Chicken litter and arsenic

The addition of roxarsone to chicken feed has stirred up debate ever since it was revealed that this organoaesenic compound can be transformed into more toxic inorganic arsenic (Environ. Sci. Technol. 2006, 40, 2864–2865). New research published in this issue of ES&T (pp 818–823) identifies the microorganisms that are responsible for the conversion and shows that carcinogenic arsenic is formed faster and more effectively than previously thought.

Roxarsone, or 3-nitro-4-hydroxybenzene arsonic acid, is routinely used by most U.S. broiler-chicken farms as a feed additive to prevent disease and stimulate growth. Chickens primarily excrete roxarsone unchanged into their waste, which is typically applied as a fertilizer on the surrounding farmlands.

Previous research had shown that inorganic arsenic is slowly formed from roxarsone after litter composting or field application, but the responsible microorganisms or processes were not identified. John Stolz and his colleagues at Duquesne University now show that roxarsone is rapidly transformed to 3-amino-4-hydroxybenzene arsonic acid and inorganic As(V) in chicken-litter enrichments under anaerobic conditions.

The team found that bacteria of the Clostridium species are responsible for the transformation. “We see As(V) emerge in less than 10 days, which is much faster than previously observed,” says Stolz, who emphasizes that Clostridium species are indeed the dominant bacteria in chicken cecum and litter. In this way, inorganic arsenic could already be generated during manure storage, he says. The process is so efficient because the microbes gain energy from the roxarsone transformation and couple it to growth, presumably through an anaerobic respiration mechanism in which roxarsone serves as the terminal electron acceptor, Stolz explains.

“This is really elegant work that amplifies previous evidence on the environmental release of inorganic arsenic from roxarsone,” says Ellen Silbergeld of the School of Public Health at Johns Hopkins University. “I am concerned about the potential contamination of groundwater with inorganic arsenic in my local region [in Maryland], because we have a lot of poultry farms and most people here get their drinking water from groundwater,” she says.

On a broader scale, Silbergeld feels that the use of roxarsone is impeding the opportunities for alternative uses of poultry waste. “One of my students found inorganic arsenic in pelletized chicken waste that is sold as a garden fertilizer, and in this way people could get exposed to the arsenic through dust—[it’s] probably not such a good idea to use chicken waste in that way,” she adds. The coauthor of the new ES&T research, environmental chemist Partha Basu of Duquesne University, points out that a previous study found elevated arsenic levels in house dust near chicken farms (Environ. Forensics 2005, 6, 83–89).

“In my view, the real threat of arsenic mineralization from roxarsone is the buildup of inorganic arsenic in agricultural soils onto which poultry litter is applied as manure,” says Andrew Meharg of the University of Aberdeen (U.K.), an expert in the biogeochemistry of arsenic. As(V) is relatively immobile in aerobic soils and, therefore, does not pose much of a risk there at slightly elevated soil concentrations, Meharg says. However, if arsenic levels build up, a possibility exists that it could transfer into food crops, he cautions. If the soils are used for anaerobic cultivation (e.g., rice), then the risk becomes larger because of transformation of As(V) into the more mobile As(III), he adds.

“This new research should stimulate the U.S. Food and Drug Administration to reconsider their approval of the use of roxarsone,” Silbergeld says, adding that roxarsone was approved before enough was known about its environmental impact. She mentions that the EU declared the use of roxarsone undesirable in 1999 and, consequently, has abandoned its use since then.
Prions in soil

The misfolded proteins thought to be responsible for brain disorders such as bovine spongiform encephalopathy (BSE), or "mad cow" disease, can stay in soil for a long time, but whether they can still spread the diseases remains a wide-open question. A study published in this issue of *ES&T* (pp 811–817) takes another step toward recovering these so-called prions from soils and adds to previous work on how they might stay sequestered there. The next step is to see what happens when animals are exposed to the recovered prions.

The suite of brain diseases connected to prions includes scrapie in sheep, BSE in cattle, chronic wasting disease in elk and deer, and variant Creutzfeld–Jakob disease in humans. After a massive BSE outbreak in U.K. livestock that peaked in the mid-1990s (which led to fears of transmission to humans), the EU sponsored a research initiative to determine what happens to prions in soils. The ultimate objective is to find out whether the proteins, which come in several forms specific to each disease in different mammals, can cause infection after months or years of burial.

Last year, two groups published data in *ES&T* examining prions’ behavior in soils (*Environ. Sci. Technol.* 2006, 40, 1497–1503; 6324–6329). Although the proteins could be eluted from some sandy soil samples from Scotland, clays seemed to trap them. However, the solvents used in this research denatured the proteins, outside researchers note, breaking them down to the point that they were not testable for their infectivity. One team recovered the recombinant version of the protein, which folds into a slightly different form of the infective prion. Whether that form causes disease is not known. Some of that data suggested that microbial activity could

"The fact that roxarsone is still routinely used here [in the U.S.] and that they ignore that something toxic is getting into the environment is causing me a problem," says Stolz. He points to a recent report by the Institute of Agriculture and Trade Policy, a nonprofit research and advocacy organization, which notes that the uptake of part of the roxarsone into the chicken body leads to elevated arsenic concentrations in the chicken meat sold in U.S. supermarkets. "The insidious thing about arsenic is the fact that it takes people decades to develop symptoms to chronic exposure," Stolz says. "Some big U.S. companies raise chickens without using roxarsone and appear to manage," he adds.

—ANKE SCHAEFER

**Big farms have big impacts**

Farms that raise poultry, swine, and cattle at an industrial scale also have industrial kinds of environmental impacts. Newly published results from a 2004 workshop cosponsored by the U.S. National Institute of Environmental Health Sciences, address issues of such operations.

Known as concentrated animal feeding operations (CAFOs), the farms can affect air quality, contaminate local water sources, and pose risks from antibiotic-resistant bacteria. The authors forecast future problems from CAFOs and suggest solutions in an overview article and five papers published in *Environmental Health Perspectives* (2006, doi 10.1289/ehp.8831).

**Ivory Coast chemical dump cleanup**

The UN is calling for international aid to clean up hazardous waste illegally dumped in Ivory Coast last summer. In August, a European-chartered ship unloaded hundreds of metric tons of petrochemicals and related compounds into trucks that dumped the waste at sites around the city of Abidjan in the West African country. UN Environmental Programme director Achim Steiner said that UN members should assist with cleanup and enforce existing laws to prevent future dumping.

Ivory Coast hired a European company to clean up the waste at a cost that could climb as high as $30 million, according to Ivorian authorities.
break down prions.

Now, researchers led by Robert Somerville of the Institute for Animal Health and Cindy Cooke, who conducted the research while at Imperial College London and is currently at the University of Reading (U.K.), have found that the enzyme proteinase K can readily pull out the form of prions that cause scrapie (known as PrPSc) in mice from sandy soils, while keeping them almost intact. The team also found that prions remained bound up in clay soil samples for several weeks and that they needed proteinase K to pull them out.

The team’s new recovery method is “an important contribution,” considering that “currently there are only a few methods to recover [prions] from soils,” says Joel Pedersen, a soil scientist at the University of Wisconsin, Madison. Pedersen and his co-workers recently published a method in *PLoS Pathogens* (2006, doi 10.1371/journal.ppat.0020032), to recover hamster-adapted scrapie in montmorillonite, a type of clay, but the detergents the team used denatured the proteins. However, the clay-bound prions remained infectious.

The main advantage of the new method, Pedersen notes, is that it “doesn’t appear to require denaturation of the protein to extract it,” but the researchers “haven’t yet proven that the extracted proteins remain infectious.” Other researchers noted that the team did not provide enough quantitative data to compare how much protein was recovered.

The ultimate test, for now, is to take the proteins eluted from the soils and put them into animals and see what happens. But Pedersen says that “another need is more sensitive detection methods that don’t rely on animal bioassays” to see whether infectious prions are present.

—NAOMI LUBICK

**Radon guidelines miss the mark**

Silent, odorless, and colorless, radon gas in homes waits decades to kill its victims, making it an overlooked public-health risk. Now that improved detection tools and research breakthroughs have proven that low doses of radon cause lung cancer, radon-prevention techniques for homeowners have advanced to the cutting edge.

In response, Health Canada and the World Health Organization (WHO) are poised to release new voluntary guidelines to tame the problem, but experts say that mandatory changes in building codes are needed.

Canada will soon announce a new voluntary radon action guideline of 200 becquerels per cubic meter (Bq/m³), down from 800 Bq/m³ set in 1988, says Bliss Tracy, a nuclear physicist at Health Canada. A becquerel measures the rate of radioactive decay in a substance. WHO’s International Radon Project is planning to release final guidelines for testing, action, and mitigation by June 2007.

Canada’s draft guideline is in keeping with other developed countries, including the U.S., where homeowners are encouraged to reduce radon when it reaches concentrations above 150 Bq/m³. The U.S. Clean Air Act doesn’t provide the U.S. EPA with the authority to regulate indoor air, including radon in homes.

Instead, Congress directed EPA to conduct outreach and education efforts.

Radon is produced by the decay of natural uranium in rocks and soil and, depending on the underlying geology, can build up to high levels indoors when it slips through cracks and openings in foundations.

About 10% of lung-cancer deaths in Canada are due to radon, which kills more Canadians than homicide, drowning, or fires, Tracy says. More than 21,000 people die each year in the U.S. and tens of thousands perish worldwide from radon-induced lung cancer, according to EPA.

Scientists have known since the 1950s that radon, at high doses such as those found in uranium mines, causes lung cancer. But individual studies of the relatively low doses in homes have had ambiguous results, Tracy says. In 2005 and 2006, two projects in North America and Europe pooled the results of more than 20 studies and, for the first time, provided direct evidence that radon in homes causes lung cancer, says Dan Krewski, who is with the University of Ottawa and is a coauthor of one of the studies.

The studies found that long-term exposure to radon concentrations of 200 Bq/m³ doubles the risk of lung cancer for nonsmokers compared with the risk at average background levels of 10 Bq/m³. Tracy says. If levels in all homes in Canada were below 200 Bq/m³, deaths from radon would fall from 1589 to 1242 per year. Health Canada set the new guideline at 200 Bq/m³ because it fell where lung-cancer risk becomes significant.
and where mitigating homes to the standard is affordable, he adds. It can cost $2000–3000 to clear radon from an existing home. However, roughly 90% of radon-caused lung cancer cases occur from exposures to less than 200 Bq/m³, according to Sarah Darby, a medical statistician at Oxford University (U.K.). If radon were regulated like other pollutants, where an acceptable cancer risk might be 1/10,000, the guideline would be less than 40 Bq/m³, says Bill Field with the University of Iowa. Instead, the current guidelines reflect what is economically and technically feasible to achieve, he says.

Building radon-prevention measures into a new home can cost as little as $350 and bring radon levels down as low as 50 Bq/m³, Darby says. The most successful approach to the radon challenge would be to first set a strong net-risk reduction goal on the basis of the number of homes with radon concentrations above the action level, says Bill Angell, a building scientist at the University of Minnesota. Currently, more than 10 million homes in the U.S. exceed the action level. EPA is missing an important trend—that most new homes in the U.S. are built with radon problems. “There are more homes [in the U.S.] above the action level for radon than at any time in history,” Angell says. In addition to a net-risk-reduction goal, countries should adopt compulsory limits for new construction, as required in Sweden and Norway, he says.

—JANET PELLEY

**Nanomaterials meet increased scrutiny**

In a major reversal, the U.S. EPA has determined that clothes washing machines that use silver ions as a disinfectant will have to be registered as a pesticide. Until now, the agency has not regulated nanomaterials, including silver, a bioaccumulating, persistent, and toxic metal. Yet EPA’s decision may be meaningless, critics point out, because if the company deletes from its advertising the assertion that silver can kill bacteria, it won’t have to register the washer. The fact that a product can slip past the agency without being registered if the company doesn’t claim that it can kill bacteria is a “quirk” of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and “it’ll be intriguing to see where we go on this,” says Andrew Maynard, science adviser to the Project on Emerging Nanotechnologies at the Woodrow Wilson International Center for Scholars. He and others are urgently calling for research into nanotechnology’s potential environmental, health, and safety risks.

In an assessment updated in November, the project found that the number of consumer products made with nanotechnologies has increased by 70% since March 2006. The most prevalent nanomaterial being used is silver, now found in 47 products, Maynard says.

The wastewater treatment industry, in particular, has pointed out that widespread use of household products, like the washer manufactured by Samsung Electronics, that release silver ions into sanitary sewer systems could greatly increase silver concentrations in treatment-plant discharges, leading to adverse effects, such as bioaccumulation in fish and killing of aquatic life. “We think it’s great that EPA’s going to regulate” this application, says Phil Bobel, manager of environmental compliance for the city of Palo Alto, Calif., and past president of Tri-TAC, a technical advisory committee on regulatory issues affecting wastewater treatment plants in California. “Whether it’ll end up going far enough to actu-

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**News Briefs**

**Nanotubes tracked in vivo**

Tracking nanomaterials in live organisms continues to be a tricky process for researchers searching for toxicological and environmental effects of these new materials. But a team of scientists found a way to take advantage of carbon nanotubes’ seemingly ready-made tracking system, using their built-in reflectance characteristics to pinpoint the materials in live rabbits.

Chemists at Rice University and the University of Texas M. D. Anderson Cancer Center discovered in 2002 that nanotubes fluoresce, or emit light, in the near-infrared range. The team has now developed a method to locate single-walled carbon nanotubes injected into rabbits’ bloodstream with that fluorescence, rather than a tag or coating. The study was published in *Proceedings of the National Academy of Sciences* (2006, doi 10.1073/pnas.0609265103).

**International nuclear fusion plant approved**

The research program to build an experimental nuclear plant known as ITER, which stands for International Thermonuclear Experimental Reactor, has officially launched.

The experimental project will use nuclear fusion to create a contained plasma cloud of atoms heated to 100 million °C. The nuclear collisions should produce an order of magnitude more energy than is put into heating the reactor, generating about 500 megawatts of electricity for minutes at a time.

Participating parties—China, Japan, Russia, Korea, India, the U.S., and the EU—signed the ITER agreement on November 21. The project will break ground in Cadarache, France, in 2008. At a cost of more than $10 billion, of which the EU provides 45% and other parties share the remainder, the plant should be up and running by 2016.
ally keep that silver out of our systems, we don’t know.”

Advertisements by Samsung Electronics claim that nanoscale silver particles released during the wash and rinse cycles achieve 99.9% sterilization of bacteria and leave behind a residual silver coating on clothing to keep it smelling fresh for up to 30 days. Yet EPA scientists aren’t certain whether this is an advertising gimmick to sell more machines or if this is a novel material. Silver is already regulated as a pesticide in a number of products.

If Samsung submits a FIFRA registration application to EPA, the agency will determine whether and under what conditions the silver ions can be used. The company must supply scientific data to show that the use of the nanoscale silver particles won’t pose an unreasonable risk to people or the environment.

A finding by EPA that the technology involves nanomaterials could affect a wide range of consumer products, scientists say.

Previously, EPA classified the machine as a device, meaning it wasn’t subject to registration requirements under FIFRA. Concerns raised by states and various industries, however, caused the agency to reevaluate the product and determine in late November “that the silver ions are defined as pesticides, and therefore it needs to be regulated,” says Enesta Jones, an EPA spokesperson. “We don’t know if it’s a nanomaterial at this point,” but if it is, “it would be the first federal restriction on nanotechnology.”

Jones admits that if Samsung pulls pesticidal claims from its advertising, the company won’t have to register the washing machine under FIFRA, meaning it won’t supply EPA with data on the potential risks from the silver ions. Other companies have already taken note, removing statements of germ-killing capabilities in marketing their nanotech consumer products. A prime example is The Sharper Image, a company that has developed socks, slippers, and food containers embedded with silver nanoparticles, according to the Natural Resources Defense Council, an environmental group that relayed its concerns in a November letter to EPA.

“Failure to identify nanoscale pesticide ingredients should not be an excuse to circumvent the FIFRA registration requirements,” NRDC wrote. “Because of the significant potential for serious environmental harm, EPA must conduct a comprehensive assessment of all products that use nanosilver as a pesticide.”

EPA will issue a Federal Register notice in the next couple of months outlining the agency’s position, according to Jones.

—KRIS CHRISTEN

Removing nutrients and pharmaceuticals

Traditional sewage treatment plants are seen as a primary source of trace concentrations of household and industrial chemicals in rivers and streams. That’s hardly a surprise, because conventional treatment plants weren’t designed to remove drugs, cosmetics, soaps, deodorants, insect repellants, and other exotic contaminants from effluent discharged into waterways.

But tightening up current methods on nutrient pollution may be all that’s needed. Research now shows that actions taken at facilities to reduce nutrients, such as nitrogen and phosphorus, are also removing a good portion of pharmaceuticals and personal care products (PPCPs).

In one of the first U.S. studies to look at how longer solids retention times (SRTs) affect PPCP removal, researchers from MWH, an environmental engineering consulting firm, characterized the passage of various PPCPs through six treatment plants of varying sizes in California and New Mexico.

The SRT is how long a facility holds on to sludge to allow processing by microbes. The researchers found that SRTs of 5–15 days were sufficient to remove many of the 20 compounds they were targeting that are commonly detected in wastewaters and waterways.

Still, some resisted biodegradation. The most problematic compounds were fragrances, such as musk ketone and galaxolide, and trichloroethylene phosphate, a flame retardant, says Joan Oppenheimer, an environmental scientist with MWH. Oppenheimer presented her findings in October at the Water Environment Federation’s conference in Dallas, Texas.

The new research validates data from Europe, where similar studies have been conducted at the bench scale or at small full-scale treatment plants. The MWH study, by contrast, sampled large full-scale plants, which operate in major metropolitan areas, with capacities ranging from 5 to greater than 300 million gallons per day. All were conventional activated-sludge plants, the industry standard, operating at SRTs ranging between 0.5 and 30 days.

Oppenheimer and her colleagues also looked at PPCP removal through subsequent filters and disinfectants as well as newer treatment processes, such as membrane bioreactors, but for the most part they found no additional re-
moval. Reverse osmosis after regular filtration, however, did reduce all of the compounds to below detection limits.

What’s encouraging about these findings is that a push by the U.S. EPA and states “to go to increased nutrient reduction also helps this problem” of PPCPs, Oppenheimer says. No federal standards exist on nutrients, just criteria guidelines that EPA issued in 2001–2002. State regulatory agencies are supposed to either implement EPA’s criteria or develop their own, but progress has been very slow.

The significance of the MWH study is that “it was done in the U.S. with our style of operation and our contaminants and that it confirms some of the same results that have been seen in Europe,” says Rhodes Trussell, head of Trussell Technologies, Inc.

Many sewage treatment plants in the U.S. commonly operate with very low SRTs, Trussell notes. “If we make a decision as a nation that we want to maximize removal of these compounds, and there are a number of them, the science is showing that longer SRTs will be necessary,” he points out.

— KRIS CHRISTEN

## News Briefs

### Smog-creating nitrogen drops in eastern U.S.

Pollution controls on power plants appear to be working, at least with regard to emissions of nitrogen oxides (NOx) in the Ohio River valley.


Summer NOx levels have decreased across the eastern U.S. Over the Ohio River valley, where power plants dominate emissions, NOx has decreased by 40% since 1999. Urban areas of the U.S. Northeast saw smaller declines.

The authors write that further reductions in eastern U.S. NOx levels will require decreases in mobile NOx sources, such as car exhaust.

### New European pollution data

An updated version of the European Pollutant Emission Register (EPER) containing emissions data from 2004 is available online. It now holds information for the 10 new EU member states. Launched in 2004, EPER records emissions of 50 air and water pollutants produced by 12,000 industrial facilities in all EU member states and Norway in 2004 and in 2001.

Total emissions were generally higher in 2004 than in 2001. This may be because the 2004 records include data on more chemicals and facilities. Emissions of hydrogen cyanide and PAHs rose by 79% and 53%, respectively. But organic water pollutants were 11% lower, possibly because of more efficient equipment in wastewater treatment plants, according to the EPER report published by the European Commission and the European Environment Agency.

## Wind power in the backyard

Homeowners will soon be able to generate clean power in their yards while reducing electricity bills, thanks to a small, quiet, and affordable wind turbine developed by Arizona-based Southwest Windpower. The company designed the turbine in collaboration with the U.S. Department of Energy’s National Renewable Energy Laboratory, has 120 orders already, and expects to sell 1500 units later this year.

The turbine can be designed with a tower as short as 35 feet. It delivers 1.8 kilowatts of power and gives best results when installed on a property of greater than 0.5 acre with wind speeds above 10 miles per hour, the manufacturer says. The costs of the turbine plus installation fees add up to $9,000–12,000, about half the price of other similar-sized wind generators.

Trial runs show that it trims $500–800 off of an average home’s yearly electricity bills, depending on the wind speed in the area and the local price of electricity.

Company officials say the system will pay for itself in 5–12 years. States such as California and New Jersey are helping to promote backyard wind power with consumer rebates that cover half the installation cost, says Miriam Robbins, the company’s marketing manager. Plus, where possible, customers could sell any extra power they don’t use to utilities.

The key to encouraging homeowners to invest in wind energy is “getting the cost down even more through more mass-produced pieces,” Robbins says. The company is pushing for more state-sponsored rebates. But interested buyers might face additional challenges—local zoning rules that prohibit wind turbines in a backyard and municipalities that restrict the tower’s height, not to mention neighbors and bird enthusiasts who object to the sight of a turbine in their neighborhood.

—PRACHI PATEL-PREDD
Phosphorus removal: how low can we go?

Until recently, water pollution control experts thought that the limits of technology had been reached for nitrogen and phosphorus removal from sewage treatment plants. But as urban populations grow, the operators of these plants must find ways to remove higher levels of nutrients to keep waterways from becoming choked with algae.

Research now shows that treatment plants may be able to remove 99–99.9% of nutrients, particularly phosphorus. A major question about the need for these removal levels arose during the Water Environment Federation’s conference in October: does a push to 100% removal make economic sense, given that other big sources, including agricultural and urban runoff, remain virtually unregulated?

Frequently, state regulators establish total maximum daily loads, or pollution budgets for waterways, that call for values as low as 10 micrograms per liter (µg/L) of total phosphorus in the water column.

The Spokane River in Washington is a prime example. To achieve levels closer to 10 µg/L phosphorus, regulators there set an interim discharge limit for treatment plants of 50 µg/L, opting not to go lower because of concerns related to cost and technological reliability.

“Everybody agrees we can do better than 50 [µg/L], but the question is how much better,” says Richard Koch, a senior environmental engineer with Washington’s Department of Ecology.

Accommodating future population growth in the region will clearly require treatment plants to achieve ever-lower discharge limits, because as effluent concentrations go down, plants can discharge higher volumes. The 50 µg/L limit is merely “buying them time to do more research and develop better technologies,” Koch says.

Some plants around the country have achieved levels just under 10 µg/L, but those levels aren’t always met, notes Glen Daigger with CH2M Hill, an environmental engineering firm. Others with similar treatment technologies haven’t. “This is still evolving science, and it gets down to better understanding the mechanisms of phosphorus removal at these very low levels,” Daigger says. Research is starting to suggest that there might not be a scientific limit to removal in terms of effluent concentration, he adds.

Few plants have to remove phosphorus to such low levels, but it is possible and “people want to position themselves” in case the need to reduce more phosphorus arises, says James Barnard with Black & Veatch, an environmental engineering firm. The U.S. EPA issued guidance in 2001–2002 to help states set nutrient criteria for different ecoregions and water body types. The phosphorus levels vary by region and water body.

EPA recently completed a national survey of treatment plants that can remove phosphorus to extremely low levels, and officials planned to release the findings in December 2006, says Dave Ragsdale with EPA’s Region 10 office.

One utility at the cutting edge of phosphorus removal is Clark County Water Reclamation District, a 110 million gallon per day plant serving Las Vegas, Nev. Using biological treatment with chemicals applied at the end of the treatment cycle, operators have achieved an average of less than 80 µg/L total phosphorus and less than 20 µg/L orthophosphorus over a year, says Doug Drury, deputy manager of operations. The plant can get very low phosphorus levels using fewer chemicals than any other plant.

The facility’s current permit lists a waste load allocation of 171 pounds per day of total phosphorus, which translates to about 200 µg/L.

However, with Las Vegas’s population increasing by about 5% annually over the past several years and showing no signs of slowing, plant operators are already making adjustments. By replacing sand filters with ultra-filtration/micro-filtration membranes in any treatment-plant expansion, they expect to achieve annual averages of 20 µg/L total phosphorus.

The plant discharges into Lake Mead, Nev., the drinking water source for a multistate area from Las Vegas to Los Angeles. Because of an ongoing drought, lake levels have declined, and regulators say that if the lake goes down even more, they’re going to change the permit limits, Drury notes. “All of these things combined are telling us we’re going to have to do better than we are today.”

Because it doesn’t rain much in the Las Vegas area, runoff from lawns and streets is scarce, so most of the water flowing into that arm of Lake Mead is wastewater, Barnard says. Consequently, treatment plants “can really make a difference by going down to these extremely low levels.”

Along parts of the wetter East Coast, it’s a different story. Maryland, for example, recently set a maximum of 300 µg/L, which is considered the limit of technology when economics are factored in, Daigger notes. Generally, “it’ll take both point-source and nonpoint-source controls to reach these very low ambient concentrations” that EPA’s nutrient criteria are calling for, he adds.

—Kris Christen
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