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Retrospective modeling of potential residential exposure to perfluorooctanic acid (PFOA) releases from a manufacturing facility

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A retrospective exposure analysis using various environmental models was conducted to estimate potential intake of perfluorooctanoic acid (PFOA) over the past 53 years by persons residing in parts of Ohio and West Virginia. PFOA has been detected in the public water supplies of water districts near Washington, WV and has been attributed to emissions from a local fluoropolymer manufacturing facility which has operated since 1951. A processing aid, ammonium perfluorooctanoate (APFO), was used in the manufacture of the fluoropolymers and released to the environment in air, water and solid waste emissions. In the environment, APFO disassociates to its anion form which is referred to as PFOA. Following considerable analyses, it was concluded that particulate deposition from facility air emissions to soil and the subsequent transfer of the chemical through the soil was the most likely source of the PFOA detected in the groundwater. For some water districts, releases to the Ohio River also served as a partial source of PFOA to the groundwater. A mass balance analysis of APFO used and released by the facility for each year of operation from 1951-2003 was the foundation of this analysis. Air emissions and deposition rates were modeled using EPA's ISCST3 model. Air deposition rates were then used as continuous input into the PRZM-3 model to estimate the PFOA concentrations in surface soil and the movement of the chemical to the groundwater. Estimates of the intake of PFOA by residents were model estimated for each water district for all relevant routes of exposure. Exposures were modeled for a 185 square mile area surrounding the facility. The highest off-site environmental concentrations were predicted to occur about 1 mile away. For this 1 square mile area, during the time period 1951 -2003, the model estimated air concentration was $0.2 \mu\text{g}/\text{m}^3$ (range = 0.00007 to $0.4 \mu\text{g}/\text{m}^3$), the estimated surface soil concentration was $11 \mu\text{g}/\text{kg}$ (range = 0.001 to $30 \mu\text{g}/\text{kg}$), and the estimated drinking water concentration was $3 \mu\text{g}/\text{L}$ (range = 0 to $14 \mu\text{g}/\text{L}$). Similar data were generated for each of the other 18 areas around the facility. Comparison of the data on the actual concentrations of PFOA in groundwater in the various water districts indicated that the models over predicted recent groundwater concentrations by factor of 3 to 5. The predicted historical lifetime and average daily estimates of PFOA intake by persons who lived within 5 miles of the plant over the past fifty years (since the plant began operation) were about 10,000 fold less than the doses that were considered acceptable by a science advisory panel which was convened to identify public health risk criteria. To our knowledge, this is the first case study where air deposition of an organic chemical from an industrial facility impacted groundwater which served as a source of public drinking water. The methodology for exposure assessment used here may well be applicable to other water soluble, persistent chemicals emitted to the air.