

BLUE RIDGE ENVIRONMENTAL DEFENSE LEAGUE

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Why sludge should be banned from critical watersheds

Background. According to the federal government (40 CFR 260.10.) the term “sludge” is defined as “any solid, semi-solid or liquid waste generated from a municipality, commercial industry, waste water treatment plant, water supply treatment plant or air pollution control facility.” The term, “biosolids” was created in 1991 by the Water Environment Federation (WEF), formerly the “Federation of Sewage Works Associations” in an attempt to make sewage sludge more palatable to the public for use as a fertilizer.¹

Ocean dumping of sewage sludge was banned by the EPA in 1988. Congress voted to ban the practice because of elevated bacterial levels, closed shellfish beds, and accumulated toxic organic compounds and heavy metals in bottom sediments which caused changes in diversity and abundance of marine life²

Since that time the EPA has instituted a policy promoting sewage sludge disposal on agricultural land. WWTPs offer sewage sludge to farmers free of charge to be used as a nutrient enhancer for soil. Sewage sludge is promoted by EPA, state governments, and industry pundits as a healthy alternative to expensive fertilizers for crops. For wastewater treatment plants, land application of sludge is a cheap and easy solution for disposal of a voluminous waste product. Haulers or applicators make billions by contracting with WWTPs to transport and spread sludge on farmlands. Sludge runoff has been reported exceeding the state’s 100-ft. buffer, and running off into creeks and streams after heavy rains.³ Sludge fields remain permitted in critical watersheds in NC despite laws that prohibit this practice, and sludge continues to be spread in critical watersheds of NC through a loophole in legislation specifically aimed at protecting public water supplies.

Uncontrolled substances in sludge. Each year, over 700 new chemicals are introduced by manufacturers, many of which do not get disclosed either to the public or to government agencies. About 95 percent of new chemical notices submitted to the government request some kind of secrecy. According to EPA records, more than half of the 65 "substantial risk" reports submitted to the agency last March involved secret chemicals. Of these, 151 of them are produced in quantities over one million tons a year and ten of them are used primarily in children's products. The vast majority of these chemicals are not tested to study their impacts on human health.

The 1976 Toxic Substances Control Act (TSCA) requires that manufacturers of products containing potentially toxic chemicals disclose their ingredients to the federal

¹ History of BIOSOLIDS: <http://en.wikipedia.org/wiki/Biosolids>

² “Reilly in New York to Mark End of Sewage Sludge Dumping,” EPA press release, June 30, 2002, <http://www.epa.gov/history/topics/mprsa/03.htm>

³ Incidents reported to DWQ, sludge running off into Cane Creek, Alamance County, after tropical storm Hanna, Sept. 2008.

government, however a loophole in the requirement allows manufacturers to arbitrarily withhold information that they deem sensitive to their business. As a result, over 17,000 product chemicals remain secret not only from the public but from government officials.⁴

In addition to the numbers of unreported “secret” chemicals, only a handful of substances are tested and/or regulated in sewage sludge. The EPA 503 rules require that only a handful of substances in sludge be tested. Only nine toxic metals are tested: arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. Also, total coliform and nitrogen and phosphorous levels are required to be tested.⁵

Depending on the types of chemicals produced by industry some pretreatment may be required for certain chemicals. However, it is well documented that wastewater treatment plants are incapable of removing the tens of thousands of potentially harmful chemicals known as organic wastewater contaminants (OWCs) that escape treatment and removal that ultimately end up in wastewater effluent discharged into rivers and streams.⁶

These chemicals include pathogens, PCBs, pesticides, prescription and non-prescription pharmaceuticals, hormones, steroids, endocrine disrupting chemicals, flame retardants (PBDEs), dioxin, nonylphenol, phthalates, heavy metals, radioactive substances, industrial solvents, and leachate from landfills. Contaminants from any waste flushed into a municipal wastewater system concentrate in sludge during the treatment process. Polymers added to thicken sludge are classified as irritants and animal carcinogens.⁷

The following sections are summaries that represent a few classes of the many chemicals of concern found in sewage sludge.

Organic wastewater contaminants (OWCs). A study conducted by Eastern Washington University and the USGS examined nine different biosolids products destined for land application from municipal wastewater treatment plants in seven states. Fifty-five OWCs from a total of 87 OWCs were detected in one biosolids product with a minimum of 30 and a maximum of 45 OWCs detected in any one sample. Among the most commonly detected compounds in sludges were pharmaceuticals (prescription and non-prescription), hormones, detergent metabolites, steroids, fragrances, plasticizers, pesticides, fire retardants, and disinfectants. The compounds detected in greater concentrations were nonylphenol and octylphenol detergent metabolites.

The study concluded that a range of compounds are “incompletely removed during wastewater treatment and sequestered in biosolids [a.k.a., sewage sludge] that are subsequently land applied.” The potential concerns surrounding the presence of these

⁴ “Nearly 17,000 chemicals remain corporate secrets – even the EPA doesn't know what they are” http://www.naturalnews.com/028091_toxic_chemicals_EPA.html

⁵ ND DENR Waste Not Discharged to Surface Waters, Subchapter 2T Rules 15A NCAC 02T.1105 Pollutant Limits, p. 59.

⁶ *Water-Quality Data for Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999-2000*, <http://toxics.usgs.gov/pubs/OFR-02-94/>

⁷ MSDS, Praestol K111L, received from DWQ regarding polymers used the City of Burlington WWTP, 5/15/09.

compounds in the environment include adverse psychological effects, increased cancer, reproductive impairment in humans and other animals, and antibiotic resistance among pathogenic bacteria.⁸ Kinney, a chemist with Eastern Washington University, adds that “little is known about the potential effects of organic wastewater contaminants in wastewater effluent or biosolids disposed of in surface water or on soil” and that potential concerns about the presence of these contaminants in the environment include “adverse physiological effects, increased rates of cancer, and reproductive impairment in humans and other animals as well as antibiotic resistance among pathogenic bacteria.” The study concludes: “the high frequency of organic waste water contaminants detected in biosolids tested and the high concentrations of individual organic wastewater contaminants present suggest that biosolids can be an important organic wastewater contaminant source to terrestrial environments, and projections about their environmental fate are warranted.”

Closer to home, a 2002 USGS study of organic wastewater compounds (OWCs) in surface waters in the Triangle area of North Carolina found similar results. Of the 108 OWCs tested, 24 were detected in at least one sample during the study that included 3 pharmaceutical compounds, 6 fire retardants and plasticizers, 3 antibiotics, 3 pesticides, 6 fragrances and flavorants, 1 disinfectant, and 2 “miscellaneous compounds.” Though source identification was not the objective of the study, the results indicated that municipal WWTPs were likely the source of antibiotics and synthetic musks.⁹

Excessive nitrates and phosphorus in sludge. As noted earlier, sewage sludge has been hailed as an excellent fertilizer because of its nutrient-rich content. However, there are many examples of nitrate contamination to ground water as a result of land applied sewage sludge. The ground water near a sludge application site in Rutherford County was contaminated with nitrates at levels greater than the EPA limit of 10 ppm suggesting that a nearby sludge field spread was responsible for contaminating groundwater and residential private wells.¹⁰ In another instance, nitrates traveled 1,400 ft. from where they were applied in sludge on land in Robeson County resulting in contamination to residential wells that exceeded the 10 ppm limit.¹¹

Short-term exposure to drinking water with a nitrate level at or just above the health standard of 10 mg/l nitrate-N is a potential health problem primarily for infants. Babies consume large quantities of water relative to their body weight, especially if water is used to mix powdered or concentrated formulas. The digestive systems of babies are more likely than adult digestive tracts to allow the reduction of nitrates to nitrites. In particular,

⁸ *Survey of Organic Wastewater Contaminants in Biosolids Destined for Land Application*, Kinney et al, Environmental Science Technology, Vol. 40, 2006, p. 7207-7215).

⁹ *Occurrence of Organic Wastewater Compounds in Selected Surface-Water Supplies, Triangle Area of North Carolina*, USGS, 2002-05.

¹⁰ *Supplemental Site Assessment Report*, Raleigh Waste Water Treatment Plant, September, 2003.

¹¹ *Hydrogeologic Characterization and Water quality assessment at Parnell Farm Site, Robeson County, NC*. Soil and Environmental Consultants, NC DENR, December 1996.

the presence of nitrites in the digestive tract of newborns can lead to a disease called methemoglobinemia.¹²

In addition to being toxic to human babies, nitrates affect young animals and are a problem for ruminant animals of all ages. Some livestock have been known to abort fetuses due to drinking water containing high levels of nitrates.¹³ A growing number of studies suggest that nitrates have the potential to be an endocrine disrupting contaminant and pose a direct threat to the conservation and restoration of vertebrate populations and the ecosystems they depend on for survival.¹⁴

It is well documented that increased amounts of nutrients can kill fish due to a lack of oxygen as a result of excessive algal growth.¹⁵ However, in addition to fish kills, research conducted by Pieter Johnson of the University of Colorado has found that increased levels of nitrogen cause deformities in amphibians. Snail populations that host microscopic parasites known as trematodes reproduce dramatically in nitrogen rich environments infecting frogs with the parasites which then cause cysts in the limbs of developing tadpoles.¹⁶

Excess phosphorus can result in algae blooms and disrupts the growth of underwater plants necessary to healthy freshwater ecosystems.¹⁷ A study conducted by DENR/NCSU of the impacts of agricultural activities in the Haw River Watershed found over 50% of fields with sewage sludge applications had high levels of phosphorous.¹⁸ While phosphorus is tested in sludge by WWTPs, currently there are no restrictions regulating the amounts of phosphorus in sewage sludge applications.

Endocrine disrupting compounds. Studies conducted by the USGS have found hormones, antibiotics, and prescription drugs in urban streams receiving effluent from

¹² *Nitrate: Health Effects in Drinking Water*, M. McCasland, N. Trautmann, and K. Porter, Natural Resources Cornell Cooperative Extension: <http://pmep.cce.cornell.edu/facts-slides-self/facts/nit-heef-grw85.html>.

¹³ *Animal Waste and Water Quality*, Alabama Cooperative Extension System, p.5: <http://www.aces.edu/crd/publications/wtrqlty/wq-animalwaste.pdf>.

¹⁴ *Is Nitrate an Ecologically Relevant Endocrine Disruptor in Vertebrates?* L. Guillette, Jr. and T.M. Edwards, *Society for Integrative and Comparative Biology*, 2005, 45(1):19-27: <http://icb.oxfordjournals.org/cgi/content/full/45/1/19>.

¹⁵ *What are the Usual Causes of Fish Kills?* USGS: <http://water.usgs.gov/owq/FAQ.htm#Q10>.

¹⁶ *Aquatic Eutrophication Promotes Pathogenic Infection in Amphibians*, Johnson et al, 2007: <http://www.colorado.edu/eeb/facultysites/pieter/documents/Johnson%20et%20al.%202007.pdf>.

¹⁷ *Phosphorus Based Nutrient Management: Essential for Clean Water*, Horne and Goldman, Limonology 2nd Edition, 1994.

¹⁸ *Delineating Agriculture in the Lake Jordan River Basin*, p. 34, DENR/NCSU, 2005-2007, http://h2o.enr.state.nc.us/nps/documents/DelineatingAgricultureintheLakeJordanRiverBasin-REVISED-DeannaOsmond_000.pdf.

wastewater treatment plants across the nation. Many of these compounds have been found to concentrate in sewage sludge. Some of these chemicals such as the detergent degradation product nonylphenol and the fragrances AHTN and HHCb have been shown to disrupt reproduction and growth in fish by affecting the endocrine systems.¹⁹ Other research shows that sheep reared on pastures containing sludge have disrupted cellular development and hormonal functions.²⁰ A chemical known as triclosan, found in popular liquid anti-bacterial soaps, may increase the antibiotic resistance of bacteria in the environment²¹ and reduce algae diversity in streams.²²

In 2009, the U.S. Environmental Protection Agency's (EPA) national sewage sludge survey identified high concentrations of toxic contaminants with heavy metals, steroids and pharmaceuticals, including the antibacterials, triclocarban and triclosan. The antimicrobial triclocarban was detected in all 84 samples of sludge collected, while its cousin triclosan was found in 79 out of 84 collected samples. Along with being the most detected pharmaceutical, triclocarban is also detected at the highest concentrations with a recorded maximum concentration of 4.41×10^{-5} ug/kg. This value is the highest ever detected in sewage sludge. Triclosan came in with the second highest concentrations in the category with a maximum of 1.33×10^{-5} ug/kg. The antibiotic, ofloxacin, had the third highest concentration with a maximum of 5.81×10^{-4} ug/kg.²³

The application of sewage sludge on terrestrial systems means that these antimicrobial compounds, as well as the host of other heavy metals, pharmaceuticals, hormones, organics and PBDEs found in this report may be absorbed by crops, earthworms and other soil organisms, and find their way up the food chain and into human diets. Many of these chemicals, such as triclosan, are persistent and do not break down easily. Their effects on soil microorganisms are still not understood. Major questions remain, such as whether these compounds harm soil microbes, or aquatic life if leached into streams.

Triclosan can combine with chlorine in tap water to form chloroform, which is listed as a probable human carcinogen. Also, triclosan is converted into dioxin, a highly toxic compound and known carcinogen, when exposed to sunlight in an aqueous environment, possibly exposing consumers to even more dangerous chemicals.²⁴

¹⁹ *Assessing the biological potency of binary mixtures of environmental estrogens using vitellogenin induction in juvenile rainbow trout*, Thorpe et al, Environmental Science and Technology, v. 35, no. 12, 201.

²⁰ *Common Environmental Chemicals In Diet Affect Fetal Ovarian Development*, Science Daily, 2007, <http://www.sciencedaily.com/releases/2007/07/070704144531.htm>

²¹ *Resistance to triclosan in laboratory and clinical strains of Escherichia coli*, McMurry et al, FEMS Microbiology Letters, v. 166, no. 2, 1998.

²² *Effects of three pharmaceutical and personal care products on natural freshwater algal assemblages*, Wilson et al, Environmental Science and Technology, v. 37, no. 9, 2003.

²³ Targeted National Sewage Sludge Survey Report, EPA, Jan. 2009; EPA 822-R-08-014. <http://www.epa.gov/waterscience/biosolids/tncss-overview.html>

²⁴ *Rising Levels of Dioxins from Common Soap Ingredient in Mississippi River, Study Finds*, Science Daily, May 25, 2010. <http://www.sciencedaily.com/releases/2010/05/100518113236.htm>

Other studies have found that levels of triclosan and triclocarban resist degradation (50% and 76 % respectively) and remain unchanged by aerobic and anaerobic digestion in a WWTP. Both these unregulated chemicals have been found to concentrate in sewage sludge spread on land. Triclosan disrupts the functions of the endocrine system in cultured cells while triclocarban contains trace amounts of dioxins.²⁵

Pharmaceuticals and personal care products (PPCPs) carried in biosolids (i.e., sewage sludge) may reach surface waters or groundwater when these materials are applied as fertilizer to agricultural land. During the high flow conditions created by land application of liquid municipal biosolids (LMB) the residence time of solutes in soil macropores may be too short for sorption equilibration which increases the risk for leaching.²⁶

Numerous research studies have shown that endocrine-disrupting compounds and pharmaceuticals have the ability to alter the sex of fish and create antibiotic resistance. In Boulder Creek and the South Platte River, Colorado, researchers found more feminized fish downstream of sewage effluent sites than upstream. At least two estrogen compounds, a natural estrogen and a type of synthetic estrogen found in birth control pills, contributed to the feminization.

The Colorado study found that each compound was potent enough to cause changes in fish on its own, but together had an even greater impact. The study found that in the Boulder Creek, upstream, where the water flows clear out of the Rocky Mountains, the ratio of males to females is 50-50. Downstream, below the Boulder wastewater-treatment plant, the females outnumber the males by 5 to 1. About 10% of the fish had both male and female sexual characteristics.²⁷

Endocrine disrupting compounds found in effluent discharged into tributaries from wastewater treatment plants are capable of disrupting the endocrine systems of fish and birds essential to maintaining a healthy ecosystem. A 2002 USGS study documented the presence of emerging contaminants, including prescription and non-prescription drugs, hormones, and other wastewater compounds, in a network of 139 targeted streams across the United States.

Nonylphenol is an organic chemical produced in large quantities in the United States and used in processing wool and metals, as a detergent, and in pesticides. Nonylphenol is considered to be an endocrine disruptor due to its ability to mimic estrogen and disrupt the natural balance of hormones in organisms. It is toxic to aquatic life, causing reproductive effects in aquatic organisms. A number of studies in the U.S. have shown that sewage treatment plants remove on average 95% of nonylphenol and its ethoxylates

²⁵ *Antimicrobials accumulate in municipal sludge used to fertilize crops*, American Scientist Observer, 2006, <http://www.americanscientist.org/template/AssetDetail/assetid/54434>.

²⁶ *Journal of Environmental Quality*: <http://www.bio-medicine.org/biology-news-1/Simulating-pharmaceutical-and-personal-care-product-transport-8506-1/>.

²⁷ *Wading in Hormones: Estrogen Invades Colorado's South Platte River*, ScienceLine, Aug, 1, 2007: http://scienceline.org/2007/08/01/environment-anderson-water_hormones/.

from wastewater. Since it is not regulated, tested or removed the remaining concentrates in sludge.²⁸

Lethal liver tumors in Morro Bay, California fish (gobies) most likely result from a carcinogenic and mutagenic chemical concentrated in sewage effluent and sludge. Researchers at Cal Poly's Biological Sciences Department have concluded that nonylphenol is "the major pollutant threatening the marine life in Morro Bay." The concentration of nonylphenol in goby livers is more than 22 times the average found in Morro Bay sediment, a clear indication of bioaccumulation and incremental contamination of the food chain. The concentration in oysters is more than 11 times the level found in that sediment. In fact, beyond being a suspected goby carcinogen, nonylphenol has been linked elsewhere as causing gender changes in gobies.²⁹ No state, federal, or proposed county regulation limits the amount of nonylphenol allowed in sewage sludge applied to land. European countries have banned the use of nonylphenol but it is spread on U.S. lands without any limit.

Phthalates, also found in sludge, are ubiquitous chemicals found in plastics, medical care products, and consumer goods. Virtually everyone is exposed to them on some level but, concerns that babies and children might be especially sensitive to adverse health and developmental effects have been growing in recent years. Scientists have established that a specific phthalate known as MEHP can directly harm the development of sperm making testicular cells in human baby boys. Specifically, phthalates have been found in urine soaked diapers of babies after parental application of baby lotions and soaps. Moreover, phthalates have been linked to altered development of boy's reproductive organs when exposed in the womb.³⁰ <http://www.ehponline.org/members/2008/11146/11146.pdf>.

PBDEs (polybrominated diphenyl ethers). PBDEs are a class of chemicals found in fire retardants that have been associated with developmental disorders and thyroid malfunctions. Low concentrations of PBDEs were found in samples of surface waters in the Triangle area of North Carolina.³¹ Three classes of chemicals include Penta, Deca and Octa BDEs. DECA-BDEs have also been found at 5,000 ppm in sewage sludges. PBDEs are chemically similar to PCBs, which were also used as a flame retardant prior to being

²⁸ *The Case of Nonionic Surfactants in Europe and America: To Ban or Not to Ban*, by Laurie Patsalides. <http://www.brighthub.com/environment/green-living/articles/17618.aspx>.

Read more: <http://www.brighthub.com/environment/green-living/articles/17618.aspx#ixzz0r7sXrBu2>

²⁹ *Suspected Morro Bay pollutant looks more prevalent than previously believed*, CA Coastkeeper Alliance, 10/28/09. <http://www.cacoastkeeper.org/news/suspected-morro-bay-pollutant-looks-more-prevalent-than-previously-believed>.

³⁰ *Phthalates Impair Germ Cell Development in the Human Fetal Testis in Vitro without Change in Testosterone Production*, *Environmental Health Perspectives*, Lambrot et al. 2009. *Phthalates Environ Health Perspectives* 117:32-37. doi:10.1289/ehp.11146. <http://ehp03.niehs.nih.gov/article/etchArticle.action?articleURI=info:doi/10.1289/ehp.11146>

³¹ *Occurrence of Organic Wastewater Compounds in Selected Surface-Water Supplies, Triangle Area of North Carolina*, USGS, 2002-05.

banned due to adverse health effects on the immune system, reproductive system, nervous system, and endocrine system, and are likely human carcinogens.³²

PBDEs are ubiquitous in the environment and found as far away as Antarctica. Canada and the U.S. are reported to have the largest concentrations as EU has banned many chemicals. PBDE levels in humans are reported to be 10-to-100 times higher in U.S. citizens than in European citizens since the U.S. is the lead producer and consumer of products containing PBDEs.³³

New data collected by Dr. Robert Hale with the Virginia Marine Institute, suggests that PBDEs are both more toxic and widespread in humans and wildlife, and that DECA-BDEs breaks down into additional toxic substances.³⁴ Studies show that PBDEs cause neurological damage and thyroid damage in lab animals. A study done in Berkeley, CA, of PBDEs in children's blood of one family who volunteered to be monitored showed high concentrations of PBDEs. DECA-BDEs have also been linked to Cryptorchidism, or undescended testicles in infant males. North Carolina is currently examining legislation to ban certain products that contain PBDEs.³⁵

³² Targeted National Sewage Sludge Survey Report, EPA, Jan. 2009; EPA 822-R-08-014.
<http://www.epa.gov/waterscience/biosolids/tnsss-overview.html>

³³ Public Health Statement for Polybrominated Diphenyl Ethers (PBDEs), ATSDR,
<http://www.atsdr.cdc.gov/toxprofiles/phs68-pbde.html>

³⁴ *Flame Retardants May Be More Toxic Than Thought*, Oakland Tribune, 2007.

³⁵ *Power point presentation by Dr. Heather M. Stapleton, Duke University, Nicholas School of the Environment & Earth Sciences, Durham, NC, See:*
<http://www.ncleg.net/gascripts/DocumentSites/browseDocSite.asp?nID=12>.