following categories: (1) Incorporation of additional fate and transport processes (e.g., degradation of chemical constituents); (2) Use of enhanced flow and transport solution algorithms and techniques (e.g., three-dimensional transport); and (3) Revision of the Monte Carlo methodology (e.g., site-based implementation of available input data). A discussion of the key enhancements which have been implemented in the EPACMTP is presented here and the details are provided in the background documents (USEPA, 1995a-g). The Agency is soliciting comments on the modeling enhancements and the modeling methodology as well as on the values derived for individual chemical constituents:

(1) Fate and Transport Processes

*Effects of groundwater mounding underneath waste unit.*—The EPACML was limited to conditions of uniform groundwater flow. It could not handle accurately the conditions of significant groundwater mounding and non-uniform groundwater flow due to a high rate of infiltration from the waste units. These conditions increase the transverse horizontal as well as the vertical spreading of a contaminant plume. The EPACMTP accounts for these effects directly by simulating groundwater flow in the vertical as well as horizontal directions (USEPA, 1995 a).

*Transformation products.*—The EPACMTP model has capability to simulate the formation and fate of multiple transformation products (up to seven) in the unsaturated as well as in the saturated zones. For constituents which have toxic transformation products, the EPACMTP can provide an assessment of the groundwater impact of the transformation products, along with that of the parent constituent. This methodology has been implemented for hydrolyzing organic constituents included in this proposal.

*Fate and transport of metals.*—The EPACMTP can simulate fate and transport of metals, taking into account geochemical influences on the mobility of metals. The EPA's MINTEQA2 (USEPA, 1995 f) metals speciation model is used to generate effective sorption isotherms for individual metals, corresponding to a range of geochemical conditions. The transport modules in EPACMTP have been enhanced to incorporate the nonlinear MINTEQ sorption isotherms. This enhancement provides the model with capability to simulate, in the unsaturated and in the saturated zones, the impact of Ph, leachate organic matter, natural organic matter, iron hydroxide and the presence of other ions in the groundwater on the mobility of metals.

(2) Enhanced Solution Algorithms and Techniques

*Linkage between unsaturated zone and saturated zone modules.*—The saturated zone module implemented in the EPACML was based on a Gaussian distribution of concentration of a chemical constituent in the saturated zone. The module also used an approximation to account for the initial mixing of the contaminant entering at the water table underneath the waste unit. The approximate nature of this mixing factor could sometimes lead to unrealistic values of contaminant concentration in the groundwater close to the waste unit, especially in cases of a high infiltration rate from the waste unit. The enhanced model incorporates a direct linkage between the unsaturated zone and saturated zone modules which overcomes these limitations of the EPACML.

*Numerical transport solution modules.*—To enable a greater flexibility and range of conditions that can be modeled, the analytical saturated zone transport module has been replaced with a numerical module, based on the highly efficient state-of-the-art Laplace Transform Galerkin (LTG) technique. The enhanced module can simulate the anisotropic, non-uniform groundwater flow, and transient, finite source, conditions. The latter requires the model to calculate a maximum receptor well concentration over a finite time horizon, rather than just the steady state concentration which was calculated by the EPACML. The saturated zone modules have been implemented to provide either a fully three-dimensional solution, or a highly efficient quasi-3D solution. The latter has been implemented for Monte Carlo applications and provides nearly the same accuracy as the fully three-dimensional option, but is more computationally efficient. Both the unsaturated zone and the saturated zone transport modules can accommodate the formation and the transport of parent as well as of the transformation products.

*Solution for nonlinear metals transport.*—A highly efficient semi-analytical unsaturated zone transport module has been incorporated to handle the transport of metals in the unsaturated zone and can use MINTEQA2 derived linear or nonlinear sorption isotherms. Conventional numerical solution techniques are inadequate to handle extremely nonlinear isotherms. An enhanced method-of-characteristic based solution has been implemented which overcomes these problems and thereby enables the simulation of metals transport in the Monte Carlo framework. Non-linearity in the metals sorption isotherms is primarily of concern at higher concentration values; for low concentrations, the isotherms are linear or close to linear. Because of the attenuation in the unsaturated zone, and the subsequent dilution in the saturated zone, concentrations in the saturated zone are usually low enough so that properly linearized isotherms are used by the model in the saturated zone without significant errors.

*Elimination of biases in determination of receptor well location.*—The internal routines in the model which determine placement of the receptor well relative to the areal extent of the contaminant plume have been revised and enhanced to eliminate bias which was present in the implementation in the EPACML. The calculation of the areal extent of the plume has been revised to take into consideration the dimensions of the waste unit. The logic for placing a receptor well inside the plume limits has been improved to eliminate a bias towards larger waste unit areas and to ensure that the placement of the well inside these limits, for a given radial distance from the unit, is truly randomly uniform. However, for this proposal, *the closest drinking water well is located anywhere on the downgradient side of the waste unit and the Agency is soliciting any comments on this procedure.*

(3) Revisions of Monte Carlo methodology for nationwide assessment

*Data sources.*—The data sources from which parameter distributions for nationwide Monte Carlo assessments are obtained have been evaluated, and where appropriate, have been revised to make use of the latest data available for modeling. Leachate rates for Subtitle D waste units have been revised using the latest version of the HELP model with the revised data inputs. Source specific input parameters (e.g., waste unit area and volume) have been developed for various different types of industrial waste units besides landfills. Input values for the groundwater related parameters have been revised to utilize information from a nationwide industry survey of actual contaminated sites.

*Finite-source methodology.*—The original version of the model was implemented for Monte Carlo assessments assuming continuous source (infinite source) conditions only. This methodology did not take into account the finite volume and/or operational life of waste units. The EPACMTP model has been