J Mater Cycles Waste Manag (2003) 5:13–21

SPECIAL FEATURE: CONFERENCE REPORT

Integrated Management for Hazardous Waste

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An evaluation of landfill disposal of asbestos-containing waste and geothermal residues within a risk-assessment framework

Received: July 9, 2002 / Accepted: October 17, 2002

Abstract The public perception of risks related to waste disposal facilities appears to reflect general societal anxieties and fears, which may not have a reasonable basis. A three-tier risk assessment study was therefore conducted to evaluate the landfill disposal of asbestos-containing waste (ACW) and geothermal residues. From the tier-1 analysis, the dominant asbestiform phase was identified as chrysotile, that is tightly bound in the matrix of calcite, while arsenic, cadmium, chromium, and lead were identified as the chemicals of potential concern associated with geothermal residues. From the tier-2 analysis, none of the possible exposure pathways associated with the landfill disposal of ACW was found to be potentially significant. On the other hand, there were potentially significant pathways associated with landfill disposal of geothermal residues because of the considerable potential pollution impact of leachate on soil and groundwater quality. From the tier-3 analysis, the health risk associated with landfill disposal of geothermal residues was found to be time-dependent, since the contributions to risk from water-dependent and water-independent pathways occur at different times, as indicated by RESRAD–Chem simulations. Component pathway analyses were performed to identify critical exposure pathways. The results from model sensitivity analysis have identified the input parameters that have the most influence on the time of peak risk, and the cancer risk associated with water-dependent and water-independent pathways.

Key words Landfill · Asbestos-containing waste · Geothermal residues · Risk assessment · RESRAD–Chem

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Introduction

Geothermal power is an attractive alternative source of energy in the Philippines. However, like other industrial activities, a geothermal plant also creates solid wastes such as asbestos-containing wastes (ACW) and geothermal residues. Significant amounts of debris were generated from insulation and fire-retardant materials that were previously installed in old buildings and the facilities of geothermal plants. These solid wastes were suspected to contain asbestos fibers, a known carcinogen. On the other hand, geothermal residues such as scale and sludge were produced from the operation of the geothermal plant within the steam-gathering facilities. These geothermal residues were reported to contain arsenic and other toxic metals at levels above those in normal soils, which also pose a hazard if not disposed of properly.[1]

Generally, landfill disposal is one of the waste management methods that can be applied to these solid wastes. However, it is imperative to integrate a risk-assessment framework to provide information and facilitate cost–effective environmental management decisions on the development and implementation of such disposal facilities, from site selection to postclosure monitoring. Therefore, a tiered risk-assessment study was conducted to evaluate whether potential human receptors are presently, or in the future may be, at risk of adverse health effects as a result of exposure to conditions resulting from potentially hazardous situations that may arise from landfill disposal of ACW and geothermal residues.

Methodology

The study framework followed a three-tier approach, as shown in Fig. 1. This framework is designed to get a preliminary site-specific risk assessment for as little expenditure of resources as possible, and use this result to evaluate whether or not further effort is needed.

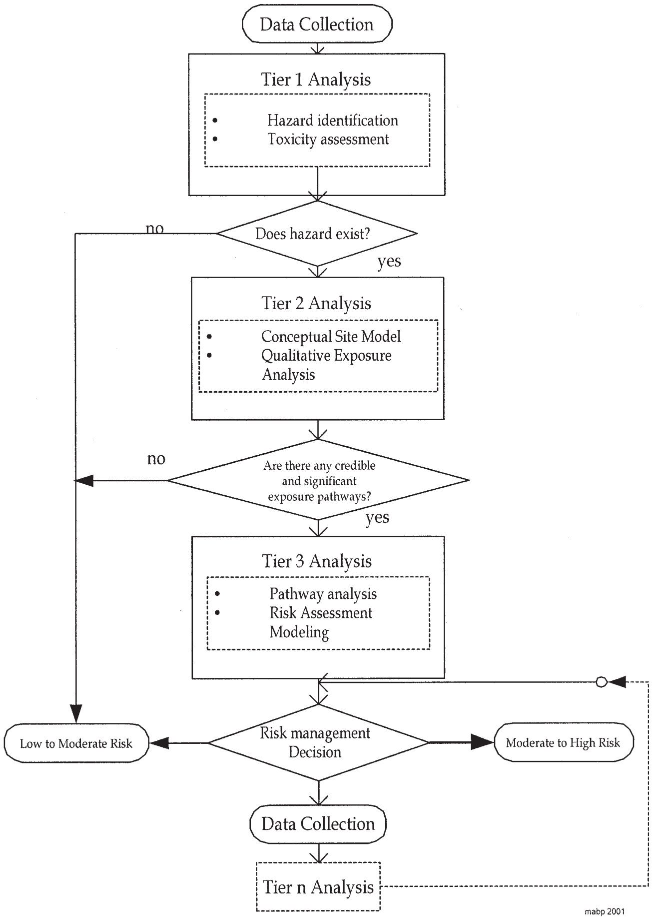


Fig. 1. The study framework used to evaluate landfill disposal of asbestos-containing waste and geothermal residues

The first tier involved hazard identification and toxicity assessment in order to assess the intrinsic hazard posed by the wastes in the landfill. Primary and secondary data were collected and reviewed to identify and select the chemicals of potential concern (COPC). The available toxicity information regarding COPC was obtained from the literature. The toxicity indexes, such as the chronic reference dose and slope factor, were obtained primarily from the Integrated Risk Information System (IRIS) database.[2]

The second tier involved the development of a conceptual site model for a reasonable worst-case scenario. Then a qualitative exposure analysis was done to identify the possible and potentially significant pathways that might arise from landfill disposal of these wastes. As well as the secondary data that were collected, site reconnaissance was conducted to describe the physical and environmental setting of the landfill site. The contaminated site in the model was assumed to be an abandoned landfill site used to dispose of untreated geothermal residues and ACW in separate cells.

A residential exposure scenario, in which a family constructs a home on the contaminated site and raises an appreciable fraction of its food on-site, was considered as a reasonable worst-case scenario for evaluating the proposed landfill site for several hundred years into the future. The permanent residents were identified as the primary critical population group, since exposure for them is more likely to be long-term, and will generally involve exposure by different modes or pathways. This was expected to result in the highest predicted lifetime dose.

Table 1. Leachable concentrations from geothermal residues

Chemical	Average concentration (p.p.m.)[b]	%[c]	Maximum leachable concentration (p.p.m)
As	779.73	60	467.84
Cr (VI)[a]	4687.76	40	1875.10
Cd	90.69	80	72.55
Pb	218.33	40	87.33

[a] The reported total assay is total chromium, but for the purpose of the modeling, this was used for chromium (VI) as the worst-case scenario
[b] Weighted average of the combined sludge and scale[6]
[c] Percentage of the total assay that is extracted in the nonresidual phase of sequential chemical extraction[7]

The third tier involved pathway analysis and risk assessment modeling, using a RESRAD–Chem computer simulation, to assess the long-term (chronic) exposure and health effects arising from on-site or nearby exposure to COPC associated with the landfill disposal of ACW and geothermal residues. RESRAD–Chem, one of the RESRAD (RESidual RADioactive material guidelines) family of computer codes, is a multiple-pathway analysis computer code for evaluating chemically contaminated sites.[3] The Environmental Assessment Division (EAD) staff of Argonne National Laboratory (ANL), Illinois, USA, developed these computer codes to provide useful tools for evaluating human health risks from residual contamination. RESRAD has been applied by the US Department of Energy to establish soil clean-up guidelines for many radioactively contaminated sites. The methodology used by RESRAD–Chem for pathway analysis is based on the structure and methodology of RESRAD code.

The disposal scenario in the risk-assessment simulation using RESRAD–Chem is a one-time disposal of wastes in the landfill. The wastes are placed in an excavated pit situated 30 m above the watertable, with a 0.5-m final cover of topsoil. Although the actual disposal is intermittent during the lifespan of the landfill, the hypothetical scenario will yield a more conservative estimate of risk. To be able to assess the upper limit of the risk, the landfill is not controlled, i.e., it has no geotechnical bed linings and no leachate collection system. With this simple landfill design, the leachates generated are all expected to percolate to the groundwater. This modeling scenario, being the worst case, will thus yield conservative results. This landfill on the proposed site is the contaminated zone in the RESRAD–Chem simulations. The values used for the initial concentrations of chemicals (mg/kg) in the contaminated zone are shown in Table 1. The model input parameters were drawn from literature values suggested by Yu et al.[4] and from site-specific data whenever possible (Table 2).

Table 2. Key model input parameters used in the RESRAD–Chem analysis

RESRAD–Chem input parameter	Value (base case)
Inhalation Unit risks, risk/(μg/m^3)	
Arsenic, inorganic	4.300E−03
Cadmium	1.800E−03
Chromium (VI)	1.200E−02
Lead and compounds (inorganic)	0.000E+00
Ingestion slope factors, risk/(mg/kg/day)	
Arsenic, inorganic	1.500E−03
Cadmium	0.000E−03
Chromium (VI)	0.000E−02
Lead and compounds (inorganic)	0.000E+00
Inhalation reference concentration (mg/m^3)	
Arsenic, inorganic	4.300E−03
Cadmium	1.800E−03
Chromium (VI)	1.200E−02
Lead and compounds (inorganic)	0.000E+00
Ingestion reference dose (mg/kg/day)	
Arsenic, inorganic	3.00E−04
Cadmium	1.00E−03
Chromium (VI)	3.00E−03
Lead and compounds (inorganic)	3.500E−03
Area of contaminated zone (m^2)	5.000E+03
Thickness of contaminated zone (m)	3.000E+00
Cover depth (m)	5.000E−01
Cover depth erosion rate (m/year)	1.800E−04
Density of contaminated zone (g/cm^3)	2.000E+00
Contaminated zone erosion rate (m/year)	1.800E−04
Contaminated zone total porosity	4.125E−01
Contaminated zone effective porosity	1.900E−01
Contaminated zone hydraulic conductivity (m/year)	3.150E+02
Contaminated zone *b*-parameter	4.050E+00
Evapotranspiration coefficient	7.000E−01
Precipitation (m/year)	2.076E+00
Irrigation (m/year)	3.000E−01
Runoff coefficient	4.000E−01
Watershed area for nearby stream or pond (m^2)	2.000E+06
Density of saturated zone (g/cm^3)	2.300E+00
Saturated zone total porosity	1.000E−01
Saturated zone effective porosity	2.000E−02
Saturated zone hydraulic conductivity (m/year)	1.000E+03
Saturated zone hydraulic gradient	1.000E−02
Saturated zone *b*-parameter	5.300E+00
Unsaturated zone thickness (m)	3.000E+01
Unsaturated zone soil density (g/cm^3)	1.750E+00
Unsaturated zone total porosity	2.500E−01
Unsaturated zone effective porosity	1.850E−01
Unsaturated zone soil specific *b*-parameter	1.140E+01
Unsaturated zone hydraulic conductivity (m/year)	1.000E+02
Distribution coefficient for arsenic (inorganic)	
Contaminated zone (cm^3/g)	3.000E−01
Unsaturated zone 1 (cm^3/g)	3.000E+00
Saturated zone (cm^3/g)	3.000E+00
Distribution coefficients for cadmium	
Contaminated zone (cm^3/g)	4.000E−01
Unsaturated zone 1 (cm^3/g)	4.000E+00
Saturated zone (cm^3/g)	4.000E+00
Distribution coefficients for chromium (VI)	
Contaminated zone (cm^3/g)	7.000E−01
Unsaturated zone 1 (cm^3/g)	7.000E+00
Saturated zone (cm^3/g)	7.000E+00
Distribution coefficients for lead and compounds (inorganic)	
Contaminated zone (cm^3/g)	1.000E+01
Unsaturated zone 1 (cm^3/g)	1.000E+02
Saturated zone (cm^3/g)	1.000E+02
Mass loading for foliar deposition (g/m^3)	1.000E−04
Depth of soil mixing layer (m)	1.500E−01
Depth of roots (m)	9.000E−01

RESRAD–Chem simulations determined the intake or uptake (average daily dose) of the chemicals for different time-periods. The calculations were based on the computed concentrations on different environmental media, and on the generic exposure parameters appropriate for the family-farm exposure scenario. Subsequently, the corresponding cancer risk and hazard index were estimated, including the maximum value within the specified time-frame. The sensitivity of the model output, i.e., the calculated cancer incidence risk and the time of peak risk for each set of model parameters, were also determined based on the graphical output of a sensitivity analysis.

Results and discussion

The results from stereomicroscopic and petrographic observations indicate that the dominant asbestiform phase in the samples suspected of being asbestos-containing waste is chrysotile, which is tightly bound in the matrix of the binding material. According to Mossman and Gee as cited by Watts,[5] chrysotile is less toxic than amphibole asbestos (crocidolite and amosite asbestos). The volumetrically dominant binding material is calcite, as identified in X-ray diffraction (XRD) analysis. None of the possible exposure pathways is potentially significant, since there is a minimal chance of the fibers being released as long as the matrix material is intact and sufficient cover is provided. Thus, the risk associated with the landfill disposal of ACW is probably low for a family-farm scenario. However, significant erosion and disturbance, such as excavation of the site, may expose the ACW. Subsequently, weathering through rain, wind, or mechanical action would result in the release of the fibers to the air and pose a potential health risk. If this scenario happens, sampling and monitoring of the asbestos fibers in the ambient air would be necessary in order to quantify the risk associated with potential asbestos exposure.

On the other hand, previous studies[1] showed that Philippine geothermal residues contain significant levels of environmentally important elements such as lead (Pb), zinc (Zn), copper (Cu), chromium (Cr), arsenic (As), manganese (Mn), and barium (Ba). Data from leaching test indicate that As, Cd, Cr, and Pb are the COPC associated with geothermal residues.[6,7] Table 3 shows the leachate concentrations from the toxicity characteristic leaching procedure (TCLP), as well as the maximum possible concentrations based on sequential chemical extraction (SCE). Note that SCE is a more aggressive test for leachability than TCLP, which is a protocol-leaching test developed in 1980 by United States Environmental Protection Agency (USEPA) to determine the mobility of both organic and inorganic constituents of liquid, solid, and multiphase waste.[8] Sequential chemical extraction involves several extractions using successively stronger reagents and higher temperatures, each intended to remove one phase from the sample.[6] Thus, the predicted leachate concentrations from SCE could represent the leaching of geothermal residues under extreme conditions. A 60% leaching based on a SCE test of a sludge containing 823.1 mg/kg As would equate to a maximum possible leachate load

Table 3. Leachate concentrations of geothermal residues based on the leachability test

Chemical	TCLP analysis[a]			SCE test		
Scale	Leachate conc. (mg/l)			Total assay[b] (mg/kg)	% leached[c]	Conc.[d] (mg/l)
	Min	Max	Mean			
As	0.0035	0.98	0.37	823.1	60	24.7
Cr	0.0	0.0	0.0	8878.7	40	177.6
Cd	0.0	0.11	0.04	155.9	80	6.2
Pb	0.0	0.06	0.02	290.1	40	5.8
Sludge	Leachate conc. (mg/l)			Total assay[b] (mg/kg)	% leached[c]	Conc.[d] (mg/l)
	Min	Max	Mean			
As	0.0	55.4	4.43	704.0	60	21.1
Cr	0.0	4.2	0.4	1565.9	40	31.3
Cd	0.0	0.2	0.03	7.8	80	0.3
Pb	0.0	0.5	0.05	138.4	40	2.8

TCLP, toxicity characteristic leaching procedure; SCE, sequential chemical extraction

[a] Leachate concentrations obtained from the database of geothermal solid waste[6]

[b] Mean of total assays obtained from the database of geothermal solid waste[6]

[c] Percentage leached based on SCE test[7]

[d] Maximum possible leachate concentration if leached based on SCE test and a solid : fluid ratio of 1 : 20

of 24.7 mg/l, i.e., 49.4 mg As in 100 g sludge dissolved in 2l extraction fluid (1 : 20 solid : fluid ratio).

These contaminants may leach out from the matrix of geothermal residues and become mobile. Thus, one potential release mechanism is leachate generation in which the soil and groundwater is directly affected. On the other hand, only fugitive dust generation is identified as the potential release mechanism. Figure 2 shows the potentially significant pathways associated with landfill disposal of geothermal residues. The pathways from the water contaminated by the leachate to the exposure point, via different modes or pathways, will be referred to as water-dependent pathways (WDP). On the other hand, the migration of a contaminant through a water-independent pathway (WIP) is also possible through plant uptake, fugitive dust generation, and surface runoff once the landfill cover is completely eroded.

The results from the RESRAD–Chem computer simulation indicate that these contributions to risk from water-dependent and water-independent pathways do occur at different times. Table 4 gives the contributions of water-dependent and water-independent pathways to the estimated total cancer incidence risk. It can be seen that the contributions to the dose from water-dependent pathways are delayed until contaminants transported by groundwater reach a point of water withdrawal. On the other hand, water-independent pathways are a significant initial contributor to the dose because of family-farm activity on the site. This implies that the chronic health effect from exposures to COPC at the start of the simulation is due to risk associated with WIP. Similarly, the predicted maximum risk is linked with the contribution of WDP, and occurs about 260 years after the initial year of this simulation. The maximum cancer risk (9.78×10^{-4} from As exposure) and hazard index (8.38 from Cd exposure) exceeded the acceptable level (10^{-6} to 10^{-4} for cancer risk, 1 for hazard index) within a time-frame of 100 years. A tolerable, or "de minimis," cancer risk for regulatory purposes is in the range 10^{-6} to 10^{-4}, i.e., one additional case in a population of 1 million to one case in 10 000 compared with a background risk of one in three or four. As a rule of thumb in the interpretation of hazard index (HI) calculations, an HI of less than or equal to unity (1) can be used as an acceptable benchmark. For any given chemical, there may be a potential for adverse health effects if the HI exceeds one, i.e., the exposure level exceeds the corresponding reference dose (RfD). The higher the value of HI, the greater is the level of concern for a potential noncancer effect. For a time-frame of 1000 years, the maximum cancer risk is 3.61×10^{-1} from As exposure, with an HI of 1.60×10^{3}. It should be noted that the estimated values tend to be the upper-bound estimates because of the conservative assumptions incorporated in the model. These do not necessarily give a realistic prediction of cancer risks and noncancer hazards because of uncertainties inherent in the risk assessment process.

Component pathway analysis indicated that the critical water-independent exposure pathway is the ingestion of plants grown on-site (plant pathway). Likewise, the critical water-dependent pathway is the ingestion of drinking water drawn from an on-site well or pond (drinking-water pathway).

Model sensitivity analysis was performed to evaluate the impact of various input parameters on the cancer risk associated with arsenic exposure from plant pathways (water-independent) and drinking water pathways (water-dependent), as well as on the time of peak risk. Each input parameter was subjected to either a ±50% range of the base parameter value, or the allowed maximum range for the base parameter value. The results of this simulation are too extensive to show here. Therefore, a sample graphical

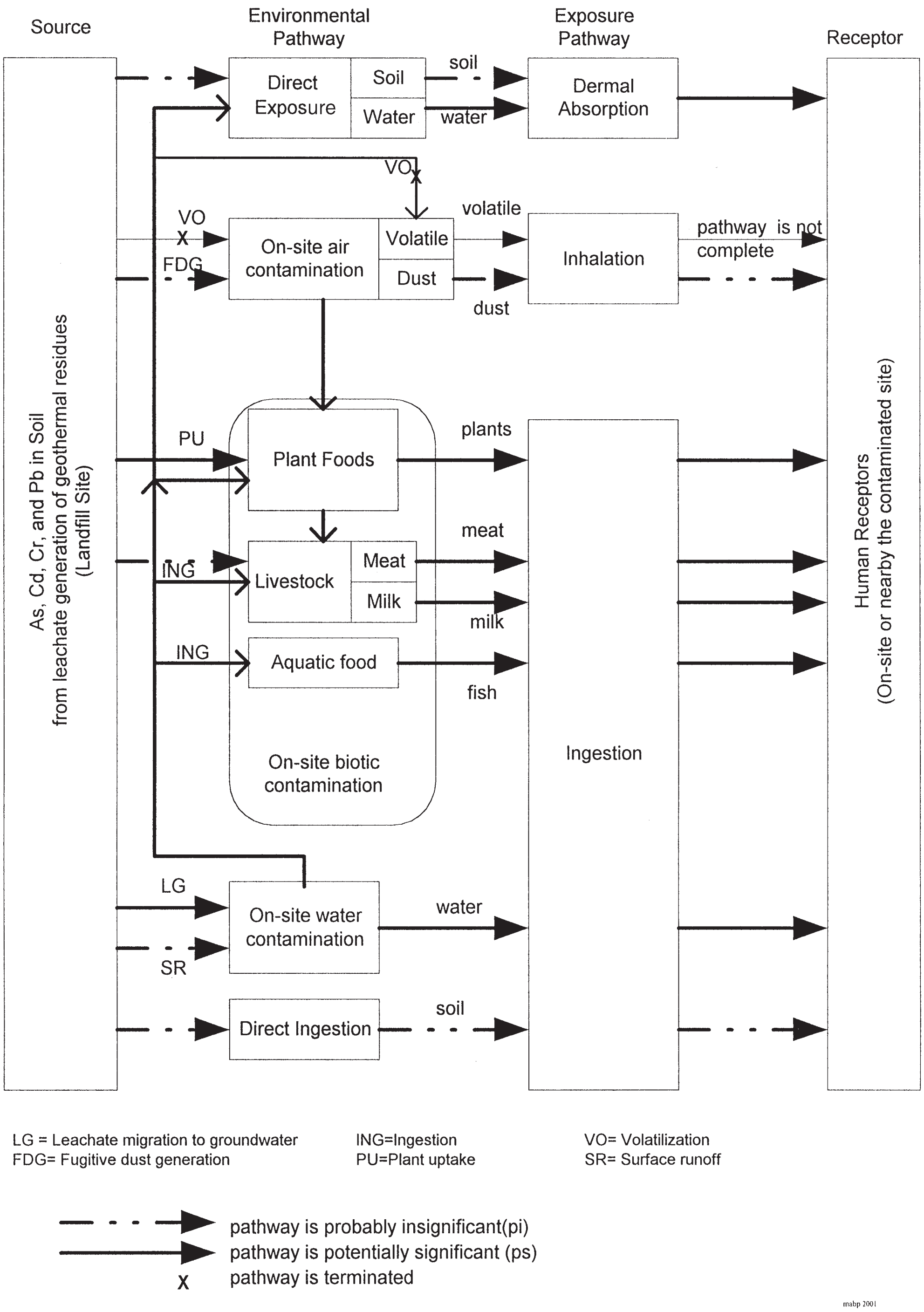


Fig. 2. Conceptual site model diagram associated with the landfill disposal of geothermal residues

output of the RESRAD–Chem sensitivity analysis is shown for the case of cancer risk (model output) resulting from As exposure through a water-independent plant pathway (Fig. 3). For example, the results indicate a high sensitivity of the calculated cancer risk to cover depth (Fig. 3b) compared with the sensitivity of the calculated cancer risk to contaminated zone total porosity (Fig. 3c). On the other hand, a low sensitivity of the calculated cancer risk to cover depth erosion rate was observed (Fig. 3a). Qualitative descriptions of the sensitivity of each parameter to the calculated cancer incidence risk from arsenic exposure (plant and drinking water pathways) and the time of peak risk are given in Tables 5–10. The results from the sensitivity analysis are as follows. (1) The input variables that have the most influence on the cancer risk contribution from water-independent pathways are: area of contaminated zone, cover depth, density of contaminated zone, evapotranspiration coefficient, precipitation, runoff coefficient, contaminant distribution coefficient in the contaminated zone, and depth of roots. (2) The input variables that have the most influence

Table 4. Contribution of water-independent and water-dependent pathways to the computed total cancer risk

Time (years)[a]	Total cancer risk[b]	Water-independent[c]	Water-dependent[d]
0	9.784E−04	9.784E−04	0.000E+00
1	8.123E−04	8.123E−04	0.000E+00
3	5.601E−04	5.601E−04	0.000E+00
10	1.524E−04	1.524E−04	0.000E+00
30	3.697E−06	3.697E−06	0.000E+00
100	8.219E−12	8.219E−12	0.000E+00
263[e]	3.608E−01	5.230E−25	3.608E−01
290	4.135E−03	3.490E−27	4.135E−03
1000	0.000E+00	0.000E+00	0.000E+00

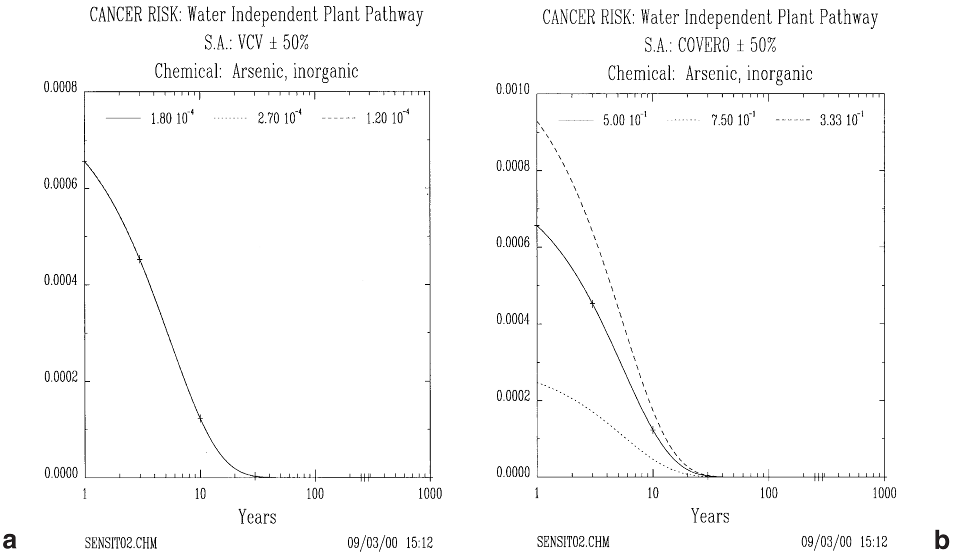
[a] Time of calculations since the initial time of simulation

[b] Total cancer risk summed for all chemicals and pathways

[c] Cancer risk summed for all chemicals and water-independent pathways

[d] Cancer risk summed for all chemicals and water-dependent pathways

[e] Time of maximum risk computed internally by RESRAD–Chem



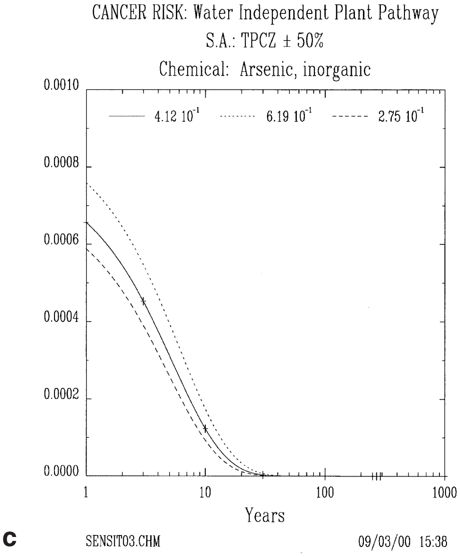


Fig. 3. Sample graphical output from the RESRAD–Chem sensitivity analysis. **a** The effect of the cover depth erosion rate (m/year) on cancer risk contributed by plant (water-independent) pathway. **b** The effect of the cover depth (m) on cancer risk contributed by plant (water-independent) pathway. **c** The effect of the contaminated zone total porosity on cancer risk contrbuted by plant (water-independent) pathway

Table 5. Contaminated zone parameter sensitivity to the calculated cancer risk, and the time of occurrence of maximum risk

Parameter	Cancer risk						Time of maximum risk		
	Plant pathway			Water pathway					
	H	M	L	H	M	L	H	M	L
Area of contaminated zone			√			√			√
Thickness of contaminated zone	√			√					√
Length parallel to aquifer flow			√	√					√

H, high; M, medium; L, low
Plant pathway refers to the water-independent pathway through plants
Water pathway refers to the water-dependent pathway through drinking water

Table 6. Cover and contaminated zone hydrological parameter sensitivity to the calculated cancer risk, and the time of occurrence of maximum risk

Parameter	Cancer risk						Time of maximum risk		
	Plant pathway			Water pathway					
	H	M	L	H	M	L	H	M	L
Cover depth	√					√			√
Cover depth erosion rate			√			√			√
Density of contaminated zone	√			√					√
Contaminated zone erosion rate			√			√			√
Contaminated zone total porosity		√				√			√
Contaminated zone effective porosity			√			√			√
Contaminated zone hydraulic conductivity		√				√			√
Contaminated zone *b*-parameter		√				√			√
Evapotranspiration coefficient	√			√			√		
Precipitation	√				√		√		
Irrigation		√			√			√	
Runoff coefficient	√				√		√		
Watershed area for nearby stream			√			√			√

Table 7. Saturated zone hydrological parameter sensitivity to the calculated cancer risk, and the time of occurrence of maximum risk

Parameter	Cancer risk						Time of maximum risk		
	Plant pathway			Water pathway					
	H	M	L	H	M	L	H	M	L
Density of saturated zone			√		√				√
Saturated zone total porosity			√		√				√
Saturated zone effective porosity			√		√				√
Saturated zone hydraulic conductivity			√	√					√
Saturated zone hydraulic gradient			√	√					√
Well pump intake depth			√	√					√
Well pumping rate			√			√			√

on the cancer risk contribution from water-dependent pathways are: thickness of contaminated zone, length parallel to aquifer flow, density of contaminated zone, evapotranspiration coefficient, saturated zone hydraulic conductivity, saturated zone hydraulic gradient, and well pump intake depth. (3) The input variables that have the most influence on the time of peak risk, which is primarily dependent on the contaminant transport time to groundwater, are: thickness, soil density, effective porosity, total porosity of the unsaturated zone, contaminant distribution coefficient in the unsaturated zone, precipitation, evapotranspiration coefficient, and runoff coefficient.

Table 8. Uncontaminated and unsaturated zone hydrological parameter sensitivity to the calculated cancer risk, and the time of occurrence of maximum risk

Parameter	Cancer risk						Time of maximum risk		
	Plant pathway			Water pathway					
	H	M	L	H	M	L	H	M	L
Unsaturated zone thickness			√		√		√		
Unsaturated zone soil density			√		√		√		
Unsaturated zone total porosity			√		√		√		
Unsaturated zone effective porosity			√		√		√		
Unsaturated zone soil-specific *b*-parameter			√			√			√
Unsaturated zone hydraulic conductivity			√			√			√

Table 9. Distribution coefficient (K_D) sensitivity to the calculated cancer risk, and the time of occurrence of maximum risk

Parameter	Cancer risk						Time of maximum risk		
	Plant pathway			Water pathway					
	H	M	L	H	M	L	H	M	L
K_D for As in contaminated zone	√					√			√
K_D for As in unsaturated zone			√		√		√		
K_D for As in saturated zone			√		√				√

Table 10. Nondietary (ingestion pathway data) parameter sensitivity to the calculated cancer risk, and the time of occurrence of maximum risk

Parameter	Cancer risk						Time of maximum risk		
	Plant pathway			Water pathway					
	H	M	L	H	M	L	H	M	L
Mass loading for foliar deposition			√			√			√
Depth of soil mixing layer			√			√			√
Depth of roots	√					√			√

Summary and conclusions

The results of stereomicroscopic and petrographic observations suggest that the dominant asbestiform phase in the samples suspected of containing asbestos waste is chrysotile, which is less toxic than amphibole asbestos. The asbestos fibers are tightly bound in the calcite matrix. Thus, the health risk associated with landfill disposal of ACW is relatively low as long as the matrix material is intact, and sufficient landfill cover is present. On the other hand, the chemicals from geothermal residues identified as being of potential concern are arsenic, cadmium, chromium, and lead. We must consider not only the issue of groundwater contamination, but also the impact on soil quality, since there is significant exposure from water-independent pathways. There is a "moderate to high" but manageable risk associated with landfill disposal of geothermal residues because of the considerable potential pollution impact of leachate on soil and groundwater quality. The health risk associated with landfill disposal of geothermal residues is time-dependent, as indicated in the RESRAD–Chem simulation. For a family-farm scenario, the significant contribution from water-independent pathways to the hazard or risk occurs in the early stage of simulation (post-closure period), while that from water-dependent pathways occurs after the migration of the contaminant to groundwater.

The preliminary site-specific quantitative risk assessment with sensitivity analysis suggests that one effective way to reduce the estimated risk contributed by water-independent pathways would be to increase the cover thickness and stop agricultural activities on the site. On the other hand, possible mitigation strategies such as waste immobilization, lining the landfill, improved low-permeability cover, and leachate control should be considered in the planning and design of waste facilities in order to prevent future exposure from groundwater pathways.

Parameters such as soil properties, distribution coefficient, hydraulic conductivity, and other hydrological parameters are determinants of the potential impacts of landfill. More resources should be directed toward reducing the uncertainties of these parameters (including other critical parameters identified from the sensitivity analysis), and therefore reducing the output uncertainty of the next level of analysis, such as a detailed site-specific dispersion modeling.

Acknowledgments We wish to thank Dr. Deborah Nelson for technical assistance regarding ACW, Engr. Ben Rojas for hydrological and hydrogeological data interpretation, Dr. Carlos Arcilla for his assistance in the analysis of ACW, Susan Maligalig, Bel Agtarap, Dr. Avila, Alex Casilla, and Prof. Jun Ballesteros for their assistance with ACW and geothermal residues generated in the geothermal plant, and Jing-Jy Cheng for assistance with RESRAD–Chem.

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