Virginia DEQ

RCRA Corrective Action Fact Sheet #2

Fate and Transport Modeling for RCRA Corrective Action Risk Assessments

EPA and VDEQ require the evaluation of soil contaminant concentrations with respect to the migration to groundwater pathway. As stated in the EPA Region 3 RCRA Facility Investigation Scope of Work (http://www.epa.gov/reg3wcmd/ca/ca_resources.htm#risk), for migration to groundwater, "RBSLs shall be developed so that contaminants remaining in soil would not; (1) increase contamination in groundwater to concentrations that exceed RBSLs; and (2) increase contamination in surface water to concentrations that exceed RBSLs." The text below assumes that background for the constituents of concern (COCs) has been exceeded and the evaluation is focused only on risk-based screening levels (RBSLs).

The following approaches are acceptable in determining whether a potential for contaminant transfer from soil to groundwater exists:

1) conduct screening against DAF-1
2) conduct additional screening against a site-specific DAF
3) utilize a F&T model such as SESOIL, or
4) utilize existing groundwater monitoring data if an adequate record exists (depends on site-specific conditions)

As an initial step, VDEQ typically requires that soil contaminant concentrations be screened against the DAF-1 soil screening levels as the most conservative screening level. Screening levels can be found at the following location: http://www.epa.gov/reg3hscd/risk/human/rb-concentration_table/Generic_Tables/index.htm

If no constituents of concern exceed DAF-1, the migration to groundwater pathway does not need to be evaluated further. However, if the DAF-1 is exceeded for one or more constituents, the facility may use another approach to demonstrate that the soils contaminants will not result in increased contamination of groundwater and surface water to levels that exceed RBSLs.

The facility should propose and sufficiently justify their approach as part of the RFI workplan or as part of their recommendations in the RFI report. If site-specific DAFs are proposed, they should be developed using the methodology described in Soil Screening Guidance, dated 2002, and the associated technical background document as found at the following location: http://www.epa.gov/superfund/health/conmedia/soil/index.htm. The use of SESOIL using the DEQ-approved methodology (REAMS guidance) is well-established and may facilitate review and approval of the results. The SESOIL predicted concentrations should be calibrated to field conditions prior to utilizing the results from the model.

According to EPA Region 3, it is not necessary to use indirect or modeled results to evaluate groundwater contamination and remedial alternatives when a substantial empirical groundwater database for the site exists. Typically, several years of monitoring, including seasonal variability, will be needed to show that there is no significant migration of soil contaminants to groundwater or significant changes in the extent or magnitude of groundwater contamination. The facility may propose the use of existing groundwater monitoring data if such a record exists. The determination to use existing groundwater data will be made by the project manager in coordination with the groundwater staff.

If the selected approach results in a determination that a potential for contaminant transfer from soil to groundwater exists, corrective measures for this pathway must be proposed. To develop the cleanup targets for the corrective measure (interim or final), the facility can utilize any of the four following methods:

1) utilize DAF-1
2) utilize a site-specific DAF
3) utilize the results from a F&T model such as SESOIL, or
4) utilize a technology-based measure followed by ongoing groundwater monitoring (depends on site-specific conditions)

If the facility proposes soil removal to bedrock or the local seasonal high water table, fate and transport modeling will not be required. For the prevention of future migration of constituents of concern from soil to groundwater, a corrective measure that interrupts the leaching pathway may also be proposed by the facility. Based on the site-specific conditions, the selected remedy may then consist of remediation (incl. removal or capping) of soils that are contaminated above risk-based levels based on direct exposure scenarios, combined with long-term groundwater monitoring. However, it is VDEQ's goal to pursue unrestricted use of property as much as possible and such a proposal must be evaluated as part of the Corrective Measures Study.

The intention to place an engineering and/or institutional control on the property or parts of the property should be clearly explained in the RFI report, including an acknowledgement that the owner is willing to submit to a mechanism to enforce the IC. An enforceable mechanism could be a post closure permit, an administrative order and/or an Environmental Covenant. The legal mechanism may not be detailed in the RFI report but must be determined during the Corrective Measures Study.

Attachment 1 summarizes the decision process for using fate and transport modeling. Attachment 2 provides additional technical detail on the SESOIL model and is available upon request.

Attachment 1 - Fate and Transport Modeling Decision Process

1. Do COC concentrations in soils exceed site-specific background (PAHs for some sites, metals)? No → NFA

2. Do COC concentrations in soils exceed one or more of the following:
   No → NFA
   a. DAF-1 Yes → apply b or c or go to item 3.
   b. site-specific DAF approved by Department Yes → apply c or go to item 3.
   c. SESOIL results Yes → go to item 3.

3. Do GW concentrations of soil COCs exceed RBSLs (such as tapwater RBCs) or MCLs, based on sufficient data (multiple seasons, years) & site-specific conditions (date of releases, soil types)? No → NFA
   Yes → go to item 4.

4. Are interim measures proposed that meet at least one of the items under 2?
   Yes → NFA following confirmatory sampling
   No → go to item 5.

5. Carry unit forward to CMS, with the following options for establishing corrective measures:
   a. proposed remedy is based on soil clean-up target derived from DAF-1, site-specific DAF or SESOIL results
   b. proposed remedy is based on institutional/engineering controls (including capping and/or monitoring and enforcement mechanisms such as permit or order) to prevent and/or monitor leaching to groundwater after source area remediation has already occurred but clean-up targets are not yet met

Summary: Fate and transport modeling is not required as long as a technically justifiable alternative for the evaluation of cross-media transfer of contaminants and clean-up targets that are protective of human health and environment is proposed.

Attachment 2 - SESOIL Model Quick Overview

The SESOIL model is used in chemical exposure assessments. SESOIL is a seasonal compartment model which simulates long-term pollutant fate and migration in the unsaturated soil zone. It can be used to estimate the average concentrations in ground water. SESOIL describes the following components of a user-specified soil column which extends from the ground surface to the ground-water table.

1. Hydrologic cycle of the unsaturated soil zone.
2. Pollutant concentrations and masses in water, soil, and air phases.
3. Pollutant migration to ground water.
4. Pollutant volatilization at the ground surface.
5. Pollutant transport in washload due to surface runoff and erosion at the ground surface.

SESOIL estimates all of the above components on a monthly basis for up to 999 years of simulation time and continuous or one-time release scenario can be selected, however for closure and CA, a 30 year timeframe and single release scenario are typically chosen.

The soil column may be composed of up to four layers, each layer having different soil properties which affect the pollutant fate. In addition, each soil layer may be subdivided into a maximum of 10 sublayers if such details of the site soils are available.

The following pollutant fate processes are accounted for: Volatilization, Adsorption, Cation Exchange, Biodegradation, Hydrolysis and Complexation. In the absence of site-specific information for the above processes, conservative values/defaults are chosen as modeling inputs. For example, if biodegradation related input values are not available, degradation is assumed to be zero or negligible.

SESOIL used for organic compounds, can be run with or without consideration of biodegradation. It is sensitive to the input value for soil organic carbon and, when biodegradation is considered, and is very sensitive to the depth to groundwater. DEQ prefers that facility calibrate the SESOIL model using site-specific input parameters for any fate and transport mechanism. Facilities may use estimated default parameter in the absence of field data,. In such cases, the model might simulate results that are inaccurate by orders of magnitude. These results should be interpreted with caution and additional site specific information for model input is required. The SESOIL model includes several other fate and transport mechanisms such as photolysis, cation exchange, and complexation.

SESOIL creates an output file which contains monthly or annual results for hydrologic cycle components, pollutant mass distribution, and pollutant concentration distribution for each layer or sublayer. The output of SESOIL also provides a monthly or annual status of concentrations of contaminants reaching to groundwater. For CA, typically the annual status is selected.

The groundwater concentrations predicted by SESOIL can be compared against MCL (where available), tap water RBC for carcinogens and 0.1 tap water RBC for non-carcinogens. If RBC values are exceeded, the facility has the option to use SESOIL predicted groundwater values as an input to a quantitative risk assessment to demonstrate that the resultant groundwater concentration will not pose harm to human health.

Note that SESOIL:

1. Does not consider existing groundwater concentration of contaminant. In order to accommodate for existing contaminations, Summers model may be used along with SESOIL;
2. Is not a risk assessment model;
3. Does not evaluation vapor intrusion pathway.

The modeled SESOIL output followed by screening or quantitative risk assessment helps decide the current potential for contaminant migration to groundwater as well as, where necessary, the soil clean-up goal that will be protective of human health and environment.