

because sewage sludge disposed in such an impoundment is likely to have the greatest potential to cause groundwater contamination of the various surface disposal configurations. For the sewage sludge lagoon scenario, EPA assumed that sewage sludge is managed in a lagoon or surface impoundment that holds the sludge for disposal. For this hazard assessment, the lagoon modeled was a non-aerated surface impoundment. Exposure to pollutants via sewage sludge in lagoons occurs through the drinking water and ambient air. We assumed that no food chain exposures occur from sewage sludge in this surface lagoon scenario because EPA has no data indicating that food is grown or raised in close proximity to surface disposal units. The surface impoundment was assumed to operate for 50 years (*i.e.*, sewage sludge is surface-disposed in the lagoon over that time period) after which it was closed. Surface impoundments were modeled based on a nationally representative sample of non-aerated, non-hazardous waste surface impoundments. See appendix A of the TBD (USEPA, 2003b).

It was assumed that these impoundments are located in a rural industrial setting where residents live within a distribution of distances relatively close to the lagoon, where they might be exposed to ambient air contaminated by sludge pollutants and where they might ingest drinking water from residential groundwater wells. These modeled residents also use their residential wells as a source of drinking water and for other household uses, such as showering. More details of the sewage sludge lagoon screening assessment are available in the TBD (USEPA 2003b).

2. Land Application Scenario

For the agricultural land application scenario, EPA assumed that sewage sludge is applied to both pastureland and cropland that are used to raise food for human consumption. The farmer was assumed to apply sewage sludge to pastureland and cropland at the appropriate agronomic rates. For this exposure and hazard screening assessment, the following assumptions were used to reflect a distribution of typical agricultural practices common throughout the United States:

- Sewage sludge is applied at a rate of 5 to 10 metric tons per hectare per application (uniform distribution).
- Applications occur once every 2 years.
- Applications are limited to a maximum of 40 years (20 applications).

- Cropland is tilled to a depth of 20 cm at application and at two additional times during the year.

- Pastureland is not tilled, but the sludge is assumed incorporated to a depth of 2 cm by bioturbation.

Application to both row crops and pasture includes runoff into two water-bodies types. The first is an "index reservoir" using the Shipman City Lake in Shipman, Indiana as a model for drinking water exposures. This reservoir covers 13 acres, is 9 ft deep, and has a watershed area of 427 acres. The ratio of drainage area to capacity (volume of water in the lake) is approximately 12 for the index reservoir in this assessment. These areas remain constant in this assessment, and the same index reservoir was assumed to occur in each of the 41 climate regions. Also, in the screening assessment, it was assumed that the 427-acre watershed area contains other farms that also apply sewage sludge occupying 10 to 80 percent of the watershed in aggregate (in addition to the modeled farm).

The second water-body type is a farm pond and was used to evaluate ecological exposure, and human exposure from fish consumption. It was assumed that the pond had the farm area as its total drainage basin and to have a drainage area to capacity ratio of five. The farm pond depth is assumed to be constant at 9 feet. The area of the pond is proportional to the area of the farm. EPA also assumed that there is no buffer between the amended agricultural land and the farm pond; thus, EPA assumes that the erosion and runoff from the agricultural land go directly to the farm pond. Additional details of the screening assessment for the land application scenario are available in the TBD (USEPA 2003b).

3. Sewage Sludge Incinerator Scenario

For the sewage sludge incinerator scenario, EPA assumed that the modeled receptor resides and inhales ambient air in the shadow of a sewage sludge incinerator's emissions plume. To estimate maximum exposure to ground-level concentrations of pollutants to which the modeled individual would be exposed, we used the following parameters in exposure modeling:

- Sewage sludge feed rate (SF) in the units of dry metric tons of sewage sludge fed into the incinerator per second.
- An emission factor (EF) in the units of grams of pollutant emitted at the incinerator stack per dry metric ton of sewage sludge fed into the incinerator.
- A dispersion factor (DF) obtained by air modeling in the units of

micrograms of pollutant per cubic meter of ambient air at ground level per grams of pollutant emitted at the incinerator stack per second.

Multiplication of these three factors together yields an estimated maximum ground level concentration of a pollutant in units of micrograms of pollutant per cubic meter of ambient air. Additional details of the screening assessment for the incinerator scenario are available in the incineration pathway analysis (USEPA 2003c).

B. Receptors

The exposure pathways by which humans and ecological species (*i.e.*, those humans and wildlife that are exposed to components in sewage sludge) for the three sewage sludge management practices are described in the TBD, section 1.7. In summary, families living near sewage sludge incinerators and sewage sludge lagoons, as well as farm families consuming food produced on sewage sludge-amended soil, were considered the affected populations in this exposure screening assessment. Ecological receptors were assessed for exposure to contaminated habitat, food and feed following agricultural land application of sewage sludge.

For the agricultural land application scenario, human members of the subpopulation defined as subject to reasonable maximum exposure (RME) are members of a farm family assumed to live on a farm and consume farm-raised foods where land-applied sewage sludge is used as fertilizer or a soil amendment. These individuals are more highly exposed to sewage sludge than the general population. Much of the information for the RME for the agricultural land application scenario comes from the EPA Exposure Factors Handbook, a peer-reviewed source of data for use in risk assessments (USEPA, 1997). A higher percentage of the farm family's diet consists of food grown on sewage sludge-amended soil. EPA assumed that adults and children on the farm consume fish caught from a nearby waterbody (a pond) and that the farm family also raised a significant portion of its fruit and vegetable diet on sewage sludge amended soils. In addition, the farm family is exposed through drinking water or showering in either untreated surface water from an index reservoir or groundwater from a residential well.

For the incineration scenario, EPA defined RME as exposure to a rural family living in proximity to a sewage sludge incinerator. These individuals were assumed to be exposed by direct inhalation of emissions from a sewage sludge incinerator.