plants may not be adequately treating wastewater entering their facilities and are at risk of discharging hazardous chemicals into receiving bodies of water such as rivers and streams. These hazardous chemical discharges can have detrimental effects on human health and the environment. The EPA's limited management controls for identifying and monitoring hazardous chemical discharges from sewage treatment plants do not support the CWA's objective to maintain the integrity of the nation's waters.

Recommendations

We recommend that the Assistant Administrator for Water:

1. Develop, in coordination with the Office of Environmental Information, a usable format for sharing TRI data on discharges sent to sewage treatment plants, with OW developing materials to explain the utility of TRI data to NPDES permit writers and pretreatment program personnel. This will include exploring options for an online search tool to more easily identify TRI discharges to specific sewage treatment plants.

2. Develop, in coordination with EPA regions, a list of chemicals beyond the priority pollutants appropriate for inclusion among the chemicals subject to discharge permits. This may include:

    a. Review of TRI-reported discharges to sewage treatment plants. Initial review could focus on RCRA hazardous chemicals reported in TRI.

    b. Review of chemicals monitored nationwide in sewage treatment plant discharge permits, especially chemicals monitored by Region 9.

    c. Review of chemical monitoring data already collected by sewage treatment plants but not included in discharge permits.

    d. Discussion with the Office of Resource Conservation and Recovery for suggested hazardous chemicals.

e. Development of mechanisms that ensure discharge and pretreatment programs coordinate during discharge permit writing.

3. Confirm, in coordination with the Office of Enforcement and Compliance Assurance and EPA regions, that sewage treatment plants and their industrial users are aware of and comply with the 40 CFR 403.12(p) requirement that industrial users submit hazardous waste notifications.

4. Develop, in coordination with the Office of Enforcement and Compliance Assurance, mechanisms to:

    a. Improve sewage treatment plant compliance with permit terms that require submission of WET monitoring results to the permitting authority.

    b. Facilitate the use of monitoring data to track facilities that have violated chemical or WET permit exceedance requirements.

Agency Response and OIG Evaluation

The agency agreed with recommendations 2, 3, and 4. They disagreed with recommendation 1 but suggested a minor revision which meets the intent of the recommendation. All recommendations are resolved. The agency provided corrective action plans with milestone dates for all recommendations. Based on the agency's response, all recommendations are open with corrective actions underway. The Agency provided the planned completion date of 9/30/15 for all recommendations. Appendix A contains the agency's response to our draft report and planned actions to address our recommendations. We reviewed the agency's technical comments and made revisions to the report as appropriate.

Status of Recommendations and Potential Monetary Benefits

		RECOMMENDATIONS				POTENTIAL MONETARY BENEFITS (in $000s)	
Rec. No.	Page No.	Subject	Status[1]	Action Official	Planned Completion Date	Claimed Amount	Agreed-To Amount
1	18	Develop, in coordination with the Office of Environmental Information, a usable format for sharing TRI data on discharges sent to sewage treatment plants, with OW developing materials to explain the utility of TRI data to NPDES permit writers and pretreatment program personnel. This will include exploring options for an online search tool to more easily identify TRI discharges to specific sewage treatment plants.	O	Assistant Administrator for Water	09/30/15		
2	18	Develop, in coordination with EPA regions, a list of chemicals beyond the priority pollutants appropriate for inclusion among the chemicals subject to discharge permits. This may include: a. Review of TRI-reported discharges to sewage treatment plants. Initial review could focus on RCRA hazardous chemicals reported in TRI. b. Review of chemicals monitored nationwide in sewage treatment plant discharge permits, especially chemicals monitored by Region 9. c. Review of chemical monitoring data already collected by sewage treatment plants but not included in discharge permits. d. Discussion with the Office of Resource Conservation and Recovery for suggested hazardous chemicals. e. Development of mechanisms that ensure discharge and pretreatment programs coordinate during discharge permit writing.	O	Assistant Administrator for Water	09/30/15		
3	19	Confirm, in coordination with the Office of Enforcement and Compliance Assurance and EPA regions, that sewage treatment plants and their industrial users are aware of and comply with the 40 CFR 403.12(p) requirement that industrial users submit hazardous waste notifications.	O	Assistant Administrator for Water	09/30/15		
4	19	Develop, in coordination with the Office of Enforcement and Compliance Assurance, mechanisms to: a. Improve sewage treatment plant compliance with permit terms that require submission of WET monitoring results to the permitting authority. b. Facilitate the use of monitoring data to track facilities that have violated chemical or WET permit exceedance requirements.	O	Assistant Administrator for Water	09/30/15		

O = Recommendation is open with agreed-to corrective actions pending.
C = Recommendation is closed with all agreed-to actions completed.
U = Recommendation is unresolved with resolution efforts in progress.

Agency Response to Draft Report

(Dated July 28, 2014)

MEMORANDUM

SUBJECT: Response to Office of Inspector General Draft Report/Project No. OPE-FY13-0015 "More Action Is Needed to Protect Water Resources from Unmonitored Hazardous Waste," dated June 27, 2014

FROM: Nancy K. Stoner
Acting Assistant Administrator

TO: Arthur A. Elkins Jr.
Inspector General

Thank you for the opportunity to respond to the issues and recommendation in the subject Draft Report. Following is a summary of the Agency's overall position, along with its position on each of the Draft Report's recommendations. For the Draft Report's recommendations with which the agency agrees, we have provided high-level intended corrective actions and estimated completion dates. For the report recommendation with which the agency does not agree, we have explained our position and proposed an alternative to the recommendation. For your consideration, we have included a Technical Comments Attachment to supplement this response.

AGENCY'S OVERALL POSITION

The EPA agrees that the effectiveness of the National Pollutant Discharge Elimination System (NPDES) permit program and the National Pretreatment Program in preventing and addressing contamination of surface water from hazardous pollutants could be improved. We believe that the current regulatory structure provides for adequate controls to address hazardous pollutants, however, we welcome the IG's recommendations on potential improvements to the implementation of these programs. While we agree that there is room for improvement, we have some concerns about some of the findings and one of the recommendations.

Generally, OW is concerned that the draft report uses terminology in unconventional manners, inconsistent with the way the same terms are specifically defined in regulations, especially with respect to the term "hazardous waste". This might have led the OIG to draw inaccurate conclusions. Similarly, readers of the report may also misinterpret both the findings and conclusions as they may rely on their knowledge and application of the regulatory definitions. We recommend that the OIG either use terms consistent with how they are defined in the regulations or clearly state how and why unconventional definitions are being used in the report.

"Hazardous waste" is a term of art under the Resource Conservation and Recovery Act (RCRA) statute, and not a term used in the Clean Water Act (CWA). A RCRA regulation known as the "domestic sewage exclusion" says that waste mixed with sewage cannot be "solid waste," see 40 CFR 261.4(a)(1). Under RCRA, if a waste is not a "solid waste", it cannot be a "hazardous waste." It is therefore regulated by the CWA and not the RCRA. Thus, the use of the term "hazardous waste" in this CWA context is incorrect. Thus, the use of the term "hazardous waste" in the Draft Report's title and throughout the draft report is incorrect. As an alternative, we suggest the terms "hazardous chemicals" or "hazardous pollutants" could be used.

There are other terms that are misused. Please see the attached Technical Comments for detailed explanation of the apparent misuse of these terms.

The OIG should update the report to clarify its use of these terms and phrases to reflect appropriate legal usage or explain why the OIG is using non-traditional use of legal terms.

OIG Response: The term "hazardous chemical" is used wherever possible, and the use of this term in referring to hazardous waste is footnoted. We have incorporated changes in terminology and explanatory footnotes as needed to address the issues cited in the technical comments.

Below is our consolidated response to the OIG Recommendations. Our response is separated into two sections: Recommendations to which we agree and identify our intended corrective action (OIG Recommendations 2, 3, and 4); and the Recommendation to which we disagree and provide a proposed alternative (Recommendation 1).

AGENCY'S RESPONSE TO REPORT RECOMMENDATIONS

Agreements

No.	Recommendation	High-Level Intended Corrective Action(s)	Estimated Completion by FY
2	Coordinate with EPA regions to develop suggested chemicals, beyond the priority pollutants, for possible inclusion in discharge permits. This may include: a. Review of TRI-reported discharges to sewage treatment plants. Initial review could focus on RCRA hazardous chemicals reported in TRI. b. Review of chemicals monitored nationwide in sewage treatment plant discharge permits, especially chemicals monitored by Region 9.	OW will issue a memorandum to the regions and notify approved pretreatment states describing best practices for how the NPDES permits and the pretreatment programs coordinate. This memorandum will include information on how to access information reported by industries per 40 CFR 403.12 on discharges sent to POTWs, including TRI data and notifications of substances, which, if otherwise disposed of, would be a hazardous waste. The best practices will describe how such data are used by NPDES permit writers and pretreatment program personnel to properly address such pollutants.	09/30/2015

	c. Review of chemical monitoring data already collected by sewage treatment plants but not included in discharge permits. d. Discussion with the Office of Resource Conservation and Recovery for suggested hazardous waste chemicals. e. Develop mechanisms that ensure discharge and pretreatment programs coordinate during discharge permit writing.	In addition, the OW will also review chemicals monitored by POTWs as reported on DMRs and available as in ICIS-NPDES. The OW will also engage in a discussion with staff from ORCR regarding suggested hazardous waste chemicals.	

No.	Recommendation	High-Level Intended Corrective Action(s)	Estimated Completion by FY
3	Coordinate with Office of Enforcement and Compliance Assurance and EPA regions to confirm sewage treatment plants and industrial users are aware of and comply with the 40 CFR 403.12(p) requirement that industrial users submit hazardous waste notifications.	OECA and OW will issue a joint memorandum to the regions and approved pretreatment states that discusses the requirement to submit notifications per 40 CFR 403.12(p) and 40 CFR 403.12(j) of substances, which, if otherwise disposed of, would be a hazardous waste and to highlight the importance of the notifications in the pretreatment program. The memorandum will also emphasize the Control Authority's responsibility to ensure industrial users are complying with this requirement.	09/30/2015

No.	Recommendation	High-Level Intended Corrective Action(s)	Estimated Completion by FY
4	Coordinate with the Office of Enforcement and Compliance Assurance to develop a mechanism to: a. Improve sewage treatment plant compliance with permit terms that require submission of WET monitoring results to the permitting authority. b. Facilitate the use of monitoring data to track	a. 1.) OECA and OW will develop training materials that explain the importance of WET permit requirements and how to comply with them (e.g., doing required monitoring and completing DMRs). 2.) OECA will post the training materials on WET compliance to the website for the Local Governments Environmental Assistance Network	09/30/2015

	facilities that have violated chemical or WET permit exceedance requirements.	(EPA compliance assistance center, http://lgean.org/). b. OECA will develop an ICIS-NPDES standard report for WET violations and announce the availability of the report to regions and states along with some explanation of how to utilize the reports for program implementation and oversight activities.	

Disagreements

No.	Recommendation	Agency Explanation/Response	Proposed Alternative
1	Coordinate with the Office of Environmental Information to develop processes for annual distribution of TRI data to EPA regions and delegated state programs.	TRI data are already publicly available. However, knowledge of how to easily access the data and how its information may be useful in program implementation may not be known.	Coordinate with the Office of Environmental Information [OEI] to develop a usable format for sharing TRI data on discharges sent to POTWs, with OW developing materials to explain the utility of TRI data to NPDES permit writers and pretreatment program personnel. This will include exploring options for an online search tool to more easily identify TRI discharges to specific POTWs.

OIG Response: For Recommendation 1, the suggested revision meets the intent of the recommendation, and the report updated to reflect this. OW clarified that the estimated completion date for this recommendation is 09/30/2015. The Agency agreed to add additional corrective actions to address Recommendation 4, developing three additional reports by 09/30/2015. These reports are (1) report that will show who is required to report WET and, if they are required report, who has not reported WET data, (2) a report on WET violations, and (3) all chemical exceedances including WET.

CONTACT INFORMATION

If you have any questions regarding this response, please contact Deborah Nagle, Director of the Water Permit Division on **(202) 564-1185 or Nagle.Deborah@epa.gov** or Marcus Zobrist, Chief of the Industrial Branch on **(202) 564-8311 or Zobrist.Marcus@epa.gov**.

Attachments
cc: Cynthia Giles, OECA
Renee Wynn, OEI

Distribution

Office of the Administrator
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Assistant Administrator for Enforcement and Compliance Assurance
Assistant Administrator for Environmental Information and Chief Information Officer
Assistant Administrator for Solid Waste and Emergency Response
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Audit Follow-Up Coordinator, Office of Environmental Information
Audit Follow-Up Coordinator, Office of Solid Waste and Emergency Response

Town of Wheatfield Supplemental Response to
Preliminary AML 305-a(1) Opinion re
Town of Wheatfield Biosolids Law

Exhibit B

New York Farm Bureau
P.O. Box 5330
Albany, NY 12205

Oswego County
Farm Bureau News

Oswego County Farm Bureau
Board of Directors

Nancy Weber, President	315-963-7311
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Orion Behling, YF	315-391-9555
John Wagner, Field Advisor	315-761-9770
CNYFB Regional Office	315-252-1367
NYFB State Office	800-342-4143

The Board usually meets on the first Monday of the month at the Cooperative Extension Office, 3288 Main Street Mexico, NY.

Oswego County Farm Bureau News

March 2015

To Serve And Strengthen Agriculture

President's Report

I know it may not look or feel like it now, but Spring is around the corner, and I know that positive things are in store for Oswego County agriculture in 2015. Despite peculiar weather patterns, 2014 was definitely an up year for the farming sector. The cropping was overall successful and the fruit and vegetable growers had great harvests. We are seeing the advent of some new crops being commercially grown in the county, primarily hops for the craft beer breweries. There is also a growing number of active farms in the county, mostly Amish, but also with our returning Veterans. In the dairy sector, the price received for fluid milk was much closer to the cost to produce it allowing many farms to retire some debt, replace worn equipment and make improvements to their farm operations.

I believe that this year's forecast is equally bright. Some farms will be taking advantage of green energy programs and installing either wind or solar alternative power sources. Fluid milk prices have fallen but hopefully will recover as the year progresses. Eating locally produced foods has now become a lifestyle instead of a fad. Visit a grocery store produce department or a farmers market to see the demand for "local" is strong. Our farms are ready to provide that local food! While the crops we produce are available at farm stands and markets, we are also looking at additional ways to capture the locally produced market through the creation of a "Food Hub". As with all things agriculture, Mother Nature holds the fortune of our farms in her hands. I'd like to order an early Spring to get the crops planted and no late frost so the fruit buds grow. And while we're at it, rain when we start to get dry, but plenty of warm sunny days this summer to grow crops and harvest the hay with a long fall to enjoy apple picking.

Nancy Weber, President
Oswego County Farm Bureau

Upcoming Workshop

"THAT'S COOPERATIVE EXTENSION!"

Farm Beverages
Tuesday, March 24th

For more information 315-963-7286

Fusion Forum
Fusing Purpose, Passion & Pride to Ignite YOUR Potential!

Featuring Steve Gilliland
Keynote Speaker
(Hall of Fame Speaker & Best-Selling Author)

Sponsored by the
NYFB Young Farmers & Ranchers and
Promotion & Education Programs
All members welcome!
Friday, March 20, 2015
Extended Young Farmer Forum:
Fri. Evening March 20 – Sat. March 21, 2015
DoubleTree by Hilton Syracuse
6301 State Route 298
East Syracuse, NY 13057
For hotel reservations: 315-432-0200

For more information or to register visit
www.nyfb.org
Deadline to register is March 10!

Oswego County Farm Bureau Recognized at 2014 State Annual Meeting

The Oswego County Farm Bureau was presented with four Silver Key Awards at the New York Farm Bureau State Annual Meeting held December 9-11 in Rochester. The Silver Key Awards are presented to county Farm Bureaus that have exhibited excellence in a variety of categories relating to the effectiveness in policy implementation, promoting agriculture among the public and in classrooms, leadership development, and membership building.

The awards were presented in the following categories:

- Membership
- Agricultural Education & Promotion
- Information and Public Relations
- Leadership Development

While at the State Annual Meeting, members also took part in the grassroots process of laying the groundwork for the year ahead. More than 100 delegates from across New York, including Nancy Weber, Vic and Dick DeGraff, and Barbara Brown, proposed discussed and voted on resolutions that set NYFB's public policy agenda for 2015.

Oswego County delegates from L to R Vic DeGraff, Dick DeGraff, Nancy Weber and Barbara Brown.

Oswego County Farm Bureau Travels to Albany for NYFB Lobby Day

Oswego County Farm Bureau Board Member Eric Behling (Right) joins members from Jefferson County as they present Assemblyman Will Barclay (3rd from Left) with the 2014 Circle of Friends Award

The NYFB Taste of NY Reception is always one of the most popular events with legislators and staff in Albany. Thank you to the team at Ashley Lynn Winery for putting the spotlight on Oswego County agriculture with your wonderful apple based wines.

Picture courtesy of Ashley Lynn Winery's Facebook page.

Oswego County Ag District in Review

Cornell Cooperative Extension (CCE) of Oswego County mailed a letter and worksheet to all landowners currently in the Ag District. Every eight years it is required by law to review Agricultural Districts in New York State. Lands currently signed into the District are renewed only by submission of the "Ag District Review Worksheet" that you received in the mail. It is not automatic and in Oswego County the Farmland Protection Board has assured that no property will be put in the Ag District unless the owner signs it up. If you did not receive a letter, need assistance in completing the worksheet, or wish to join the Ag District, please call CCE of Oswego County at 315-963-7286.

Benefits of having your agriculture land enrolled in the Agricultural District as defined in the Ag Districts Law...

- *Encourage the maintenance of viable farmland*
- *Limitations are placed on the use of eminent domain*
- *Discourage private nuisance lawsuits pertaining to farming practices*

You also may be eligible for property tax reductions on your farmland in the Ag District.

Max Lowery Selected for NYFB Scholarship

Max Lowery was chosen as the Oswego County Farm Bureau scholarship winner by NYFB's Promotion and Education Committee. Max, a senior at Pulaski Jr./Sr. High School, is the son of Ellen Lowery. Growing up and working on the family farm has been a great place for Max to grow and learn, and he wants to continue that tradition for future generations. As he pursues a career as a DEC Officer, he wants to make agriculture awareness a top priority.

For the required scholarship essay *"If you had the power to change something in the community or on your farm, what would you change and why?"*, Max wrote about the disconnect between farmers and the non-farm public. He is passionate about working to expand educational programs for children and greater opportunities for community awareness, to bring a better understanding of where our food comes from and highlight the importance of agriculture to the state's economy.

Congratulations Max! We have no doubt that you will be a great advocate for our community.

Faye (L) and her husband Jack. Photo courtesy of beckwithchristmastrees.com

Congratulations go out to Oswego County Farm Bureau member Faye Beckwith, President-elect 2016 of the Christmas Tree Farmers Association of New York (CTFANY). Faye and her husband Jack along with their three children planted their first Christmas trees in 1985 on their 57 acre farm in Hannibal. Today, the farm now embraces more than 180 acres, with about 35 acres in trees. With the help of the entire family, including six grandchildren, Beckwith Family Christmas Trees is now a place were families come to make cherished memories while finding their perfect tree.

Faye's dedication, passion, and knowledge make her a great choice to lead the CTFANY.

NEWS from *your* County Farm Bureau

The Board has voted to dissent from New York Farm Bureau policy on two resolutions that involve the spreading of biosolids. NYFB policy favors spreading biosolids on farmland in both resolutions. Your County Farm Bureau has reservations about the policy from several perspectives. They include the contamination of farmland, GAP, and organic farming. By dissenting, we can engage our legislators and members in discussion reflecting all points of view.

The Board has also been involved in trying to mediate a resolution to a local law in the Village of Lacona, in the town of Sandy Creek, that we believe is ill advised. The law requires that owners of farm animals in the village must remove them unless they own two acres of land. There is no grandfather clause, and there are fines for non-compliance. As a result of this law, a 4-H'er must get rid of her goats. Additionally our Ag District may be compromised. Please be diligent about what your local officials are legislating. Often these onerous laws are the result of a complaint. It is always preferable to mediate a solution rather than legislating one.

If you have any questions, concerns, or want to get involved, please feel free to contact any Board Member (see back panel for contact information).