UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VII
901 NORTH 5TH STREET
KANSAS CITY, KANSAS 66101

FEB 29 2012

MEMORANDUM

SUBJECT: Indoor Air Action Levels
10th Street Site
Columbus, Nebraska

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As requested, we are providing indoor air action levels for tetrachloroethylene (PCE), trichloroethylene (TCE), and vinyl chloride. However, because of a lack of toxicity data, action levels are not provided for *cis*-1,2-dichloroethylene (*cis*-1,2-DCE) and *trans*-1,2-dichloroethylene (*trans*-1,2-DCE). Action levels calculated for PCE, TCE, and vinyl chloride address potential residential and commercial/industrial indoor air contamination resulting from the migration of volatile contaminants in the subsurface into overlying buildings via the vapor intrusion pathway. Given the complex nature of indoor air, these levels are not intended to be used solely for determining a remedial/removal action. Consideration should be given to background levels of volatile organic compounds (VOCs) as well as other site characteristics that could contribute to indoor air contamination. Furthermore, the indoor air action levels can be used to derive subslab vapor action levels, which may be necessary for evaluating future exposures. However, we defer to the Superfund program and project team on the selection of the appropriate subslab-to-indoor air attenuation factor to derive subslab vapor action levels.

The following table summarizes the recommended indoor air action levels for the residential and commercial/industrial exposure scenarios. The residential indoor air action levels are intended to be used for residential land uses, but can also be applied to land use scenarios, including schools and daycare centers, where children may be exposed on a regular basis. The commercial/industrial indoor air action levels apply to land uses that are primarily occupational. The corresponding action levels equate to an excess individual lifetime cancer risk of 1E-05 and 1E-04, and a hazard quotient (HQ) of 1, which is consistent with the Region 7 Vapor Intrusion Risk Management Decision Matrix. Because of the presence of multiple contaminants, it may be appropriate to select an action level based on a cancer risk of 1E-05. The supporting documentation for the action levels is attached.

	Residential Exposure			Commercial/Industrial Exposure		
	Cancer Risk			Cancer Risk		
	1E-05 ($\mu g/m^3$)	1E-04 ($\mu g/m^3$)	HQ = 1 ($\mu g/m^3$)	1E-05 ($\mu g/m^3$)	1E-04 ($\mu g/m^3$)	HQ = 1 ($\mu g/m^3$)
PCE	94	940	42	470	4,700	175
TCE	4.3	43	2.1	30	300	8.8
Vinyl chloride	1.6	16	100	28	280	440

ATTACHMENT
Residential Indoor Air Action Levels for 10th Street OU2 Site
Columbus, Nebraska

1.0 Site Description and History

The 10th Street Superfund Site is located in the south-central portion of the City of Columbus in Platte County, Nebraska. The site is comprised of two operable units (OUs). OU1 includes an area generally south of the Union Pacific rail line that crosses the central portion of the city and includes the southern municipal well field where groundwater contamination was originally identified. The contamination was traced to two dry cleaning operations, former Jackson Services and Liberty Cleaners. Subsequent groundwater sampling events indicated an extended area of contamination existed upgradient of the original site area. Four removal assessments conducted between 1998 and 2000 showed the plume extended to a third primary source area, the One Hour Martinizing (OHM) dry cleaning facility (now occupied by Prestige Cleaners), located over ½ mile north of OU1. This extended site area comprises OU2, the subject area of the current long-term response action.

The OHM property includes the OHM building and paved surfaces. Soil and groundwater at the OHM source area are contaminated with tetrachloroethylene (PCE), trichloroethylene (TCE), and *cis*-1,2-dichloroethylene (*cis*-1,2-DCE). The area surrounding the site is a mixture of commercial and residential buildings.

Contaminated groundwater has migrated off-site into residential and commercial areas. Based upon the extent of the plume, shallow depth to groundwater, and concentrations of chemicals in the groundwater, the EPA has conducted indoor air monitoring to assess if groundwater contamination is impacting residential and commercial/industrial indoor air.

2.0 Selection of Chemicals of Potential Concern (COPCs)

Previous environmental investigations conducted by the United States Environmental Protection Agency (EPA) have documented the presence of volatile organic compounds (VOCs) in groundwater, soils, subslab vapor, and indoor air. These compounds included PCE and TCE. Also, a few degradation products of PCE and TCE have been detected and were retained. These compounds include *cis*-1,2-DCE, *trans*-1,2-dichloroethene (*trans*-1,2-DCE), and vinyl chloride.

3.0 Exposure Assessment

The residential and commercial/industrial indoor air action levels are based on default exposure parameters and factors that represent Reasonable Maximum Exposure (RME) conditions for long-term or chronic exposures and are based on the methods outlined in the EPA's Risk Assessment Guidance for Superfund (RAGS), Part B (USEPA, 1991a). Consistent with the RAGS, Part F (USEPA, 2009), inhalation intake is a function of gas solubility, not body weight or inhalation rate. Thus, no adjustments are needed in the intake equations to account for differing body weights and inhalation rates among adults and children. The exposure factors used to derive the action levels are provided in Table 3.1.

Table 3.1. Exposure factors used to derive action levels for residents and commercial/industrial workers.

Symbol	Definition	Units	Value	Source
TR	Target Cancer Risk	-	10^{-5}	-
THQ	Target Hazard Quotient	-	1	-
ATc	Averaging Time – carcinogens	days	25,550	USEPA, 1989
ATn_R	Averaging Time – non-carcinogen – Resident	days	10,950	USEPA, 1989
EF_I	Exposure Frequency – Commercial/Industrial Worker (Indoor)	days/yr	250	USEPA, 2002
EF_R	Exposure Frequency – Resident	days/yr	350	USEPA, 1991b
ED_I	Exposure Duration – Commercial/Industrial Worker (Indoor)	years	25	USEPA, 2002
ED_R	Exposure Duration – Resident	years	30	USEPA, 1991b
ED_{0-2}	Exposure Duration – Resident (Child Age 0 - <2)[1]	years	2	-
ED_{2-16}	Exposure Duration – Resident (Child Age 2 - <16)[1]	years	14	-
ED_{16-30}	Exposure Duration – Resident (Adult Age 16 < 30)[1]	years	14	-
ET_I	Exposure Time – Industrial/Commercial Worker (Indoor)	hrs/day	8	BPJ
ET_R	Exposure Time – Resident	hrs/day	24	USEPA, 2009
CF	Conversion Factor	µg/mg	1000	-

[1] These exposure durations are used when evaluating carcinogens with a mutagenic mode of action (MOA) where default age-dependent adjustment factors (ADAFs) are being applied.

4.0 Toxicity Information

The inhalation unit risks (IURs) and reference concentrations (RfCs) for the COPCs were obtained according to the OSWER Directive 9285.7-53 (USEPA, 2003). Table 4.1 summarizes the COPC toxicity values and provides additional information including their cancer weight-of-evidence (WOE) characterizations and the target organs for non-cancer health effects. Note that there are slight differences in the cancer classification schemes for the WOE characterizations depending on whether the toxicological evaluation was performed before or after the EPA's *Guidelines for Carcinogenic Risk Assessment* (USEPA, 2005a) were published.

No IUR or RfC toxicity values are available for *cis*-1,2-DCE, and although there is a PPRTV RfC value for *trans*-1,2-DCE, the summary file of the 2010 IRIS toxicological review of *trans*-1,2-DCE states that the same study used in the derivation of the PPRTV was considered insufficient to support derivation of an RfC (USEPA, 2010). Thus, the use of the PPRTV RfC is not supported for the purposes of deriving an action level.

The following sections provide additional information on TCE and vinyl chloride with respect to their carcinogenicity and increased early-life susceptibility, which affect the use and application of their IURs.

4.1 Trichloroethylene (TCE)

TCE is characterized as "carcinogenic to humans" by all routes of exposure. This determination is based on convincing evidence of a causal association between TCE exposure in humans and kidney cancer, compelling evidence for non-Hodgkin lymphoma (NHL), and limited evidence for liver cancer (USEPA, 2011). Additionally, epidemiologic studies provide more limited evidence of an association between TCE exposure and other types of cancer, including bladder, esophageal, prostate, cervical, breast, and childhood leukemia (USEPA, 2011).

The EPA has also concluded that TCE is carcinogenic by a mutagenic mode of action (MOA) for induction of kidney tumors (USEPA, 2011). Thus, quantitative adjustments are made to the TCE cancer slope factor (i.e., IUR) to account for increased early-life susceptibility. Additional discussion on these adjustments is provided in Section 4.3.

4.2 Vinyl Chloride

Vinyl chloride is characterized as a Category "A" or "known human carcinogen" by the inhalation and oral routes of exposure and a "highly likely to be carcinogenic" by the dermal route (USEPA, 2000). Additionally, the EPA has identified vinyl chloride as being carcinogenic via a mutagenic MOA (USEPA, 2000). Thus, similar to TCE, quantitative adjustments are made to the vinyl chloride IUR (see Section 4.3).

4.3 Early-Life Susceptibility

As noted in the *Guidelines for Carcinogen Risk Assessment* (USEPA, 2005a) and the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, 2005b), individuals with early-life exposures to carcinogens acting through a mutagenic MOA may be more susceptible to the development of cancer. To account for increased early-life susceptibility, quantitative adjustments are made to the cancer potency values (i.e., IUR) for only those portions of the cancer risk estimates that account for a child's exposure. These adjustments are made using either factors derived from chemical-specific data or default age-dependent adjustment factors (ADAFs) when chemical-specific data is not available. Default ADAFs are provided in Table 4.2 and address the potential for differential potency associated with early-life exposure (less than 16 years of age).

The only contaminants for this site having a mutagenic MOA for carcinogenicity are TCE and vinyl chloride. Currently, chemical-specific data is available for vinyl chloride and adjustments to its increased susceptibility are accounted for in its IUR and a unique set of equations for characterizing risks to vinyl chloride when exposures are less than a lifetime (e.g., 30 years). TCE lacks chemical-specific data; therefore, default ADAFs are used to make adjustments to its IUR.

Also, as discussed in the TCE toxicological evaluation, the IUR accounts for the total risk of developing kidney cancer, liver cancer, and NHL (USEPA, 2011). Because EPA has determined that TCE is carcinogenic via a mutagenic mode of action for the induction of kidney tumors, the IUR has to be apportioned according to tumor type so that the default ADAFs can be properly applied to the kidney cancer component of the total risk estimate. Table 4.1 provides IURs for all tumor types as well as for the individual tumor types. The IUR for all tumor types is only applied to non-residential scenarios where early-life exposure does not occur.

Table 4.1. Summary of Carcinogenic and Chronic Non-Carcinogenic Toxicity Data.

COC	Cancer			Non-Cancer		
	IUR $(\mu g/m^3)^{-1}$	WOE	Source	RfC (mg/m^3)	Target Organ	Source
PCE	2.6E-07	Likely Human Carcinogen	IRIS	4E-02	Neurological	IRIS
TCE	4.1E-06 Total (IUR) 1.0E-06 Kidney (IUR_K) 3.1E-06 NHL/Liver (IUR_{NL})	Carcinogenic to Humans	IRIS	2E-03	Development, Immune System, and Kidney[1]	IRIS
Vinyl Chloride	4.4E-06	Known/Likely Human Carcinogen	IRIS	1E-01	Liver	IRIS

IRIS: Integrated Risk Information System (USEPA, 2011a).
na: not available.
NHL: Non-hodgkin lymphoma.
[1] The TCE RfC is based on two critical effects and one supporting effect that yielded similar candidate RfCs.

Table 4.2. Recommended Default ADAFs (USEPA, 2005b).

Age Groupings (years)	ADAF (unitless)
0-2	10
2-16	3
16-30	1

5.0 Calculation of Action Levels and Target Risk Levels

The action levels were calculated for indoor air using a formula based on methodology presented in the *Risk Assessment Guidance of Superfund, Volume I, Part F* (EPA, 2009). Equations for the TCE and vinyl chloride residential carcinogenic action levels have been modified to account for early-life susceptibility and are consistent with the recommendations provided in their respective toxicological evaluations (USEPA, 2000, 2011). The action levels in this assessment use default exposure parameters based on established EPA guidance and policies. The exposure parameters and variable definitions are presented in Table 4.1, while the carcinogenic and non-carcinogenic action level formulas are presented below.

Action levels were derived based on an excess individual lifetime cancer risk of 1E-05 and 1E-04, and a hazard quotient (HQ) of 1, which is consistent with the Region 7 Vapor Intrusion Risk Management Decision Matrix. Because multiple carcinogens may be present in indoor air, it may be appropriate to select an action level based on a cancer risk of 1E-05.

Residential Air Action Levels

Non-Carcinogenic Action Level ($IAnc_R$) (µg/m^3)

$$IAnc_R = \frac{THQ \times ATn_R \times CF}{\frac{ET}{24\frac{hrs}{day}} \times EF_R \times ED_R \times \frac{1}{RfC}}$$

PCE Carcinogenic Action Level (IAc_R) (µg/m^3)

$$IAc_R = \frac{TR \times ATc}{\frac{ET}{24\frac{hrs}{day}} \times EF_R \times ED_R \times IUR}$$

TCE Carcinogenic Action Level (IAc_R) (µg/m^3)

$$IAc_R = \frac{TR \times ATc}{\frac{ET_R}{24\frac{hrs}{day}} \times EF_R \times ((ED_{0-2} \times ADAF_{0-2} \times IUR_K) + (ED_{2-16} \times ADAF_{2-16} \times IUR_K) + (ED_{16-30} \times IUR_K) + (ED_R \times IUR_{NL}))}$$

Vinyl Chloride Carcinogenic Action Level (IAc_R) (µg/m^3)

$$IAc_R = \frac{TR \times ATc}{IUR + (\frac{ET_R}{24\frac{hrs}{day}} \times EF_R \times ED_R \times IUR)}$$

Industrial Air Action Levels

Non-Carcinogenic Action Level ($IAnc_I$) (µg/m^3)

$$IAnc_I = \frac{THQ \times ATn_I \times CF}{\frac{ET_I}{24\frac{hrs}{day}} \times EF_I \times ED_I \times \frac{1}{RfC}}$$

Carcinogenic Action Level (IAc_R) ($\mu g/m^3$)

$$IAc_I = \frac{TR \times ATc}{\frac{ET_I}{24\frac{hrs}{day}} \times EF_I \times ED_I \times IUR}$$

6.0 Recommended Action Level

Table 6.1 summarizes the recommended indoor air action levels for the residential and commercial/industrial exposure scenarios. The residential indoor air action levels are intended to be used for residential land uses, but can also be applied to land use scenarios including schools and daycare centers where children may be exposed on a regular basis. The commercial/industrial indoor air action levels apply to land uses that are primarily occupational. The corresponding action levels equate to an excess individual lifetime cancer risk of 1E-05 and 1E-04, as well as an HQ of 1. Because of the presence of multiple contaminants, it may be appropriate for the Superfund program to select an action level based on a cancer risk of 1E-05. Please note that in selecting an appropriate action level, it must be recognized that levels of the PCE and the TCE corresponding to a target cancer risk of 1E-05 or 1E-04 may exceed their respective non-carcinogenic level.

Table 6.1. Recommended Indoor Air Action Levels for the Residential and Commercial/Industrial Exposure Scenarios.

	Residential Exposure			Commercial/Industrial Exposure		
	Cancer Risk			Cancer Risk		
	1E-05 ($\mu g/m^3$)	1E-04 ($\mu g/m^3$)	HQ = 1 ($\mu g/m^3$)	1E-05 ($\mu g/m^3$)	1E-04 ($\mu g/m^3$)	HQ = 1 ($\mu g/m^3$)
PCE	94	940	42	470	4,700	175
TCE	4.3	43	2.1	30	300	8.8
Vinyl chloride	1.6	16	100	28	280	440

7.0 References

U.S. EPA. 1989. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part A. EPA/540/1-89/002. Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA. 1991a. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual - Part B. EPA/540/R-92/003, Publication 9285.7-01B. Office of Emergency and Remedial Response, Washington, D.C.

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U.S. EPA. 2011. Toxicological Review of Trichloroethylene (CASRN 79-01-6) In Support of Summary Information on the Integrated Risk Information System (IRIS). (EPA/635/R-09/011F). Washington, DC.