REMEDIATION TECHNIQUES FOR MANURE NUTRIENT LOADED SOILS. An Animal Waste Management white paper. 32 pages. National Center for Manure and Animal Waste Management, Raleigh, NC. 2002.

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Challenges in animal manure management intensify when animal production shifts from a pastoral setting to a highly concentrated and confined environment. Large volumes of nutrients in feeds are imported to a relatively small land area, creating an imbalance in nutrient distribution. Most of the manure is applied to lands in the immediate vicinity of the animal feeding operations because of the high cost of transporting such material away to more distant locations for redistribution. Many agricultural fields in the United States are loaded with nutrients. The runoff and eroded soils from those fields carry soluble and particulate nutrients to water bodies even if no additional manure is applied. The N to P ratio in manure is much narrower than the ratio needed by crops. With the widely used practice of land application based on n requirements of the crops, the imbalance results in the unintended high loading of p, and in many cases, metals used in livestock feed mineral supplements or antibacterial agents. Thus, repeated land application of manure may saturate the soil's capacity to retain manure p and commonly resulted in excessive p concentrations in soils. Elevated trace minerals are found in manured soils as mineral supplements, routinely added to livestock feeds to minimize potential deficiency or suppress disease are excreted in urine and feces. Sediment-associated and dissolved nutrients in runoff water from manure nutrient-loaded soils can impair water quality in watersheds. Nutrient-loaded soils also degrade air quality by contributing malodorous compounds, greenhouse gases, and dust particles of 10 microns or less. The purpose of this white paper is to highlight current techniques to remove nutrients from nutrient loaded soils and strategies to reduce nutrient loss from manured fields to surface water bodies. Future research to prevent nutrient from buildup and to reduce nutrient loss from fields containing excessive levels of nutrients, especially phosphorus, is also discussed.

Available technologies to remediate soil containing excessive levels of manure nutrients and metals are grouped remedial techniques in two broad categories to include: (i) techniques and strategies to lower nutrient levels in the soil, and (ii) methods and technologies to reduce edge of field losses of sediments and nutrient in runoff water. Novel plants as bioaccumulators and alternative cropping systems that include these species offer promising avenues to lower soil levels of manure n, p, and metals. Dramatic improvement in identifying superior accumulators is needed while the use of high dry matter yielding forage crops provide an immediate means to lower nutrient

concentrations in problem fields. Nutrient concentrations can also be lowered by mixing chemical amendments such as water-treatment residuals, coal-combustion by-products, or other non-hazardous aluminum-, iron-, or calcium-rich industrial by-products to immobilize excess nutrients, by forming insoluble metals or phosphates. Organic polymers in combination with p-immobilizing agents also offer the means to concentrate and aggregate suspended sediments and thereby, sediment-associated nutrients. Residue management and conservation tillage systems are efficient BMPs to reduce raindrop impact, soil detachment, and runoff water velocity to reduce particulate nutrient export from nutrient-loaded soils. In addition, conservation buffers such as riparian strips, grass waterways, living vegetative fences when strategically placed in a problem field or threatened watershed, can effectively modify runoff water velocity to control particulate offsite losses. Dilution by deep profile modification is a short-term solution to nutrient-loaded soils. Supplemental conservation practices should be considered concurrently to deep profile modification to control the greater potential for erosion losses. All in all, remedial techniques exist to lower the environmental risks of nutrient-loaded soils. There are also emerging technologies for nutrient immobilization such as vitrification and nutrient recovery that are at the research and exploratory stages. Should the novel approaches lead to promising solutions, we can anticipate more intense development effort and creativity to return nutrient-loaded soils to a more sustainable and productive status. Additional remediation research and development areas exist. Clearly, single solutions are not going to be effective in alleviating the problems of manure management given the scope of the problem. Integrated solutions are needed for managing excess manure nutrients found in soils that have received repeated applications of manure across very diverse physiographic and climatic zones.