MEMORANDUM

To: Tom Bloom, EPA
From: Mark Ferrey, MPCA
CC: Dave Douglas, John Betcher
Re: Use of the MPCA soil leaching model for NIROP soils.
Date: 23 June, 1994

The MPCA soil leaching model generates soil cleanup numbers intended to protect the ground water from chemicals leaching from the overlying contaminated soil. The model takes into account site specific geologic conditions, so data on a variety of factors such as adsorption constants, soil organic carbon concentrations, contaminant degradation rates is required. While a detailed discussion concerning the use of the MPCA leaching model can be found in the MPCA's memorandum entitled "Procedures for Establishing Soil Cleanup Goals", the selection of specific data is site dependent. The following is a discussion of the site dependent data used in the MPCA model to calculate the cleanup numbers for the Naval Industrial Reserve Ordnance Plant (NIROP) soils.

Application of the leaching model to the NIROP site:

RMT indicated in the Interim Report for the RI/FS (1987) that "the majority of the area has Hubbard soils" and that "the permeability of these soils is rapid". Falling head/percolation tests conducted by Enecotech Midwest, Inc. (1992) indicate that the soils are quite permeable and implies that contamination found in the subsoil at NIROP poses a threat to the underlying aquifer. Therefore, the application of the leaching model is relevant and appropriate to generate cleanup numbers for the soil at this site.

1. Selection of contaminants included in the leaching model:

We reviewed the ground water monitoring data from 1983-1991 (5,6) and identified the following chemicals that were reported as above method detection limits:

vinyl chloride
methylene chloride
1,1-dichloroethylene (1,1-DCE)
1,2-dichloroethylene (1,2-DCE)
1,1-dichloroethane (1,1-DCA)
1,1,1-trichloroethane (1,1,1-TCA)
trichloroethylene (TCE)
tetrachloroethylene (PCE)
toluene
benzene
ethylbenzene
xylenes
polychlorinated biphenyls (PCB)

Of these, methylene chloride, benzene, toluene, and PCB appear sporadically and at low concentrations in the data prior to 1986. Benzene and PCB have not been detected since June 1985. Methylene chloride and chloroform have been detected rarely and at low levels (<6 ppb) in the 1990 and 1991 (5) data. Toluene appears very seldom and at very low levels in the soil and water data. In addition, these chemicals have not been found in the soil at NIROP. This indicates that these chemicals are probably laboratory contaminants rather than contaminants of concern for the NIROP site. These compounds have therefore not been included in the leaching model analysis. Vinyl chloride was detected once in well AT03 in Oct. 1990 at 5 ppb and once

in the off-site well M23S at 4 ppb (5). However, vinyl chloride has not been detected in the soil. Given this data, vinyl chloride is not considered a contaminant in the NIROP soil that needs addressing by the leaching model. In addition to these, DDT and its breakdown products, DDD and DDE, have been found often in the soils at NIROP. Almost all of these detects appear in the upper four feet of the soil, with few detects below this level. The extremely high Koc values (3) make their movement unlikely in the soil. Ground water monitoring data (5,6) shows that this pesticide and its breakdown products have never been found in the ground water, providing de facto evidence that these chemicals are not leaching to ground water.

However, the available data shows frequent ground water detects of TCE, PCE, 1,1,1-TCA, 1,2-DCE, 1,1-DCA, 1,1-DCE in numerous monitoring wells. Ethylbenzene, while not detected in the soil frequently, has been found consistently in well FMC33 since 1983 (5,6). Xylenes have not often been detected in the ground water. However, samples from soil boring AB031 (7) show that the soil at this location is contaminated by xylene from intervals "C" through "H". Based on this evidence, ethylbenzene and xylene are considered contaminants at the site and have been included in the soil model cleanup calculations.

2. Depth of contamination/depth to ground water.

The 1991 soils data (5) reveals that the vertical extent of contamination extends from the surface ("A" interval) to the deepest interval ("J") in numerous soil borings for TCE, PCE, and 1,2-DCE. The contaminant 1,1,1-TCA was found primarily in the "A", "B", and "C" intervals of the soil profile. As mentioned above, ethylbenzene has not been detected at high concentrations in the soil, so the depth of contamination is unknown a this time. Also as noted above, xylene has been shown to be a contaminant in the soil in AB031 from interval "C" through interval "H".

Available data indicate that the bulk of the soil contamination probably is due to leakage from barrels buried on site or disposal pits. Most of these barrels were excavated from trenches to an average depth of 11 feet in area A (8). However, MPCA witnessed one barrel uncovered "while stripping off the topsoil" (9). The observation of one barrel near the surface notwithstanding, the assumption that the soil contamination at NIROP is due to leakage from the buried barrels is consistent with the observed vertical extent of the contamination. Most of the soil detects for TCE, PCE, 1,1,1-TCA, 1,2-DCE occurs at interval "C", corresponding to a depth of 6-8 feet and consistent with the depth at which many of the barrels were found. Therefore, the bulk of the contamination exists between roughly 6 feet and the ground water (given as approximately 20 feet in reference 6), or 14 feet.

The model calculates the time that the center of the contaminant mass will take to reach the aquifer, so the distance from the center of the contamination to the ground water must be specified. The thickness of the contamination is roughly 14 feet, as discussed above; the center of this contamination is seven feet above ground water, or 214 cm.

3. Soil organic carbon data:

Total soil organic carbon data is needed to calculate the adsorption constant (Kd) for each contaminant found in the soil. This data was collected as part of the Soils Remedial Investigation (7). Because most of the contamination is found between 6 and 20 feet, the organic carbon data was averaged over this distance for use in the model cleanup calculations. Soil organic carbon averaged 0.3% over this subsoil interval.

4. Adsorption constants:

The leaching model relies on the soil adsorption constant, Kd, for each chemical to determine its tendency to move or leach through the soil. Kd is defined by the organic carbon content of the soil (OC) and the organic carbon partitioning constant, Koc, through the following relationship:

$$Kd = (Koc)(OC) \qquad (2)$$

Adsorption constants for each of the contaminants of concern are as follows:

Compound	log Koc values	Average Koc	Kd
TCE	1.81 (1) 2.1 (1) 2.03 (1) 2.1 (3)	2.02	.315
PCE	2.42 (1) 2.56 (1) 2.32 (1) 2.56 (2) 2.56 (3)	2.49	.936
1,2-DCE	1.77 (1) 2.18 (1) 1.77 (3)	1.95	.27
1,1-DCE	1.81 (1) 1.81 (3)	1.81	.195
1,1,1-TCA	2.23 (2) 2.18 (1) 2.02 (1) 2.18 (3)	2.16	.438
1,1-DCA	1.15 (1) 1.28 (1) 1.48 (3)	1.32	.063
Xylene	2.38 (3)	2.38	.72
Ethylbenzene	1.98 (1) 2.41 (1) 3.04 (3)	2.25	1.45

5. Soil water recharge rate and soil moisture content.

The average soil recharge rate from rainfall is 15.24 inches based on climatological data for the Twin Cities area. The soil moisture content of 20% used in our calculations represents the approximate soil field capacity.

6. Ground water ARARs:

The model generates cleanup numbers for the soil by back-calculating from accepted applicable or relevant and appropriate requirements (ARARs) for ground water. Maximum contaminant levels (MCLs) are used when available for specific chemicals. However, no MCL is available for 1,1-DCA, so the recommended allowable limit (RAL) of 70 ppb for this chemical is used instead.

7. Half-life data for the contaminants:

A range of half-life data was considered in generating the cleanup numbers for the contaminants in NIROP soils. This range is based on a variety of available research data for biodegradation and abiotic degradation rates for individual contaminants (2, 3, 4, 10) The specific rates will vary, of course, from site to site depending on soil types, oxygen concentrations, organic matter present in the soil, and site specific microbial consortia. An average of available half-life values was calculated for use in the model.

For xylene and ethylbenzene, the half-life and adsorption data used in the model combine to yield an unrealistically high cleanup number for the subsoil. These values have been italicized in the modeling report to indicate that these compounds do not threaten ground water due to leaching processes from the soil.

If you have further questions regarding individual data that have been incorporated into the model, please call me at (612) 296-7775.

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