Appendix B
USMP Model

The USMP model accounts for production of major crops (corn, soybeans, sorghum, oats, barley, wheat, cotton, rice, hay, and silage) and confined animals (beef, dairy, swine, and poultry), comprising approximately 75 percent of crop production and more than 90 percent of livestock and poultry production in the United States. USMP is a comparative-static, spatial, and market equilibrium model that incorporates agricultural commodity, supply, demand, environmental impacts, and policy measures. The model permits agricultural sectors to adjust to nutrient standards for air and water by substituting across space, production activities, and cropping and tillage practices with varying input requirements.

Crop and animal production choices are linked to edge-of-field environmental variables using the Environmental Policy Integrated Climate Model (EPIC), which uses a daily time step to simulate weather, hydrology, soil temperature, erosion-sedimentation, nutrient cycling, tillage, crop management and growth, and pesticide movements to the field's edge (Mitchell et al., 1998). The transport of nutrients, pesticides, and sediment across the landscape is calibrated to USGS estimates of regional pollutant loads (Smith, Schwartz, and Alexander, 1997).

Estimates of CAFO and AFO spreading practices on hog operations taken from Ribaudo, Gollehon, and Agapoff (2003) allow us to account for prior land application of manure in the simulations. Accordingly, CAFOs are assumed to spread manure on the nearest 155 acres and the smaller AFOs are assumed to spread manure on the nearest 90 acres. While these numbers are not necessarily representative of the range of production conditions across the Nation, we feel that these are reasonable for initial estimates of the environmental effects of excess manure application at the Farm Production Region scale. The above levels provide a lower bound on the estimated costs from meeting nutrient standards since many livestock facilities have little or no land on which to spread manure (Kaplan, Johansson, and Peters, 2004). Given the acres currently receiving manure nutrients, we calculate the quantity of manure nutrients in excess of the crop requirements on those acres. These excess nutrients are subject to leaching, runoff, and volatilization, similar to commercial fertilizers.

Manure transportation costs are determined using the Fleming et al. (1998) formulation in conjunction with regional and species-specific cost coefficients from the literature (Borton et al., 1995; Pease et al., 2001). The costs to develop a nutrient management plan, and to test periodically for manure nutrient composition and soil nutrient content are also included using USDA estimates (USDA, NRCS, 2003). Current market values for commercial nitrogen and phosphorus are used to calculate the savings from substituting manure nutrients for commercial fertilizers. The costs of using manure nutrients (testing, transporting, and applying) as fertilizers are covered by the livestock sectors. The savings in forgone commercial nutrient purchases by cropping enterprises are included in the returns to crop production.