Sludge In Our Waters

An investigation of industrial contaminants in sewage sludge and the impacts on surface waters in North Carolina

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Introduction

The purpose of this report is to investigate whether municipal wastewater sewage sludge applications to agricultural fields are contaminating surface waters in North Carolina. In particular, we are concerned about industrial chemicals that are not required to be monitored either in the wastewater, the finished sludge, or in drinking water sources that are downstream from the sludge application fields. We have also created a map showing locations of permitted sludge fields in North Carolina, with an overlay of river basins. The maps include all blue line streams (perennials and intermediate tributaries) and the location of drinking water sources. With the ultimate goal of exploring solutions, the effort is intended to inform the public and policy makers about the potential pathways to human and environmental contamination from sludge applications, and to outline the overall scope of this problem.

A Brief History of Policy and Regulation on Land Application of Sewage Sludge

Wastewater treatment plants take raw sewage from cities and outlying areas and remove the pollutants and solids to produce treated water (effluent) to government standards. The solids removed become a byproduct (sewage sludge) that contains organic matter, nutrients, and other constituents present in the original sewage water, including heavy metals and chemical contaminants.

The system used in this country for wastewater treatment co-mingles residential, commercial, and industrial wastewaters for treatment at wastewater treatment plants (WWTPs). Requirements exist for pre-treatment of industrial wastewater, but there are minimum thresholds for pre-treatment (smaller operations are excluded) and the entire system relies on self-monitoring. This co-mingling can become a pathway for industrial chemicals and heavy metals into the wastewater. Treated sewage sludge is marketed as “biosolids” and promoted as “free fertilizer ”to farmers and home gardeners - if treated to Class A standards. In the United States, over 50% of total WWTP biosolids generated are used in this way, the rest is mostly incinerated or landfilled. For many cities however, 100% of the sludge is land applied. Landfill leachate (the liquid that drains to the bottom of the landfill) collected from municipal solid waste landfills is

also taken to WWTPs, along with leachate from other kinds of landfills, such as coal ash. These can introduce a broad mixture of contaminants into the wastewater system, much of it of unknown and unmonitored.

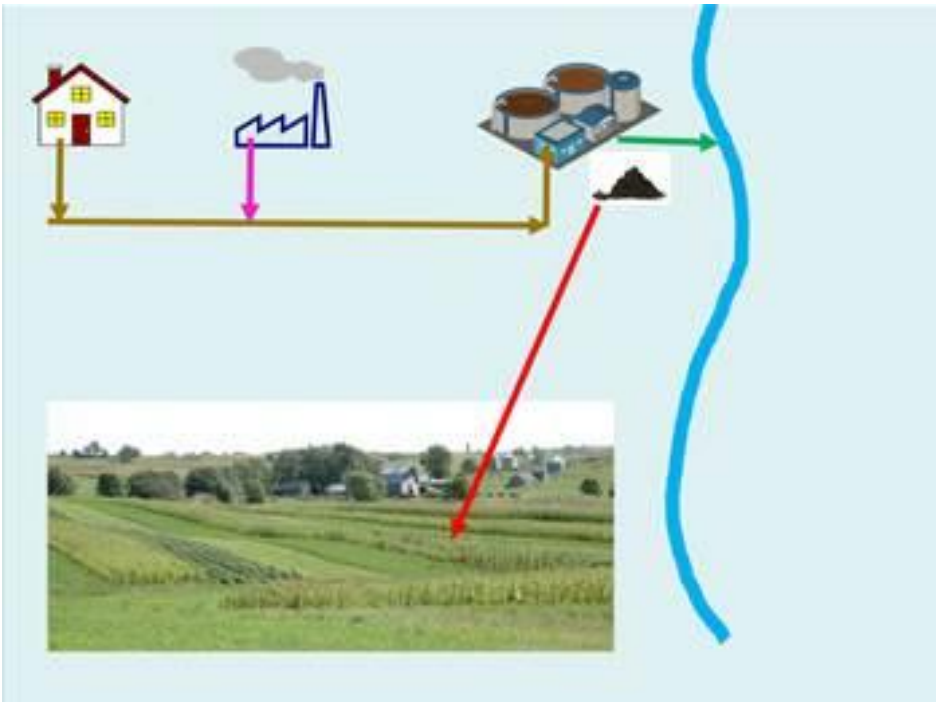

Figure 1: Diagram shows how residential, commercial and industrial wastewaters are treated together. The treated wastewater (effluent) is returned to a river or creek and the sludge is applied to farmland.

The EPA has approved and promoted this use of biosolids. In the "Frequently Asked Questions" section of the agency's discussion of sewage sludge (biosolids), the EPA states that "After treatment and processing, biosolids can be recycled and applied as fertilizer to improve and maintain productive soils and stimulate plant growth. By treating sewage sludge, it becomes biosolids which can be used as valuable fertilizer, instead of taking up space in a landfill or other disposal facility."[1]

The federal biosolids rule is contained in Title 40 of the Code of Regulations Part 503 -*The "Standards for the Use or Disposal of Sewage Sludge*" The rules are commonly known as the 503 Rules.[2]

[1]United States Environmental Protection Agency. "Water: Sewage Sludge (Biosolids)," n.d. http://water.epa.gov/polwaste/wastewater/treatment/biosolids/genqa.cfm.

[2]See United States Environmental Protection Agency. "Use of Disposal of Sewage Sludge Biosolids," n.d. http://water.epa.gov/scitech/wastetech/biosolids/upload/2002_06_28_mtb_biosolids_503pe_503pe_1.pdf.

Biosolids are either Class A (almost no detectible levels of pathogens and lower metal content) or Class B (treated, but containing detectible levels of pathogens, and higher levels of metals and chemical contaminants). There are buffer, public access, and crop harvesting restrictions for virtually all forms of Class B biosolids. In many states, including North Carolina, the regulations governing sludge application are inadequate and poorly enforced. The 503 Rules are supposed to be reviewed and updated every other year; however, the EPA is significantly behind in this process. Much of the science and policy supporting the current 503 Rules are the same as they were when they were first developed more than 25 years ago. EPA's policy (i.e., the 1984 Beneficial Reuse Policy and the 1991 Interagency Policy on Beneficial Use of Sewage Sludge) strongly supported the beneficial reuse of sewage sludge, and was closely linked to its objective of reducing the volume of waste generated.[3]

Concerns about safety of land application: What's in sewage sludge?

Many in the scientific community have raised concerns about the safety of applying urban-generated sewage sludge in ever growing amounts around rural communities. A study by the National Research Council (NRC), "Biosolids Applied to Land, Advancing Standards and Practices," released in July 2002 recognized the absence of scientific investigations of reported health incidents. It "concludes that because of the lack of epidemiological study and the need to address the public's concerns about potential adverse health effects, EPA should conduct studies

[3]United States Environmental Protection Agency. "Standards for the Use or Disposal of Sewage Sludge; Final Rules," February 19, 1993 http://water.epa.gov/scitech/wastetech/biosolids/upload/fr2-19-93.pdf.

that examine exposure and potential health risks to workers and community populations."[4] The committee noted that the absence of evidence was not evidence of the absence of an effect.

The USGS states on their webpage, "Land Application of Municipal Biosolids," that

> The mass of biosolids applied to soils is substantial, approaching 3 million dry tons throughout the United States in 1998. These biosolids and biosolids composts are used widely in both residential and commercial landscaping and in row-crop agriculture. Because a variety of pharmaceuticals and other organic chemicals have been found in the wastewater discharged from WWTPs, questions have been raised about the presence of these chemicals in biosolids. The application of municipal biosolids on land may be a widespread source of emerging contaminants to surface and ground water.[5]

We are also concerned about the impacts to air quality through dust or spray applications and the long term consequences to agricultural lands. We have not been able to find out what the current amount of sludge being applied in the United States is; surely it is a much larger number than in 1998, given population growth.

The public and many independent scientists have also raised serious concerns. The following statement from the Bioscience Resource Project's "Sewage Sludge (Biosolids) — land application, health risks, and regulatory failure" is an excellent summary of the concerns that have been raised:

> "Risk assessment is complex because sludge contains highly varied amounts of organic chemicals, toxic metals, chemical irritants, and pathogens. Furthermore, the effects of their interactions, long-term build-up in soils, leaching into waterways, and uptake into crops and the food system have not been well studied. Thus, little is known about the long-term human health and ecological consequences of sludge application. The paucity of scientific research is not accidental. Journalists and researchers have chronicled how the EPA's Conflicts of Interest and those of other institutions, including the NAS, USDA, municipalities, and universities, obstruct sludge research and further undermine risk assessment and regulation."[6]

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[4]National Research Council. "Biosolids Applied to Land." Washington, DC: National Academies Press, 2002, p. 121. http://www.nap.edu/openbook.php?isbn=0309084865.

[5]United States Geological Survey. "Land Application of Municipal Biosolids. "Accessed September 8, 2015. http://toxics.usgs.gov/regional/emc/municipal_biosolids.html

[6]"Sewage Sludge (Biosolids) — Land Application, Health Risks, and Regulatory Failure." Accessed September 8, 2015. http://www.biosciencеresource.org/sewage-sludge-biosolids-land-application-health-risks-and-regulation-2/.

In the 2012 report "Land Application of Biosolids in the USA: A Review" the problem of uncharacterized and potentially toxic chemicals in sludge is discussed.

> "Synthetic organic compounds used in food production, personal care products, plastics manufacturing, and other industrial processes such as flame retardants, dioxins, and steroid hormones may end up in sludge and migrate to the natural environment. Many of these compounds are toxic or carcinogenic to organisms exposed to critical concentrations over certain periods of time, and their presence in biosolids causes great concern also because they are persistent, poorly degrade, and bioaccumulate. But no organic chemicals are currently regulated under Part 503."[7]

According to the National Toxicology Program of the U.S. Dept. of Health and Human Services about 84,000 chemicals are registered for commercial use in the USA. On average, there are 2,000 new chemicals added each year.[8] A 2010 article in Scientific American by Mark Fischetti discussed the lack of protection for consumers:

> "Experts guesstimate that about 50,000 chemicals are used in U.S. consumer products and industrial processes. Why the uncertainty? The 1976 Toxic Substances Control Act does not require chemicals to be registered or proven safe before use. Because the Environmental Protection Agency must show, after the fact, that a substance is dangerous, it has managed to require testing of only about 300 substances that have been in circulation for decades. It has restricted applications of five."[9]

The Toxic Substance Control Act (TCSA) is not protecting us. Instead of requiring chemical manufacturers to demonstrate that their products are safe before they go into use, the law says the government has to prove actual harm in order to control or replace a dangerous chemical. Only a tiny percentage of chemicals that are manufactured and disposed of are required to be monitored in our waters; we don't even know what pollutants to look for. In 2010 the Washington Post[10] reported that Environmental Working Group had used a public records

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[7]Qin Lu, ZhenliL.He, and Peter J. Stoffella. "Land Application of Biosolids in the USA: A Review." *Applied and Environmental Soil Science* 2012 (2012). doi:10.1155/2012/201462.

[8]"About NTP - NTP."Accessed September 8, 2015. http://ntp.niehs.nih.gov/about/index.html.

[9]Fischetti, Mark. "The Great Chemical Unknown: A Graphical View of Limited Lab Testing - Scientific American."*Scientific American*, October 1, 2010. http://www.scientificamerican.com/article/the-great-chemical-unknown/

[10] " Lyndsey Layton, Use of potentially harmful chemicals kept secret under law" Washington Post, January 4, 2010

request to EPA to document that the identities of nearly 20% of the chemicals being manufactured - about 17,000 are trade secrets, under a little known provision in TCSA.

> "Government officials, scientists and environmental groups say that manufacturers have exploited weaknesses in the law to claim secrecy for an ever-increasing number of chemicals. In the past several years, 95 percent of the notices for new chemicals sent to the government requested some secrecy, according to the Government Accountability Office. About 700 chemicals are introduced annually."

Another emerging concern about sewage sludge composition is coal ash residuals. Duke Energy and its contractor Charah are planning on disposing of up to 20 million tons in two clay pit sites in Chatham and Lee counties from the Riverbend, Sutton and Cape Fear ash ponds. The leachate collected from these disposal sites (structural fill with liners) is estimated to be 288,000 gallons per day according to information provided in a presentation by the consultants Hazen and Sawyer to the City of Sanford.[11]

The coal ash is expected to contain arsenic**,** beryllium, cadmium, chromium, copper, cyanide, lead, mercury, molybdenum, nickel, selenium, silver, zinc, beryllium as well as other unmonitored and unregulated contaminants found in coal ash . If the City of Sanford agrees to accept this coal ash leachate at their WWTP, both the treated effluent and sludge will contain the coal ash contaminants. In order to comply with limits on metal in their liquid effluents, the Hazen and Sawyer report to the city suggests that more metals and other contaminants will end up in the sludge. The sludge from Sanford is spread on farmland in the surrounding area, including lands that drain to the Rocky River in Chatham County, in the Cape Fear watershed.

[11]Hazen and Sawyer, Technical Memorandum to the City of Sanford on June 11, 2015 "Evaluation of Coal Ash Leachate, Big Buffalo WWTP, City of Sanford"

Pathways of contamination

Land application of sewage sludge reintroduces pollutants removed from wastewaters into the environment, including pathogens, metals and synthetic organic chemicals. This occurs through transport of airborne particles during spray application or through dust blown from fields after sludge application. Runoff from fields during storms into nearby streams is compounded by liquid sludge sprayed onto fields that are too wet or during rain events.

Fields used over a long period of time may be monitored for some heavy metals, but not for persistent organic chemicals. Farmers and rural residents are told that the sludge has been treated and is safe to use. However, in reality the material is contaminated, including many chemicals that the generators have yet to identify, let alone establish safe limits. In addition to air and water pollution, there is increasing concern that livestock and crops grown where sludge is applied may introduce pathogens and other contaminants into the food chain. The uncertainties about the safety of the practice are not explained to farmers, or those who live near sludge application or storage sites.

A 2009 article in *Environmental Science & Technology*[12] pointed the finger at Decatur, Alabama municipal sludge for the high levels of perfluorinated compounds, chemicals used for a variety of industrial products. Concerns were raised about the chemicals entering the food chain through meat from cattle that grazed in these fields, and noted that "published data on the concentrations of perfluorinated compounds in sludge is minimal, and almost nothing is known about concentrations in soil."

Many of the chemical contaminants in sludge survive treatment at the WWTPs and end up in biosolids. For example, in 2006, researchers at the Johns Hopkins Bloomberg School of Public Health[13] measured levels of the antibacterial hand soap ingredient, triclocarban, as it passed through a wastewater treatment facility. They determined that approximately 75% of the triclocarban washed down the drain by consumers persists during wastewater treatment and accumulates in municipal sludge. This is then used as fertilizer for crops. The Food and Drug

[12] "EPA Finds Record PFOS and PFOA in Alabama Grazing Fields" *Environmental Science & Technology*, March 2009

[13] "Sludge Recycling Sends Antiseptic Soap Ingredient to Agriculture" Johns Hopkins Bloomberg School of Public Health Press Release April 26, 2006
http://www.jhsph.edu/news/news-releases/2006/halden-sludge.html

Administration raised concerns in 2013 that triclocarban and certain other ingredients in anti-bacterial soaps may contribute to bacterial resistance to antibiotics, and may have unanticipated hormonal effects that are of concern to FDA.

> "The observed persistence of triclocarban is remarkable," said lead author, Jochen Heidler, a PhD candidate in the Bloomberg School's Department of Environmental Health Sciences. "In the plant, the chemical contained in sludge underwent biological treatment for an average period of almost three weeks, yet very little degradation took place. Triclocarban, an ingredient of antibacterial bar soaps and toothpaste, is "potentially problematic" because it breaks down slowly, which means it is accumulating in soil and perhaps water, said Rolf Halden, an Associate Professor at Johns Hopkins University's Department of Environmental Health Sciences, who led the study."What we are finding is this chemical is building up in the environment," Halden said. "This is an example of an emerging contaminant. It has been in the environment for almost five decades, and we manufacture large volumes of it, but we don't know what happens to it."

Regulation of Land Application of Sludge in North Carolina

Land application of sewage sludge in North Carolina is regulated by a non-discharge permit, which is issued by the state. The provisions and renewal process of a non-discharge permit are very similar in style to those of a National Pollutant Discharge Elimination System (NPDES) permit which are for point sources such as pipes that discharge directly into water. Non-discharge permits specifically do not allow discharges into waters of the U.S. Permits are issued to utilities, though third parties contractors (e.g., Synagro), who often develop the permit application. In fact, the third parties handle most every aspect after sludge is generated, from the application truck fleet to the permit's reporting requirements.

According to a report in the Independent Weekly,[14] Synagro has contracts with more than 600 municipal WWTPs in 37 states, including Burlington and Durham.

[14] "Sludge, a free fertilizer for farmers, can pose health and environmental risks" Rebekah L. Howell, Independent Weekly July 28, 2010 http://www.indyweek.com/indyweek/a-free-fertilizer-for-farmers-sludge-can-pose-health-and-environmental-risks/Content?oid=1562962)

> "The company has a checkered environmental record nationwide. Within the last 10 years, according to EPA documents, the Maryland Department of the Environment fined the company $27,000 for violating air regulations; Pennsylvania environmental officials fined it $35,000 for sewage sludge storage and land application violations, which included failing to prevent runoff from entering nearby waterways and spreading sludge on a landowner's property without permission. In Virginia, dozens of complaints have been filed against the company over allegations of road damage, odor, groundwater issues and truck traffic."

Independent Weekly reporter Rebekah Cowell discovered the state Division of Water Quality itself is violating a 1992 law, the Water Supply Watershed Protection Act, by allowing fields to remain permitted for sludge application in critical watersheds in Orange, Alamance, Gaston, Caldwell, Catawba and Wake counties. North Carolina has a state law that prohibits counties and cities from regulating sludge in their jurisdictions even though the federal Clean Water Act allows it, and other states have done so. Without adequate state regulation and oversight, and with a ban on local control, rural residents have found there is almost no recourse for the problems associated with land application of sludge in their communities.

According to an article in "LAW 360",[15] in July 2015, ten residents and the citizens group Sludge Free UMBT, appealed permits granted in January 2014 to Synagro Mid-Atlantic by the Pennsylvania Department of Environmental Protection. These permits allowed the company to spread sewage sludge on three farms in Upper Mount Bethel Township owned by former Northampton County Councilman Ron Angle. The plaintiffs contend the treated sludge could affect water quality, and that DEP did not properly consider possible water contamination when it granted the permits. Pennsylvania's Environmental Hearing Board refused Syngro's motion to limit a challenge to these permits. The Board ruled that a hearing on the merits is necessary in order to weigh environmental claims from concerned residents including threats of contamination of local waters and to habitats of an endangered salamander, according to an opinion filed July 1.

[15] "Synagro Can't Dodge Challenge to Sewage Sludge Permits" Lance Duroni, LAW 360 July 2015 http://www.law360.com/articles/675718/synagro-can-t-dodge-challenge-to-sewage-sludge-permits

North Carolina's Permitting System

Land application of sewage sludge occurs on agricultural fields that have been permitted by the state. A site is a collection of fields with a common owner and location. A field name consists of a county abbreviation, site number and field number (e.g., MG-07-06 for Mecklenburg County, Site 07, Field 06). For a spreading event, multiple factors go into determining how much sludge can be applied on a field:

- Crop and its agronomic rate
    - Based on the concentration of nutrients (typically regulated only by nitrogen) in the sludge, how much can the given crop take up in its growth?
    - Sludge does not come at the ideal nitrogen: phosphorous ratio for a given crop, so this often means extreme over-application/saturation of phosphorous, which can then run off.
- Regulated contaminant (i.e., metals) concentrations
    - Even if concentration is below standards, net metals accumulation in soil occurs
- Sludge is not supposed to be applied on frozen fields or immediately before or after rain events.

The purpose of a non-discharge permit is to regulate application of a material such that it is absorbed and there is no discharge, as is the principle with the land application of confined animal feeding operations. In both cases the reality is much different from the principle. Fields receiving sludge in a given year are supposed to have a soil sample collected and analyzed and the results included in the subsequent annual report. These annual reports can be rich in lab data useful in identifying over-application issues.

Upstream of fields that have received sludge

Downstream of fields that have received sludge

Figure 2: Photographs of stream areas upstream and downstream of sludge-treated fields

In spring 2015, the N.C. General Assembly saw the introduction of a bill that would allow local governments to set biosolids quality requirements (e.g., Class A vs. Class B) for any sludge applied in the jurisdiction. The bill made little progress, but citizens have generated interest in revisiting the issue. While the League of Municipalities and the Farm Bureau remain powerful pro-biosolids lobbies, sludge often crosses county lines. In general rural counties become the recipients of the huge amounts of sewage sludge generated by urban areas, a clear environmental justice issue. For example, a vast majority of sludge generated in Charlotte-Mecklenburg is spread in rural counties to the east. A large amount of Burlington sludge is spread in Chatham and Orange counties, even onto land drained by headwater streams of the otherwise strictly protected Cane Creek Reservoir that supplies drinking water to Chapel Hill and Carrboro. While sludge generators compare the material to premium fertilizer, most municipalities (densely populated ones in particular) don't apply it themselves locally because of odor issues.

Sewage Sludge Application Fields in NC

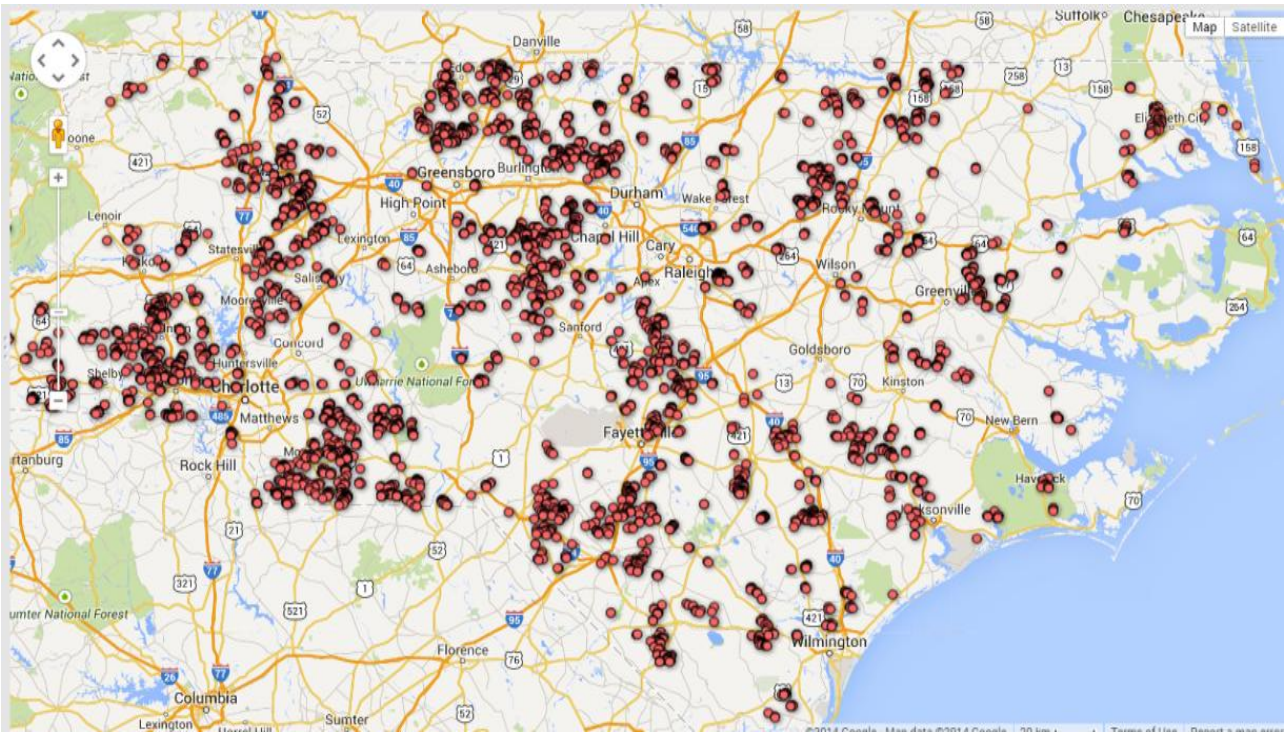


Figure 3: Locations of permitted sludge fields in central and eastern North Carolina

According to the In NC Division of Water Resources there are currently (as of September 2015) 4,146 permitted fields on a total of 78,669 acres. in North Carolina (Figure 3). Some river basins clearly stand out as having higher numbers of sludge fields – these are primarily in the Piedmont and coastal plain – especially in the Haw, Catawba, Yadkin-Pee Dee, Cape Fear

(Cumberland, Harnett counties), Neuse and Tar-Pamlico basins. Some areas have environmental justice issues similar to what is seen with swine CAFO waste application where more sludge applications occur in communities of color and low-income areas. Complaints from residents about odor, illness and being unable to engage in outdoor activities due to air pollution are also very similar to the problems of communities near factory farms.

Waterkeepers Carolina Sludge Application Mapping Tool

We have created a map of river basins in North Carolina that overlays permitted sludge sites and streams that can be found at this link: http://www.waterkeeperscarolina.org/sludge-in-our-waters/ This mapping tool provides valuable information to the public by documenting where sludge can be applied in relation to the location of streams that may be impacted by runoff from these application sites. Drinking water source intakes and impaired waterways appearing on the 303 (d) EPA Impaired Waters List are also included. Combining all of these data in a mapping tool makes it possible to visualize where sludge applications could be impacting agricultural production, ground and surface water resources, fisheries resources, drinking water intakes, and overall environmental quality. The example below (Figure 4) maps the entire Haw River watershed (in the upper Cape Fear Basin).

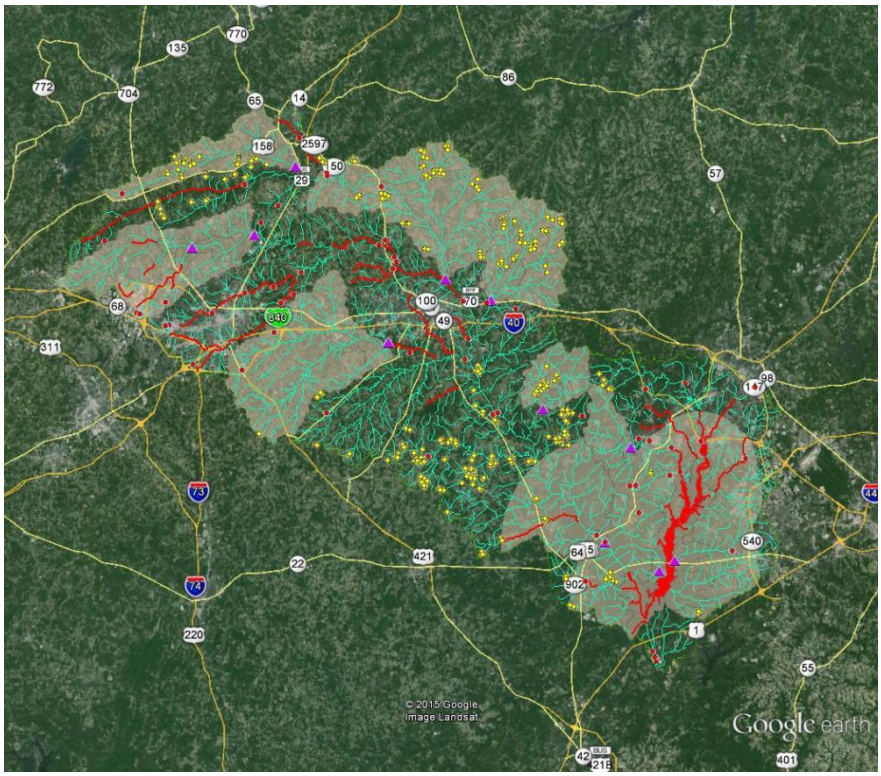


Figure 4: Yellow dots indicate permits for sludge application, the red lines show waters on the the NC 303(d) List of Impaired Waters. The areas in grey are Water Supply Watersheds.

Zooming in on the map (Figure 5) we can see yellow dots that indicate permits for sludge application within the Haw River watershed. Clicking on a yellow dot (as seen in the red box in the following figure) brings up a table of permit information, including the acreage and origin of the sludge, and whether this is an active permit. The table of information is shown below the map. In the case studies that are discussed below, we show how this Mapping Tool can be used to explore sources of local contamination that may be related to sewage sludge applications.

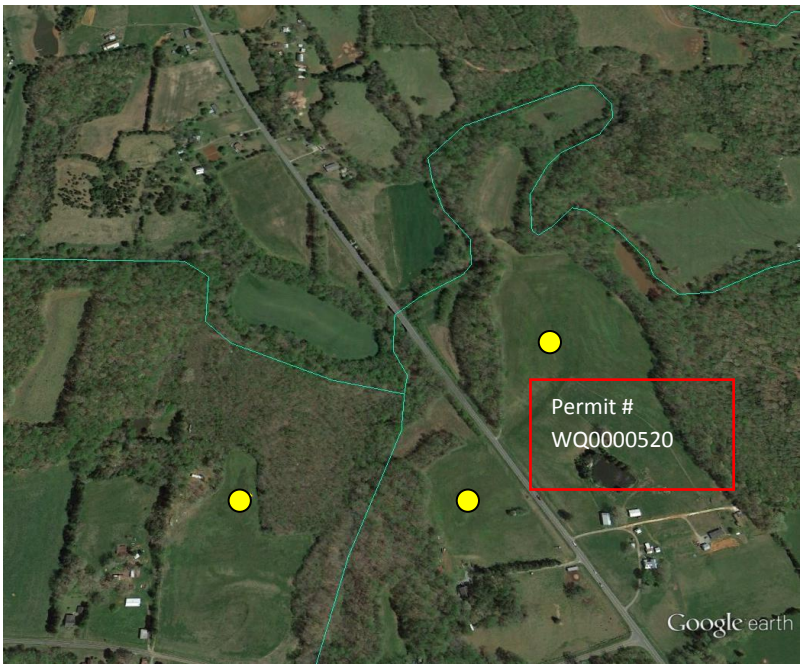


Figure 5: Sample sludge permit application information

PERMIT_NUM WQ0000520

FACILITY_N	City of Burlington Residuals Land Application Program
TYPE	Land Application of Residual Solids (503)
CATEGORY	Non-discharge
FIELD_ID	NC-AM-110-01
ACREAGE	28.2
LATITUDE	35.88389
LONGITUDE	-79.29306
COUNTY	Alamance
STATUS	Active

Haw River Case Study #1: PFC Contamination in Dry Creek, Chatham County

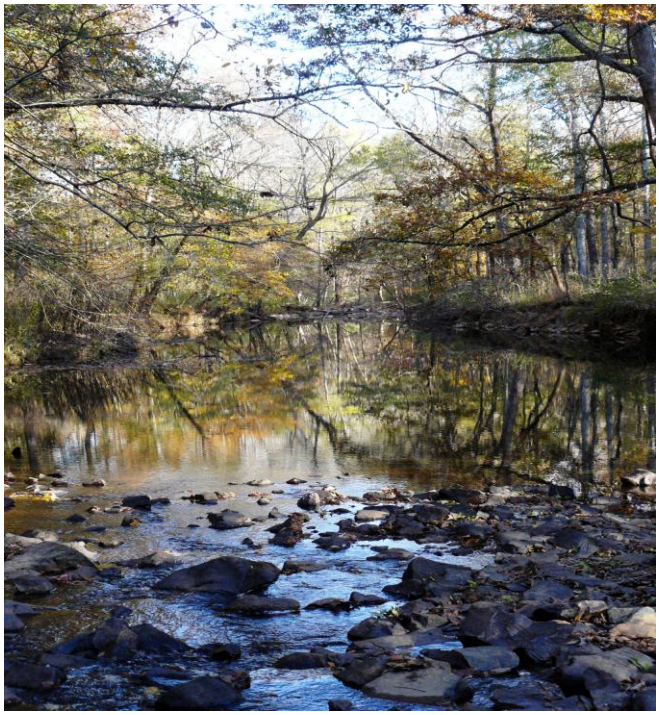


Figure 6: Dry Creek, a tributary of the Haw River in Chatham County. What's in the water?

In 2007, a study was published in Environmental Science &Technology[16] that showed elevated levels of perfluorinated compounds (PFCs) were present in the Cape Fear River basin, with the highest concentrations in the Haw River. Perfluorooctane Sulfonate (PFOS) was found to be as high as 127 ng/L and perfluorooctanoic acid (PFOA or C8) was measured as high as 287 ng/L. These levels were considered significant on a national scale. There are many different kinds of PFCs including PFOS, PFOA, and other related compounds which are used in textile treatments (for stain resistance), pesticides, cleaning products, adhesives, coatings, fire fighting foam, and more. In March 2014, the EPA released a fact sheet "Emerging Contaminants – Perfluorooctane Sulfonate (PFOS)and Perfluorooctanoic Acid (PFOA)"[17] on these 2 chemicals that includes information from studies on environmental and health impacts. "Studies also indicate that continued exposure to low levels of PFOA in drinking water may result in adverse health effects (Post and others 2012)".

[16]Nakayama et al *Environ. Sci. Technol.* 2007, 41: 5271-5276

[17]http://www2.epa.gov/sites/production/files/2014-04/documents/factsheet_contaminant_pfos_pfoa_march2014.pdf

Over the past several years, the Haw Riverkeeper has been working with researchers who have collected and analyzed data on industrial chemicals (including PFCs and flame retardants) in the Haw River. Their research has pointed to runoff from sludge fields, as well as the wastewater effluents, as being sources. Water samples were taken upstream and downstream in several creeks where fields with active permits are located. The data show PFC contamination in streams downstream from sludge land application sites in watersheds where there are no other apparent sources for the identified pollutants. Monitoring data upstream of the sludge fields showed minimal levels of these chemicals. Sludge from the industrially-impacted City of Burlington WWTP was associated with the high levels of PFOA and PFOS in streams. Lower levels were found in creeks where municipal sludge from other municipalities was applied.

The following illustration (Figure 7) from "Municipal waste water treatment plant biosludge applications and perfluoroalkyl acid surface water contamination in North Carolina"[18] presented at the N C American Water Works Association & Water Environment Association, shows results of water samples for Dry Creek in the Haw River basin, where Burlington sludge is land applied:

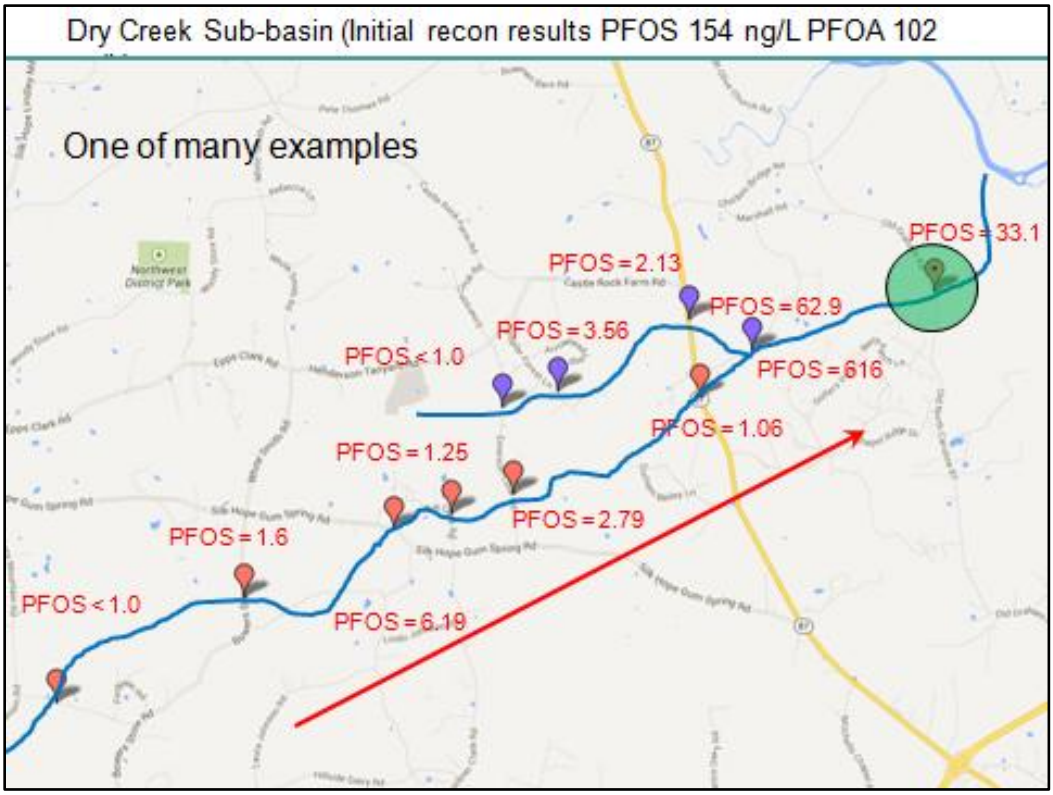


Figure 7: The monitoring sites on Dry Creek are depicted as red pins, with amounts of PFOS (a perfluorinated compound) concentrations in ng/L. Purple pins show data collected on a tributary of Dry Creek. The arrow shows the direction of streamflow, with the Haw River to the right.

[18] "Municipal waste water treatment plant biosludge applications and perfluoroalkyl acid surface contamination in North Carolina"[18] (A.B. Lindstrom, M.J. Strynar, R.L. McMahen, L. McMillan, and D.R.U. Knappe) North Carolina AWWA-WEA 14th Annual Spring Conference, April 12-14, 2015 Wilmington, NC

Zooming in, we see that the highest amount of PFOS collected was 616 ng/L (Figure 8).

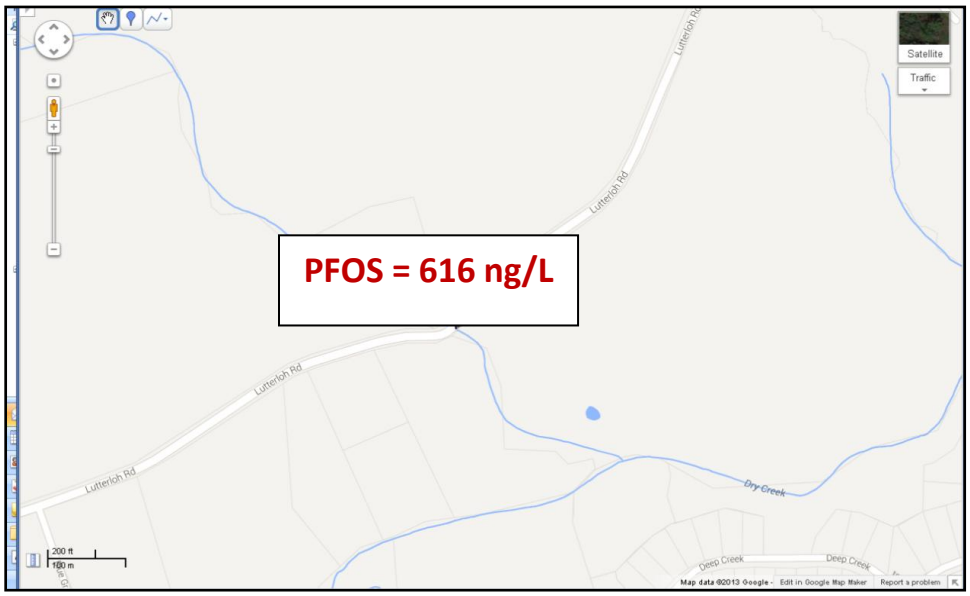
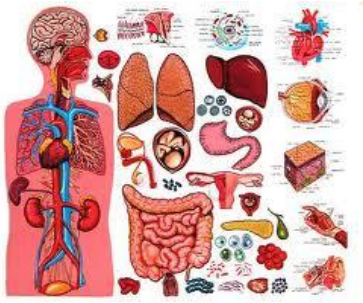


Figure 8: A close-up of the site downstream of the sludge fields

The EPA Provisional Health Advisory level for short term exposure to PFOS in drinking water is 200 ng/l. [19] Studies have shown that PFCs in the general population and/or communities with contaminated drinking water are associated with multiple health effects[20]:



- Diabetes
- Testicular and kidney cancer
- Pregnancy-induced hypertension
- Ulcerative colitis
- Estrogenic effects in young adulthood from prenatal exposures

Dry Creek flows to the Haw River, about 3 miles upstream from the intake for the Town of Pittsboro's drinking water supply, raising concerns for long term exposure to these chemicals for residents of that town. There is also new monitoring data that shows troubling levels of another industrial chemical, 1,4-Dioxane in the Haw River, and Pittsboro's drinking water.[21] Further

[19] http://water.epa.gov/action/advisories/drinking/upload/2009_01_15_criteria_drinking_pha-PFOA_PFOS.pdf

[20] Post et al., (2012) Perfluorooctanoic acid (PFOA) , an emerging drinking water contaminant: A critical review of recent literature, *Environmental Research* (116) 93-117 and Steenland et al., (2014), *Epidemiology* (25) 167-169; http://www.c8sciencepanel.org

[21] "Testing the waters: 1,4-Dioxane in North Carolina's Cape Fear River Basin" May 4, 2015 *Science Nation*, National Science Foundation http://www.nsf.gov/.../science_nation/capefearwatershed.jsp

study of the drinking water impacts of these chemicals should be a high priority, as well as new treatment options. An alternative source for the town's drinking water could be Jordan Lake. Although the lake is a reservoir of the Haw River, its particular geography provides some protection for drinking water. There is not nearly as much heavy industry or sewage sludge applications in the watershed that feeds the Lower New Hope arm of the lake, location of the drinking water intake for the Cary/Apex and Chatham County water treatment plants.

Haw River Case Study #2: PFOS and PFOA Contamination in Cane Creek Watershed, Orange County

The Cane Creek reservoir is part of the drinking water supply for the Orange Water and Sewer Authority, serving the Carrboro, Chapel Hill and southern Orange County, North Carolina (Figure 9). The Reservoir can store about 3 billion gallons from its 32-square mile watershed and has a surface area of about 540 acres. More than 3,000 acres of watershed land is either owned by OWASA or protected through conservation easements. OWASA prides itself on the protection and treatment of their drinking water. In May 2011, OWASA became the ninth water utility in the United States to receive the Partnership for Safe Water's "Excellence in Water Treatment" award for achieving the highest level of performance in drinking water treatment.

Figure 9: Cane Creek Reservoir

But outside the protected watershed are agricultural fields where sludge from Burlington's WWTP has long been applied. Water samples from creeks that are adjacent to these permitted

sludge application fields and which flow directly into Cane Creek Reservoir have shown high levels of PFOS and PFOA (Figure 10). Given the complete lack of industrial sources of contamination in the headwaters of this reservoir, it is logical to conclude that sewage sludge applications are a likely source of the PFCs. The Orange Water and Sewer Authority 2014 Drinking Water Test Results Summary[22] reports an average level detected of Perfluorooctanoic acid (PFOA) of .01 parts per billion (ppb) with a range of <.02- .03 ppb. The average level converts to 10 ng/L using the units used in this report, with a maximum concentration to 30 ng/L. PFC levels in OWASA drinking water would likely be higher if OWASA were not using powdered activated carbon in their treatment plant.

While this is well below the 400 ng/L EPA Provisional Health Advisory level for short term exposure to PFOA in drinking water, it is higher than the much lower levels advised for long term exposure . A 2013 Environmental Health Study that looked at exposure in children suggests a long term exposure level of < 4 ng/L for PFOA and other similar PFCs .[23]

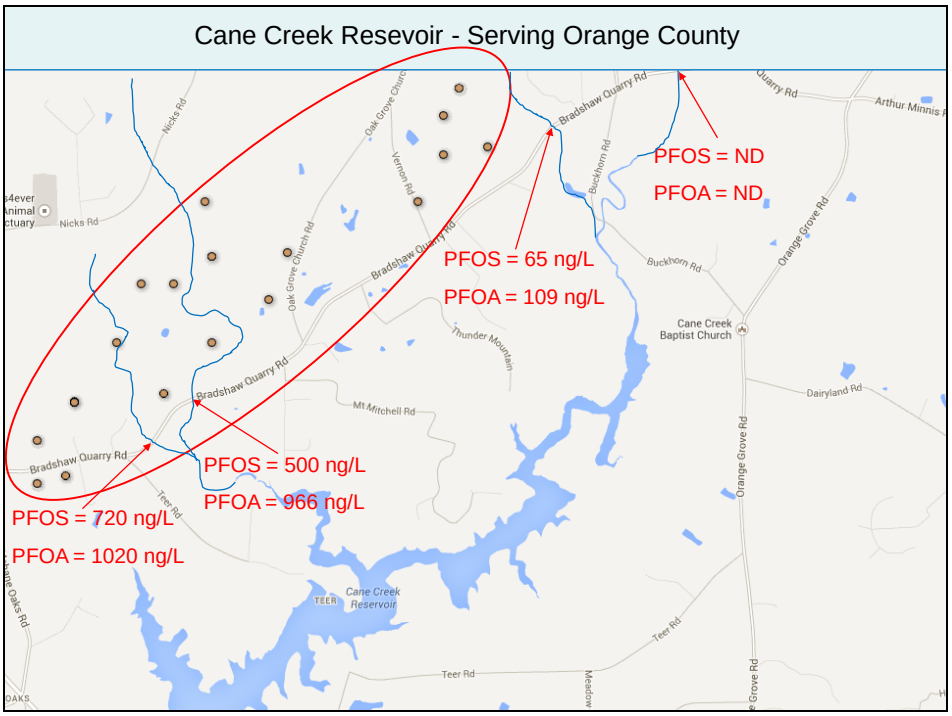


Figure 10: Brown circles indicate permitted sludge application sites. PFOS and PFOA concentrations are from water samples collected at bridge crossings over small tributaries of Cane Creek Reservoir. [24]

[22] http://www.owasa.org/Data/Sites/1/media/whatWeDo/drinking%20water/2014-test-results-summary.pdf page 16

[23] Grandjean and Budtz-Jørgensen Environmental Health 2013 http://www.ehjournal.net/content/12/1/35 ***and*** "Perfluorinated Alkyl Substances: Emerging Insights Into Health Risks" Philippe Grandjean and Richard Clapp, NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy 2015, Vol. 25(2) 147–163

[24] From "Municipal waste water treatment plant biosludge applications and perfluoroalkyl acid surface water contamination in North Carolina", (A.B. Lindstrom, M.J. Strynar, R.L. McMahen, L. McMillan, and D.R.U. Knappe) North Carolina AWWA-WEA 14th Annual Spring Conference, April 12-14, 2015 Wilmington, NC

There are a large number of these sludge fields in the Haw River watershed, where we believe the load of perfluorinated compounds may represent a public health risk to downstream drinking water users, including those in Pittsboro, and further downstream to drinking water users including Fayetteville and Wilmington. This is in addition to other chemical contaminants that have been found in the effluents from WTTPs that are released to surface waters. There also may be a risk to recreational users through dermal exposure to these chemicals. Currently, research is underway to see what the daily and accumulated load of PFCs are in the finished drinking water in the municipalities most at risk, as well as possible solutions through improved treatment methods.[25] What other chemicals are in our waters that we are not even aware of?

Catawba River Case Study #3: PCB Dumping

Figure 11: Catawba River

Two years ago, authorities in South Carolina realized that someone had been dumping PCB oil into grease traps, and the chemical had made its way into the wastewater treatment plants for Charlotte-Mecklenburg, in the Catawba River watershed. PCBs (polychlorinated biphenyls) are an industrial contaminant banned in the late 1970s. Often mixed with other chemicals, they were common in transformers (in the form of an oil) and capacitors. They are notoriously environmentally persistent and readily accumulate in river sediment and fish tissue. An arrest was eventually made, though little has been made public regarding the status of the case. Shortly

[25] EPA "Basic Information about the Unregulated Contaminant Monitoring Rule 3 (UCMR 3)" http://water.epa.gov/lawsregs/rulesregs/sdwa/ucmr/ucmr3/basicinformation.cfm

after learning about the contamination, the Charlotte-Mecklenburg Utilities Department (CMUD) started detecting PCBs in the sludge from this contaminated wastewater - sludge which was ultimately applied to agricultural fields nearby.

Figure 12: Fields after sewage sludge is land applied in South Carolina on July 31, 2015

Then, in early 2014, CMUD was hit by a major dumping incident, which was detected because of odor associated with another chemical present in the waste dumped with the PCBs. A visible sheen was observed in the influent at Mallard Creek Wastewater Treatment plant. While in this case it appears that most of the contamination was caught before the tainted sludge could be applied to local fields, disposal of the problem sludge cost CMUD, and hence taxpayers, more than $5 million. To see a video about this event go to: https://www.youtube.com/watch?v=1K8xKRrNlvg

In this case, disposal of the contaminated sludge instead of land applying it was viewed as a relatively inexpensive cost in the short term, far outweighing the potential cleanup that might have been required if it had been spread on farmland. Persistent, toxic and bioaccumulative pollutants, such as PCBs and other untested compounds that may be present in sludge must not be reintroduced to the natural environment. An excerpt from a Charlotte Observer article[26] shortly after CW's dumping incident reported"

> "Tom Reeder, director of the N.C. Division of Water Resources, said the chemicals "would have been very damaging to both the Mallard Creek Wastewater Treatment plant and the environment, had they been released."

[26] "Task force named to probe chemical dumping "Bruce Henderson, Steve Lyttle and April Bethea. Charlotte Observer, February 7, 2014. http://www.charlotteobserver.com/news/local/article9095525.html

> Amy Ringwood, an associate professor at UNC Charlotte who specializes in environmental toxicology, said PCBs, or polychlorinated biphenyls, are among the longest-lasting environmental contaminants and toxic in very low doses. "I consider PCBs to be one of our worst," Ringwood said. "To be honest, I put them with mercury."

DENR's own director recognizes how critical the PCB issue is. Other DENR departments have also recognized problems with PCBs, most notably in fish tissue. North and South Carolina have both issued fish consumption advisories throughout the Catawba and other river basins because PCB's have contaminated fish tissue to the point that it is not safe for human consumption. Given these well-documented problems, Charlotte Water must be required to test its sludge for all 209 PCB congeners and other industrial waste chemicals (including the EPA Priority Pollutants), plus those recently identified as contaminating sludge in recent investigations.

Pharmaceuticals and illicit drugs also have been identified in wastewaters and sewage sludge.[27] These highly bioactive chemicals pass through our bodies and enter the wastewater infrastructure. They may represent risks to drinking water supplies and wild life in receiving streams. The United States Geological Survey and others have performed extensive testing documenting this link. However, given the large volume of sludge produced each day and the almost infinite number of problematic contaminants that might be present, DENR should be seeking a sustainable long term solution. This long term approach should focus on three elements that have been enacted elsewhere in the developed world: 1) A strong industrial pretreatment program, shifting the burden pollution to the companies making the contaminants and the profit, 2) waste minimization and promotion of Green Chemistry[28] (the design of chemical products and processes that reduce or eliminate the generation of hazardous substances), 3) and research into incineration of sewage sludge - without creating new air pollution problems - and with safe reuse of the mineralized ash.

[27] Clarke & Smith, Review of 'emerging' organic contaminants in biosolids and assessment of international research priorities for the agricultural use of biosolids, Environment International 37 (2011) 226–247.

[28] http://www2.epa.gov/greenchemistry

Conclusion

The case studies in this report highlight only a few of the many chemicals that are released to local watersheds via land application of treated sewage sludge. But with just these three examples we have demonstrated that this practice does lead to contaminated drinking water supplies. Moreover, it is also very likely to cause contamination of agricultural products and wildlife resources. Many of the compounds in sludge are persistent and resist degradation, making it more likely that they will not be effectively removed by conventional drinking water treatment options.

Land application of sludge, as "biosolids" is being marketed to farmers as safe and free fertilizer. In reality, biosolids are a complex stew of ingredients, which includes known, but as yet uncharacterized, toxic industrial chemicals. Municipalities have a quandary in figuring out how to safely dispose of this contaminated substance. With the aid of third parties (i.e., Synagro), hired to dispose of the generated sewage sludge, municipalities have shifted liability from themselves. But in addition to the promised 'free' nitrogen and phosphorous, what other industrial chemicals, pharmaceutical and cleaning products from household use, pathogens, heavy metals and nutrients are being applied to agricultural lands, and then entering streams from stormwater runoff?

The premise stated by EPA that sewage sludge could be treated and recycled as *"biosolids which can be used as valuable fertilizer, instead of consuming space in landfills"* fails to take into account the substantial burden of toxic contaminants concentrated in sewage sludge. The permits for sludge application on farmland are for "non-discharge permits". This is untrue, as demonstrated in this report, as many pollutants are eventually discharged to local water bodies. This is a core problem, made worse by weak regulations and poor oversight, monitoring and enforcement.

Recommendations

1. Testing and Removal of Industrial and Chemical Contamination

- There needs to be a much greater effort to monitor the wide range of chemicals coming into the wastewater. DENR should require all major municipal wastewater treatment plants to test for industrial chemicals, particularly those known to be used by upstream industries. Testing should also be done on each batch of sludge for additional constituents that have been identified as contaminants.

- Industrial sources of contamination must be removed before ever reaching the wastewater treatment plants. The state needs to immediately evaluate the current system of pre-treatment and removal of industrial chemicals to understand and fix this broken system.

- Landfill leachate, including that from solid waste, coal ash and other industrial landfills, introduce variable and unpredictable toxic constituents and should not be sent to municipal wastewater treatment plants.

2. Improve Treatment and Application Standards

- Class B Biosolids must be treated to a higher standard in order to remove more contaminants, including live pathogens, heavy metals and industrial chemicals before being applied to agricultural fields.

- Stricter land application standards need to be developed, with much larger buffers from streams, residences and other buildings (schools, day care centers. elder care, etc.).

- Further studies and demonstrations are needed to examine the benefits and impacts of soil injection instead of surface application of sewage sludge, based on soil types. Likewise, more research is needed into incineration of sewage sludge (without creating new air pollution problems) and with safe reuse of the mineralized ash.

- There should be much better inspection, enforcement and record keeping for land application of WTTP sludge, and a better understanding of the cumulative amount of contaminants in the soils. No sludge should ever be applied within land that drains to water supply watersheds.

3. Local Control of Sludge Application

- There should be greater control at the local government level concerning land application of sewage sludge and its impact on both residents and the environment, including receiving streams. The NC General Assembly should pass a bill to allow local governments to set biosolids quality requirements for any sludge applied in the jurisdiction.

- Local governments should provide more information for residents concerning land application of sludge. Adjacent residents of these fields need notification of applications in order to protect themselves from air borne particulates.

4. Better Federal Policy and Oversight

- The Environmental Protection Agency should be part of the solution on this issue and immediately conduct its long delayed Biennial Review of 40 CFR Part 503, as required under the Clean Water Act Section 405(d)(2)(C).

- The review must include
    - a thorough examination of the current science about the constituents of sludge, including industrial and other contaminants, live pathogens and pharmaceuticals;
    - the impact of air pollution on neighboring properties;
    - the frequency of stormwater runoff of sludge and its constituents into nearby surface waters, and
    - impacts on groundwater; and the resulting impacts to environmental and human health.

In addition to the above recommendations there is the overarching issue about the everyday use of the tens of thousands of chemicals produced and consumed in this country. The public needs to be better informed about the true cost and risk of chemicals in household cleaners, body products, pharmaceuticals, etc., and their persistence through the wastewater cycle and back into the environment and drinking water.

These are complex problems, but ones we can no longer ignore. Federal, state and local governments must confront these issues and find better solutions to how we handle wastewater and sludge in our society. We hope the questions raised, and the information provided in this report will jumpstart further discussions - and answers - to this continuing problem.

Further Information

Waterkeepers Carolina NC Sludge Application Mapping Tool
http://www.waterkeeperscarolina.org/sludge-in-our-waters/

The mapping tool provides valuable information by documenting where sludge application permits are located in NC, in relation to streams that may be impacted by runoff from these application sites. Drinking water source intakes, and surface waters on the current 303(d) EPA Impaired Waters List are also included. You can use the map to find out where permitted sludge application sites are located in your community, and what streams may be impacted by them.

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Waterkeepers Carolina works to enhance and coordinate the impact of North Carolina's Riverkeepers, guardians of our water and health from the mountains to the sea.
www.waterkeeperscarolina.org

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