NON-CANCER TOXICITY OF CARCINOGENIC CHEMICALS AS A RISK DRIVER FOR TOXIC WASTE SITE CLEANUP DECISIONS

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ABSTRACT

Ordinarily, the non-cancer toxicity of carcinogenic chemicals receives comparatively less consideration when conducting a human health risk assessment at hazardous waste sites. Carcinogenicity is assumed to be the "risk driver," and cleanup decisions are based on cancer risk alone. Recently new toxicity evaluations of several carcinogenic chemicals have caused this assumption to be reconsidered. We identified five volatile organic compounds (VOCs) frequently found at sites where non-cancer toxicity exposures [hazard quotient (HQ)] are significant (HQ greater than 1), but result in cancer risks within the 1E-06 to 1E-04 cancer risk management (RM) range. These include the 2011 USEPA and provisional peer-reviewed toxicity values (PPRTV) non-cancer assessments for trichloroethene (TCE) and 1,1,2-trichloroethane (TCA), respectively, and the 2014 OEHHA non-cancer assessment for benzene. In addition the USEPA toxicity assessment for methylene chloride also exhibit HQ greater than 1 at exposures in the RM range for cancer. We present several case studies to demonstrate examples where hazard rather than cancer risk was the risk driver for cleanup decisions. At Sites A and B, potential vapor intrusion issues from modeled benzene and 1,1,2-TCA soil vapor data resulted in a HQ of 1.6 and 12, respectively, while cancer risks were within the RM range. At Site C, detected indoor air TCE concentrations resulted in a HQ of 2, while the cancer risk was at the low end of the RM range. Additionally, the potential for adverse health effects from exposure to these chemicals is heightened due to the exposure period of non-cancer, of particular concern is the potential developmental effect from short-term (weeks) TCE exposure and shorter time period in which DTSC and USEPA consider when evaluating non-cancer hazard compared to lifetime for cancer. These case studies illustrate that non-cancer threshold may now play more of a role in RM decisions and have important implications on site risks and cleanup.

INTRODUCTION

Carcinogenic risk generally drives cleanup decisions at hazardous waste sites (HAZWS). This is particularly true at sites where risk is driven by volatile organic chemicals (VOCs). Non-carcinogenic toxicity (hazard quotient or HQ) frequently plays a minor role and is often ignored. New non-cancer hazard inhalation toxicity criteria (RfCs) for several chemicals from Cal EPA and US EPA are more stringent (health protective) than in their earlier iterations and may play a major role in cleanup decisions. This is illustrated with data from three HAZWS where we present data illustrating that the non-cancer criteria (reference concentrations or RfCs) may play a larger role than the cancer criteria (Inhalation Unit Risk or IUR) when deciding whether remediation is warranted at the site.

Superfund guidance mandates that the risk range for managing cancer risk at HAZWS is between one in one million (1E-06) and one in ten thousand (1E-04), with 1E-06 as the point of departure for making risk management decisions. Trichloroethene (TCE), 1,1,2-trichloroethane (TCA), benzene, and methylene chloride (MC) have non-cancer HQs that are greater than 1.0 when cancer risks are within the risk management range of 1E-06 and 1E-04. Failure to take into account the RfCs of these chemicals may lead to overlooking significant non-carcinogenic health risks.

Table 1. Comparison of Reference Concentrations (RfCs)

Analyte	Previous RfC (mg/m^3)	Current RfC (mg/m^3)
Benzene	3.0E-02[1]	3.0E-03[2]
Trichloroethene (TCE)	4.0E-02[3]	2.0E-03[4]
1,1,2-Trichloroethane (TCA)	1.4E-02[5]	2.0E-04[6]
Methylene Chloride (MC)	4.0E-01[7]	6.0E-01[8]

Table 2. Indoor Air Screening Levels (IASLs)

		Residential			Industrial		
Analyte	Source	$IASL_{cancer}$ ($\mu g/m^3$)	$IASL_{noncancer}$ ($\mu g/m^3$)	HQ of 1 = Cancer Risk	$IASL_{cancer}$ ($\mu g/m^3$)	$IASL_{noncancer}$ ($\mu g/m^3$)	HQ of 1 = Cancer Risk
Benzene	OEHHA	0.1	3.1	3.0E-05	0.42	13	3.0E-05
	IRIS	0.36	31	8.6E-05	1.6	130	8.3E-05
TCE	IRIS	0.48	2.1	3.0E-06	3	8.8	3.0E-06
TCA	IRIS	0.18	0.21	1.0E-06	0.77	0.88	1.0E-06
Methylene Chloride	OEHHA	1.01	420	1.5E-04	12	1800	1.5E-04
	IRIS	100	630	2.0E-06	1200	2600	2.0E-06

OEHHA – CalEPA Office of Environmental Health Hazard Assessment
IRIS – Integrated Risk Information System
HQ – Hazard Quotient

CASE STUDIES

Site A – Benzene – Vapor Intrusion

- Former Northern California Industrial Site.
- Currently under redevelopment for mixed use to include residential homes and commercial businesses.
- Site was divided into parcels and sampled for gasoline range constitutes and chlorinated VOCs.
- A Tiered screening level risk assessment was conducted.
- The benzene cancer risk for this parcel is within the risk management range of 1E-06 to 1E-04, however, the non-cancer hazard index exceeds 1.
- The non-cancer threshold must be discussed and considered in the risk management decision.

Former Northern California Industrial Site		
	Residential	
	Hazard	Cancer
Parcel 1	**1.6**	6.2E-05

Site B – 1,1,2-TCA – Vapor Intrusion

- Current Northern California Industrial Site.
- Site has ongoing commercial/industrial operations.
- Site was divided into source areas and sampled for chlorinated VOCs, metals, and explosives.
- Maximum soil vapor 1,1,2-TCA concentration of 27,900 $\mu g/m^3$.
- The 1,1,2-TCA cancer risk for this source area is within the risk management range, however, the non-cancer hazard index exceeds 1.
- The non-cancer threshold must be considered in the risk management decision.

Current Northern California Industrial Site		
	Industrial	
	Hazard	Cancer
Source Area 1	**12**	1.4E-05

Site C – TCE – Indoor Air

- An operating industrial site located in Southern California.
- Indoor air samples were collected in the building at two locations, during two sampling events in 2012 and 2013.
- Detected indoor air TCE concentrations ranged from 12 $\mu g/m^3$ to 17 $\mu g/m^3$.
- The TCE indoor air cancer risks are at the low end of the risk management range, however, the non-cancer hazard index exceeds 1.
- The non-cancer threshold is driving remediation for this building.

Current Southern California Industrial Site			
Building X		**Industrial**	
Location	Sampling Date	Hazard	Cancer
1	4/2012	**1.7**	4.7E-06
	4/2013	**2**	5.7E-06
2	4/2012	**1.4**	4E-06
	4/2013	**1.6**	4.7E-06

DISCUSSION and SUMMARY

- The vapor intrusion to indoor air pathway and/or indoor air tend to be a driver for cleanup at many hazardous waste sites.
- In the past, the cancer risk drove cleanup at these sites.
- As illustrated in our Case Studies, for these three chemicals, the cancer risk maybe within the risk management range, while the non-cancer threshold exceeds the acceptable level of 1 for a single chemical.
  - If multiple chemicals are present at the site, the non-cancer threshold could well exceed 1.
- Additionally, the non-cancer threshold, (i.e., hazard quotient) may exceed 1 at sites where the cancer risk is at the low end of the risk management range or at the point of departure, 1E-06.
- The non-cancer threshold may now play more of a role in the risk management decision for these chemicals and must be discussed and considered during the risk management process.
- When reviewing the risk assessment during the Five Year Review process, there is a potential that the original proposed remediation, land use controls, and/or institutional controls will have to be revised if these chemicals are on site.

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