Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health

PREFACE

In 1996, the CCME released "A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines" (CCME 1996), followed in March 1997 by "Recommended Canadian Soil Quality Guidelines" (CCME 1997), which contained soil quality guidelines for 20 substances and four types of land uses derived using the protocol. The 1997 guidelines were intended to replace, for these 20 substances, the interim criteria that were in "Interim Canadian Quality Criteria for Contaminated Sites" (CCME 1991). The CCME's Soil Quality Guidelines Task Group (SQGTG) approved the aforementioned 1996 and 1997 publications for release as working documents to be tested through application and to be commented on by users. Comments and opinions from users have been received and have generated discussions that led to the improvement of these documents and to the release of this chapter with the soil quality guidelines found herein. This preface presents a synthesis of the comments and opinions received while addressing them by presenting a critical overview of the soil quality guideline derivation process and guidance for application of the resulting CCME soil quality guidelines.

Generic Parameter Values

The guideline derivation procedure described in the soil protocol relies mainly on single point estimates, generally a mean or a logarithmic mean value, to represent the generic value used for variables such as body weight, daily food intake, background concentration, etc. The decision of the SQGTG to rely primarily on single point estimates in the derivation of generic guidelines was made so as to introduce a simple, transparent, and consistent procedure through which generic soil quality guidelines can be developed based on the available scientific data applied to generic assumptions. The transparency of this process could be curtailed by the use of distributions since, for example, modifying the shape of the distribution can have a very significant impact on the final result and yet remain unnoticed by inexperienced readers. However, probability distribution and stochastic assessments are presently, and will continue to be, used where appropriate, e.g., for vapour and solute transport models.

The CCME soil quality guidelines are derived to approximate a "no- to low-" effect level (or threshold level) based only on toxicological information and other scientific data (fate, behaviour, etc.) without considering socioeconomic, technological, or political factors. CCME soil quality guidelines are not intended to represent the ecosystem sustainability breaking point, in exceedence of which sustainability is compromised. Nonscientific factors (socioeconomic, technological, or political) are to be considered by site managers on a site-specific level as part of the risk management process. It is the opinion of the SQGTG that adequate, long-term risk management can only be achieved if science-based levels, unbiased by other factors, have been established.

Indirect Soil Contaminant Exposure and Other Check Mechanisms

The soil protocol includes calculation procedures for various check mechanisms intended to serve as additional protection tools to fine-tune the generic guidelines and allow their application to a broader range of sites with different exposure pathways or physical conditions. The models adopted by the SQGTG to calculate these checks values are simple, but are believed to serve the purpose for which they were developed, which is to approximate a "no- to low-" effect level for the protection of human health and all ecological receptors.

The check mechanisms are intended to provide confirmation that the soil quality guidelines based on direct contact, ingestion, and inhalation toxicity data are protective of receptors exposed indirectly to contaminants. In cases where the check mechanisms reveal that the direct contact/ingestion-based guidelines are not sufficiently protective of the potential receptors, the guideline is adjusted using the information outlined by the check mechanism. This does not imply that checks that yield a lower value than the direct contact/ ingestion/inhalation calculations automatically drive the guideline. For example, when the nutrient and energy cycling check, which is part of the direct contact calculation process, yields a value lower than that of the preliminary direct contact value, the geometric mean

between these two values is taken as the direct soil contact guideline. Also, the environmental groundwater check for the protection of aquatic life is generally calculated, but is often not considered in the final environmental soil quality guideline derivation. It is allowed to drive the generic guideline only in the case of hydrophilic compounds (high lixiviation potential and low soil retention capacity) where there is greater concern for groundwater than for soil. In other cases, its integration to the final environmental soil quality guideline must be addressed on a site-specific basis. The calculation of a soil quality guideline based on direct contact, ingestion, and inhalation toxicity data is fundamental to the derivation of a final environmental soil quality guideline or a final human health soil quality guideline and cannot be overlooked (see CCME 1996, Part B, Section 8, and Part C, Section 6).

To confirm appropriateness of the final recommended soil quality guidelines, the soil quality guidelines should also be compared, on a site-specific basis, to an acceptable geological background soil concentration to ensure that the final value is not below natural background levels. Where the soil quality guideline is below the accepted geological background soil concentration, the SQGTG recommends a thorough review of any exposure and effects literature pertaining to upper range concentrations. Depending on the outcome of such a review, the final soil quality guideline may be set at the background concentration or confirmed below this value where warranted.

Guideline Application

The guidelines derived through the process described in the soil protocol are generic guidelines. They are not intended to be applied to all contaminated sites in Canada without a proper site characterization. Guidance on characterization of sites in terms of probable risk and need for action can be found in the "National Classification System for Contaminated Sites" (CCME 1992). Information gathered during the site characterization step is to be compared with that of the generic site characteristics used in generic guideline derivation. When all characteristics are similar, the generic guidelines can be applied directly, but in cases where they differ, the generic guidelines may be modified to site-specific objectives considering site-specific characteristics. In some situations, the gap between the characteristics of the specific and the generic sites can not be reconciled through reasonable modifications, and thus a full site-specific risk assessment must be done. The latter option requires the involvement of experienced personnel to overcome the difficulties associated with the high variability in results, with the low transparency, and with evaluating the quality of the work done in the risk assessment process. The combination of these factors reduces the possibilities of comparison between sites, adding yet another level of difficulty to the fair and consistent management of contaminated sites. In certain situations, however, it is the only acceptable method that can be applied to obtain site-specific objectives.

Limited Data Availability and Provisional Guidelines

The methods described in the soil protocol are all limited by minimum data requirements. Limitations in the availability of quality soil toxicity data hinder the derivation of soil quality guidelines. However, literature searches often yield data that do not meet the minimum requirements of the protocol, but still provide some toxicity information. Also, toxicity tests using standard methodologies may produce data that do not meet the regular QA/QC laboratory standards defined by toxicologists due to difficulties in handling and evaluating certain substances such as volatile organic chemicals in the context of a soil contact test. While acknowledging the need for toxicity data of the highest quality, the SQGTG believes that guidelines based on limited toxicity information are still more practical, scientifically defensible, and protective of the environment and human health than the absence of guidelines or than guidelines that are not risk-based. Thus, a provisional method for deriving environmental soil quality guidelines was proposed (CCME 1997). The guidelines derived using this method are called "provisional" to clearly indicate that the underlying data do not meet the requirements of the soil protocol and that there is an urgent need for additional research. Also, given the increased uncertainty surrounding the provisional soil quality guidelines, such provisional guidelines may not be used to raise existing criteria or guidelines, such as the 1991 interim criteria, but only to lower them if the provisional value indicates that the existing criteria or guidelines are not adequately protective. Once data gaps are filled, provisional guidelines will be replaced by full guidelines. Guidance to allow derivation of provisional guidelines is included in the present chapter in the summary of the soil protocol.

Protection of Secondary and Tertiary Consumers

Bioaccumulation and long-range transport of persistent chemicals were not accounted for in the soil quality guideline derivation process presented in the soil protocol. To fill that gap, a food chain check was developed and was first applied in the derivation of soil quality guidelines for DDT and PCBs (see Environment Canada 1998a, 1998b). This food chain check is an extension of the soil and food ingestion guideline calculation procedure presented in the soil protocol. The soil and food ingestion guideline procedure uses the soil-to-plant bioconcentration factor to calculate the soil concentration of a substance that is protective of herbivores consuming that soil and the plants growing in it. In the same way, the new food chain check uses the soil-to-prey bioconcentration factor to calculate the soil concentration of a substance that is protective of the predators consuming this prey. The food chain check has been used successfully to calculate soil concentrations protective of predators of the secondary and tertiary consumer levels of the food chain. A description of this procedure is included in the present chapter in the summary of the soil protocol.

New Challenges

As this document was being published, the SQGTG was tackling a new challenge: the derivation of soil quality guidelines for total petroleum hydrocarbons (PHCs). The difficulty with deriving soil quality guidelines for PHCs is that the procedures described in the soil protocol allow only for the derivation of compound-specific guidelines. This is not practicable for substances like PHCs. The SQGTG is presently addressing this problem and establishing a procedure to support guideline derivation for families of chemicals. This new procedure as well as guidelines for PHCs should be available soon.

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