

receives runoff from a sewage sludge-amended field. Table 4 shows the affected wildlife and exposure pathways in the ecological screening assessment. It was assumed that exposure concentrations in sediment and soil were the maximum annual average modeled concentrations. For exposure

through surface water contact, exposure concentrations were calculated to match benchmark exposure durations. For example, if the benchmark for aquatic organisms was derived from a toxicological study in which fish were exposed to the contaminant for 96 hours, then the 4-day (96-hour)

maximum modeled concentration was selected as the exposure concentration. For chronic benchmarks intended to reflect long-term or lifetime exposure, the maximum annual concentration was used in the assessment.

TABLE 4.—EXPOSURE PATHWAYS FOR WILDLIFE SPECIES

Receptor	Direct contact	Direct contact medium	Ingestion
Fish	x	Surface water (farm pond) .....	.....
Aquatic Invertebrates	x	Surface water (farm pond) .....	.....
Aquatic Plants	x	Surface water (farm pond) .....	.....
Amphibians	x	Surface water (farm pond) .....	.....
Aquatic Community	x	Surface water (farm pond) .....	.....
Sediment Biota	x	Sediment (farm pond) .....	.....
Soil Invertebrates	x	Soil (agricultural field) .....	.....
Mammals .....	.....	.....	x
Birds .....	.....	.....	x

The exposure dose of the ingestion pathway for terrestrial and aquatic species was calculated as a function of the combination of concentrations in each receptor's diet items and receptor-specific ingestion rates, body weight, and bioconcentration factors. The dietary compositions were based on species-specific data on foraging and feeding behavior and reflected a year-round adult diet. Diet items were grouped by category, including different types of vegetation (e.g., fruits, forage, grain, roots) and several types of prey (e.g., small birds, small mammals, invertebrates, fish).

Each species' diet was modeled using the midpoint of dietary percentages for each diet item, beginning with the item with highest midpoint value and proceeding through the diet items until a full diet (100 percent) was accumulated. In this example, a robin's diet would consist of 50.5 percent soil invertebrates and 49.5 percent fruits.

The species-specific exposure factors (ingestion rates and body weights) were taken from EPA's Wildlife Exposure Factors Handbook (USEPA, 1993) and are presented in the Technical Background Document (USEPA, 2003b).

D. Screening Criteria Development

1. Human Health Benchmarks

As indicated in the data collection and evaluation steps, we used in the screening assessment human toxicity values (or HHBs) that are available in EPA's IRIS, RED, or IRED. These toxicity values include chronic reference doses (RfDs), chronic population adjusted doses, inhalation reference concentrations (RfCs), oral cancer slope factors, air unit risk factors, and oral doses and air concentrations at specified

cancer risk levels. The HHBs used in this assessment are critical doses for ingestion pathways or critical concentrations used as an air pathway criterion. For air exposures to pollutants, the critical concentration is the lower value of the RfC or concentrations in air associated with an excess cancer risk of E-5 (1 in 100,000), based on the air unit risk factor. For ingestion, the critical dose is the lower of the RfD, population adjusted dose, or dose for an excess cancer risk of E-5, based on oral cancer slope factor over a lifetime.

2. Ecological Benchmarks

The benchmarks used for ecological hazard assessment are effects or toxicity values expressed in terms of media concentration (e.g., mg/l for surface water or mg/kg for soil) for the direct contact pathway and in terms of dose (mg/kg-d) for the ingestion pathway. Because there is no single repository for EPA-approved ecological benchmarks analogous to EPA's IRIS or OPP RED and IRED documents, ecological benchmarks from EPA, other government reports, and from toxicological studies in the published literature were considered for the ecological screening assessment. General criteria for selecting ecological benchmarks, as well as a hierarchy of data sources, used in the screening assessment are included in Appendix P of the TBD (USEPA 2003b).

The ecological hazard screening assessment addresses the potential for adverse effects to terrestrial and aquatic wildlife, which EPA believes are the receptors which are anticipated to experience the highest exposure to pollutants in sewage sludge. The

potential for pollutants to bioaccumulate in wildlife receptors is specifically addressed through the assessment of the ingestion pathway. The assessment includes receptors exposed through ingestion of both aquatic and terrestrial food items and thus addresses the potential for bioaccumulation of pollutants from soil, surface water, and sediment.

3. Hazard Characterization

The potential hazard to human and ecological receptors is expressed in terms of hazard quotients (HQs). An HQ equal to or greater than one indicates a potential for adverse effects to occur and the need to conduct a more detailed or refined risk assessment and risk characterization. For chemicals with a human health benchmark (HHB) for ingestion, the results of the screening assessment are a ratio of the estimated average daily dose or lifetime average daily dose to a critical dose for each pollutant. For chemicals with an HHB for inhalation, the average daily air concentration is compared with the critical concentration for these pollutants. If either of these ratios exceeds one at the 95th exposure percentile, the pollutant fails the screen.

A similar comparison is performed for ecological benchmarks. If the HQs equal or exceed one for any pollutant, that pollutant also fails the screen. For the direct exposure pathway, HQs are calculated as the ratio of the exposure concentration to the relevant toxicity value. For example, we calculate the HQ for fish as the ratio of the surface water concentration to the fish 96-hour toxicity value. For the ingestion pathway, HQs are the ratio of the exposure dose to the relevant