A federal court in Yakima, WA, ruled in January 2015 that a dairy farm is liable for over-application of nutrients that impacted groundwater quality with nitrate pollution. This new case law puts a heightened emphasis on both developing and carefully following formal nutrient management plans. Most biosolids are applied in accordance with such plans for nitrogen. But the question can be much more complicated when phosphorus (P) is simultaneously managed.

The court’s ruling in Washington raises the question of how balanced a recycled soil amendment (manure or biosolids) must be. In the future, might excess P in applied manure that negatively impacts surface water be the subject of a lawsuit? Could biosolids be a target of similar action?

Biosolids inherently contain phosphorus. When applied to farmlands to meet crop nitrogen (N) requirements, biosolids deliver more P than needed for crop growth. Over years of repeated biosolids use, P loadings to the soil increase and soil test reports may register high or extreme levels.

Is this a problem for the environment or for regulatory compliance? Yes, and no, depending on your state and the type of biosolids produced. Some states are moving to regulating farmland and residential fertilizer use to ensure that soil P levels are not allowed to reach high levels.

The Massachusetts Case – Regulatory Conflicts

An example of just such a state is Massachusetts. In 2014, the Massachusetts Department of Agricultural Resources (MDAR) proposed a new fertilizer nutrient management regulation on the basis of a law passed by the Legislature in 2012. That law required MDAR to adopt regulations that would reduce non-point P sources in order to “maximize the credits relative to storm water discharge or similar permits issued by the United States Environmental Protection Agency (EPA).” The MDAR promulgated regulations for fertilization of turf starting June 5, 2015. Agricultural parts of the regulation went into effect in December 2015.

The scope of MDAR regulatory control over fertilizer-borne P, including and especially biosolids and biosolids-derived products, is enormous. MDAR has provided a fact sheet that cuts through any uncertainties:

“In general these regulations impact anyone who applies plant nutrients (including commercial fertilizer and various other plant nutrient materials) to both agricultural and non-agricultural land (lawns and turf). ... Phosphorus containing fertilizer may only be applied when a soil test indicates that it is needed or when a lawn is being established, patch ed or renovated.” (MDAR, 2016)

Further:

“In determining the amounts of phosphorus and nitrogen that may be applied, the amount known to have been applied with organic plant nutrient sources (such as natural organic fertilizer, compost, and biosolids) should be accounted for,” and “[t]he amount of phosphorus applied with organic sources shall not exceed the maintenance phosphorus rates for turf as specified in the UMass Guidelines. Soil testing provides the most accurate method for determining the phosphorus requirements.” (MDAR, 2016)

Unlike New Jersey and Virginia, in which biosolids advocates were closely involved in developing turfgrass phosphorus regulations, Massachusetts has no breaks for naturally-sourced organic fertilizers. It offers no waivers for composts or for heat-dried pellets. Massachusetts regulations impact residential turf and they impact farmers. You can apply P only to newly-established lawns and to soils shown by soil test to be deficient in P.

The strange irony of the Massachusetts situation is that this state holds a leading position in commanding diversion of organics away from landfills. The presumption is that digesters and composters will fill the management need. But the contrary regulatory system for P erects incredible hurdles to the recycling of processed organics, now requiring additional testing, nutrient planning (a nutrient management plan is required if the application site is greater than 10 acres), and application best management practices.
Scientific Understanding of Phosphorus Mobility in the Environment

To make matters worse, many scientists believe Massachusetts regulations are not based on sound science. Tests of P concentrations in biosolids and in soils very poorly predict risks to the environment relative to P release and mobility. Scientists have shown that an abundance of Fe, Al, and Ca in the soil bind a great deal of P added as fertilizer, holding P strongly in mineral form and making it environmentally unavailable for surface water eutrophication. What is more, the P borne in biosolids is held tightly in a mineral and organic matrix, and when the properties of the P are measured with a test of “water extractability,” most of the P stays undissolved. Using this test, when compared with commercial fertilizers, biosolids P solubility is merely 40 percent of that in commercial fertilizers (Sullivan, Cogger and Bary, 2015). What is relevant is not the total concentration of P in soil and organic matter, but rather that portion of the P that is water soluble. A water extractable test for P has been tested extensively and in some states has replaced a Total P test for environmentally available P. Massachusetts is not one of those states. Neither is New York.

Phosphorus regulations in Pennsylvania, Ohio, and New Hampshire, for example, are not a threat to organics recycling. These states take into account the P “source coefficient,” meaning approximately the proportion of total P that is prone to dissolving in water. Some biosolids products, such as those produced by the Biological Nutrient Removal (BNR) Process, and biosolids generated without iron and/or lime, have a greater coefficient, and have been shown to increase the more labile forms of soil P over time when applied repeatedly. Many forms of biosolids contain abundant iron, aluminum, and/or calcium and tend to have favorably low coefficients. In fact, multiple studies have found that the added iron and aluminum found in biosolids can significantly mitigate potential for P losses in runoff and via leaching, especially if applied to soils with high P saturation. Most heat-dried biosolids fertilizers measure in the very lowest category of P availability in the “source coefficient”. The phosphorus regulatory approaches of Pennsylvania, Ohio and New Hampshire would not raise the barrier to local recycling outlets of Massachusetts if the state adopted this approach.

Also an irony in Massachusetts’ regulatory approach is that organic residuals provide a suite of benefits to soil and plant growth that promote healthy environments and are sought by landowners for the benefits to plant and crop growth. Sustainable management of organic wastes will only be possible if there are vibrant markets and customer demand for the end products; meaning that the demand for organic-based soil products helps pull organic wastes out of landfills. A stiff rule on P stymies the growth of markets for organic-waste based fertilizers that are so helpful in keeping organics out of landfills.

Today, in New York State, regulatory initiatives have targeted chemical fertilizers used to grow turf, both residential and commercial. Regulations don’t extend to composts or digestates, and regulations don’t apply to commercial farming. Biosolids still have a place in New York State as an ingredient in soil amendments or for direct application to farms. But the regulatory approach in Massachusetts seems to have its champions, and the waste-water community is advised to monitor changes to statutes and guidance.

Managing for Phosphorus in Biosolids

In the meantime, there are multiple steps that can be used wisely to improve the environmental impacts of phosphorus in biosolids, and, in turn, provide argument against regulatory initiatives banning biosolids as a fertilizer. This would include matching the biosolids application rate with the crop’s P needs, and supplement with the addition of N and potassium (K). However, when biosolids are applied to meet one year’s P crop need, the application rate is very low and may be difficult to accomplish due to limitations of spreading equipment. A more suitable and realistic method is to land-apply on a 3- to 5-year cycle based on the N application rate, and allow other fertilizers to be applied in off years. The applications can be better managed under this approach, and additional fertilizer applications are not necessary during biosolids application years. Also, farmers are accustomed to having the N need of the crop satisfied from biosolids applications. Soil P levels may continue to increase slightly over time using this method, but at a slower and more acceptable rate.

Another method to reduce the potential of the environmental impacts of biosolids P includes technology being developed for use in facilities that include anaerobic digestion to extract phosphorus from the wastewater stream as it passes through treatment processes. The genesis of this technology is for control over the damaging deposition of a crystalline mineral called struvite (highly concentrated phosphorus, ammonium, and magnesium) on pipes and pumps within the plant that can substantially reduce flow capacities and increase maintenance requirements. One company that has gained traction in the industry is Ostara, which operates a controlled precipitation of struvite granules, typically extracted from the liquid discharge of dewatering equipment. The result is a “mining” of P from wastewater, to generate a commercially-desirable slow release fertilizer with a formulation of phosphate-P (12.7 percent) and ammonia-N (5.7 percent). The main payback for a wastewater plant is avoiding unintended struvite deposits within the treatment plant equipment.

The wastewater industry is in the early stages of seeing a variety of P extraction technologies being developed. One option precipitates and separates a calcium phosphate salt. One provides a technology for production of a saleable mineral product, others produce a residual liquid that can be hauled away economically. The promise that is ahead is the refinement of a P extraction system that enables wastewater operators to “dial-in” the ratio of nitrogen to phosphorus of greatest value to the users receiving the biosolids.

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