Soil Cleanup Goals

Guidance Document 19

This guidance document outlines the Minnesota Department of Agriculture's (MDA) approach to determining soil cleanup goals for agricultural chemical incident sites. Included are generic preliminary soil cleanup goals based on the potential for ground water contamination as well as other factors. Final soil cleanup goals for all agricultural chemical incident sites are always site specific and are dependent upon the unique characteristics of each site. Soil containing contaminants at concentrations below these soil cleanup goals should not cause an unreasonable adverse effect on the environment.

Preliminary soil cleanup goals have been developed for Lists 1, 2, 3 and certain unique chemistry pesticides as well as nitrogen compounds commonly monitored in soil and ground water at agricultural chemical incident investigations (Table 1). Soil cleanup goals for compounds not included in Table 1 are available from MDA staff.

1. Pesticide Soil Cleanup Goals

Human health exposure routes, leaching of contaminants to ground water and label application rates were considered in the development of the soil cleanup goals. The soil cleanup goals based on leaching of contaminants to ground water also considered scenarios of high, moderate and low risk to ground water. The soil cleanup goals presented in Table 1 are the lowest of the human health-based goals, the label application rate-based goals and the goals based on leaching of contaminants to ground water using the high, moderate and low risk to ground water scenarios for each compound. Only the leaching based goals changed in each of the three ground water risk scenarios.

The soil cleanup goals for the high risk to ground water scenario in Table 1 are the default soil cleanup goals for all sites. The characteristics of the high, moderate and low risk to ground water scenarios are outlined in part I.C. If you believe the characteristics of your site are more closely aligned with the moderate or low risk to ground water scenarios based on a thorough evaluation of available data for the site, then you may present your evaluation to MDA staff and propose that the goals based on moderate or low risk to ground water be used instead of the high risk goals for your site.

Additional information on final cleanup goal selection is outlined in part II. The proposed use of alternative soil cleanup goals should be discussed in the Remedial Investigation Report/Corrective Action Plan for the site (see MDA guidance document GD10 Agricultural Chemical Incident Remedial Investigation Report and Corrective Action Plan).

2. Nitrogen Soil Cleanup Goals

The soil cleanup goal for nitrate-nitrogen is 150-200 mg/kg. The soil cleanup goal for Total Kjeldahl Nitrogen is 5000 mg/kg for the upper two and a half (2.5) feet of soil and 1000 mg/kg for soil below two and a half (2.5) feet in depth.

3. Natural Attenuation

Natural attenuation, or the reduction of contaminant concentrations in soil to the appropriate cleanup goals without artificial enhancement of the site conditions, may be an appropriate technology for some sites. The requirements for natural attenuation proposals are described in MDA guidance document GD20 Natural Attenuation of Contaminated Soil and Ground Water at Agricultural Chemical Incident Sites.

4. Use of Background Values

In some instances the levels of contaminants in soil adjoining the site may be equal to or exceed the levels of these same contaminants in soil on site. This may be the result of naturally occurring compounds, the legal application of similar products, other non-point sources of contamination or off-site point sources of contamination. If you believe that background contaminant levels are appropriate soil cleanup goals for your site, then you should discuss your reasoning with MDA staff and propose that background contaminant levels be used as soil cleanup goals.

The information provided in the proposal to MDA staff shall include the use of the surrounding property and suspected sources of the background contamination. The proposal shall also describe the pathway of migration from the background contaminant source to the site and the leaching potential of contaminants from on-site soils.

A background soil cleanup goal will generally be based on the mean value of the concentrations in at least three soil samples collected from the source of the background contamination. Alternative approaches such as the use of published regional background data for naturally occurring compounds will be considered on a site-specific basis

I. Criteria Used To Develop The Soil Cleanup Goals For Pesticides

A. Human Health Based Goals

The human health based goals were determined using standard U.S. Environmental Protection Agency (EPA) human health risk assessment methodologies modified for use in Minnesota in an unrestricted (residential) land use scenario (U.S. EPA, 1989). Human health-based soil cleanup goals for each compound were calculated separately for the ingestion of incidental soil/dust and dermal contact exposure pathways. There is insufficient information available to calculate cleanup goals for the inhalation pathway. Additive risk for selected groups of compounds was not considered.

B. Label Based Goals

The label based cleanup goals are based on twice the application rate for each pesticide for a coarse to medium textured soil with less than 3% organic matter. This level is viewed as sufficiently protective of human health and the environment at most sites. Label rate based cleanup goals have been included to address the possibility of potential residual pesticidal effects of the contaminants in a labeled or non-labeled setting. Label rate based cleanup goals have also been included because the application rate is based in part on extensive ecological toxicity and environmental fate testing by the EPA. However, cleanup to label based goals may be phytotoxic to some vegetation (for example, grass) and a lower soil cleanup goal may be required for areas which are to be planted with susceptible vegetation.

C. Soil Leaching Based Goals

The soil leaching based goals are the levels above which contaminants will likely leach from contaminated soil to ground water at concentrations which exceed the ground water goals if the soil is left in place. The soil leaching goals were determined with an approach developed by the EPA (U.S. EPA, 1996a and b). Partitioning of the contaminant to organic carbon in soil, to soil water and to soil air was calculated using compound specific characteristics and generic soil characteristics such as organic carbon content and bulk density in an equation modified from Dragun (1988).Using an EPA equation that accounts for dilution of the contaminated soil water when it reaches the ground water, a generic dilution factor was calculated using parameters applicable to Minnesota. This dilution factor was applied to the ground water goals which were used in the soil partitioning equation.

The value obtained from the soil partitioning equation was adjusted to account for chemical and biological degradation of the contaminants. Various attenuation factors were selected, based on potential geologic scenarios, the presence of usable quantities of ground water, the actual or potential uses of this ground water and the vulnerability of this ground water to contamination. The geologic portion of the risk to ground water determination was based on a Minnesota Department of Natural Resources (MDNR) approach for assessing ground water sensitivity (MDNR, 1991).

The MDA approach focused on the presence and thickness of low permeability earth materials. In general, greater thicknesses of low permeability deposits will provide protection of ground water from surficial sources of contamination. In addition, the leaching-based soil cleanup goals for alachlor, cyanazine, phorate, propazine, terbufos, aldicarb and bentazon were modified slightly based on method detection limits, practical limitations and implementability at agricultural chemical incident sites.

In the following discussion the term aquifer refers to the first geologic formation capable of producing usable quantities of water to a well or spring (Heath, 1984). In addition, those formations which are reasonably permeable and are hydraulically connected to water producing aquifers should also be considered aquifers for purposes of this discussion. The term low permeability geologic materials refers to clay, shale, clay loam, clay till or glacial lake clays.

i) High Risk to Ground Water

The leaching to ground water calculation used in the high risk to ground water scenario assumes that 1) there is little or no attenuation of contaminants within the unsaturated or saturated zones; 2) there is some dilution of contaminants within the aquifer prior to migration of the contaminants to a potential receptor, and 3) the applicable ground water cleanup goal would be a drinking water standard.

ii) Moderate Risk to Ground Water

The leaching to ground water calculation used in the moderate risk to ground water scenario assumes that 1) low permeability geologic materials are present overlying the aquifer which increase the potential for attenuation of contaminants within the unsaturated zone; 2) there is some dilution of contaminants within the aquifer prior to migration of the contaminants to a potential receptor, and 3) there is no short term risk to receptors using the ground water downgradient of the site. As shown on Table 1, at sites where the aquifer is protected by at least 50 feet of low permeability geologic materials, a higher soil cleanup goal may be used for alachlor, cyanazine, phorate, terbufos and aldicarb.

iii) Low Risk to Ground Water

The leaching to ground water calculation used in the low risk to ground water scenario assumes that leaching of contaminants to ground water is minimal because of a large thickness of low permeability geologic materials. The low risk to ground water soil cleanup goals are appropriate for sites where there is approximately 100 feet of low permeability geologic materials, which will allow for significant attenuation of the contamination before it reaches the aquifer of concern. Some dilution of contaminants within the aquifer prior to migration of the contaminants to potential receptors is also assumed for these sites.

Low ground water risk should not be assumed if unsealed or leaking wells or other mechanisms are present which may provide a direct conduit for site contamination into the aquifer of concern. If contamination from anthropogenic sources is present in the aquifer of concern, then the aquifer is not well protected from surface contamination and it may be inappropriate to assume a low ground water risk for your site.

II. FINAL SOIL CLEANUP GOAL SELECTION

The approach used to develop the preliminary soil cleanup goals does not specifically consider the initial concentration or volume of contaminated soil; the presence of karst at or adjacent to the site; ecological, food crop or livestock risks; phytotoxicity of the contaminated soil, and discharge of contaminated ground water or runoff to surface water. These factors should also be considered when assigning final soil cleanup goals to sites.

In addition, you may request modification of the preliminary soil cleanup goals as appropriate, based on the following factors:

a. overall protection of human health and the environment;
b. long term effectiveness and permanence;
c. reduction in toxicity, mobility and volume;
d. short term effectiveness (impacts resulting from the cleanup);
e. implementability of the remedial action and technology limitations;
f. community acceptance;
g. practicability, and
h. cost.

Modification of the soil cleanup goals may or may not involve the calculation of a new cleanup goal. For instance, if soil contamination is widespread across a site in a low risk area and contaminant levels are just above the soil cleanup goals, then it may not be practical or cost effective to clean up the entire site, and the clean up approach may then focus instead on the most highly contaminated areas and/or those areas which pose the greatest risk. Another example is soil contamination under a building. In this instance it would be difficult to remediate the soil. A deed notification or restriction may be necessary which would record the location of the contaminated soil and require further investigation and cleanup if the building is removed in the future. Alternatively, the MDA may close the site by issuing a No Further Action letter which is contingent upon notifying the MDA if the building is removed in the future. At that time, the MDA may request further investigation and/or remediation of the contaminated soil.

The use of an alternative human health exposure scenario in the calculation of human health based soil cleanup goals may also be appropriate for some sites. For instance, if use of the site will be primarily industrial and access to the site is restricted, it may be appropriate to calculate different human health based soil cleanup goals. Appropriate institutional controls would likely be required when the human health based goals are based on a use other than an unrestricted (residential) use of the site. For more information on incorporating alternative property use scenarios into the soil cleanup goal selection process, please see the Minnesota Pollution Control Agency's *Risk-Based Site Evaluation Process, Guidance on Incorporation of Planned Property Use Into Site Decisions*.

In some situations, it may be appropriate for the consultant to propose and negotiate different cleanup goals with MDA staff. For instance, the consultant may wish to use site-specific data instead of generic data to calculate the leaching to ground water goal. The consultant will be asked to gather site specific data for all of the soil parameters used in the leaching equation and this information will then be used to calculate the soil leaching goals. Finally, as mentioned previously in the guidance document, it may be appropriate to use an alternate soil cleanup goal in areas where background levels of contamination exceed the preliminary soil cleanup goal for the site.

REFERENCES

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