EMRAS – Environmental Modelling for Radiation Safety
Theme 2 – Remediation of sites with radioactive residues

Working Group 1- NORM Issues:_Scenario Development

Hypothetical area source + river scenario: Version 1.1

Introduction

The purpose of a scenario is to provide a means for comparing the predictions of different models against each other. This particular scenario is for an area source with a nearby river, using the information supplied in the Figures and Tables below.

Site Description

The site is an area source consisting of a layer of contaminated waste 1000 m long by 1000 m wide by 10 m thick, with a cover layer of soil 2 m thick. Below the waste is a 3 m thick unsaturated layer consisting of a mixture of sand and clay (see Figure 1). Below the unsaturated layer is a saturated layer of sand 10 m thick.

A diagrammatic representation of the vertical layout of the waste site is shown in Figure 1.

The waste dump is situated 300 m from a river. The plan of the site is shown in Figure 2. This figure also shows the reference direction for the wind rose, the direction of groundwater flow, and the locations of two houses.

The annual wind rose data and atmospheric stability data are shown in Tables 1 and 2 respectively.

The river data are shown in Table 3.

The dietary data are shown in Table 4. Assume that the contaminated fraction for each type of food is 0.5.

In Table 6, the run-off coefficient and evapotranspiration coefficient are defined such that the water infiltration rate is given by (Yu et al, 2001)

$$I = (1 - C_e)[P_r(1 - C_r) + I_{rr}],$$

where
C_e = evapotranspiration coefficient (0.5, dimensionless),
C_r = runoff coefficient (0.2, dimensionless),
P_r = precipitation rate (annual rainfall, 1.0 m/yr), and
I_{rr} = irrigation rate (0.2 m/yr).

The aim is to estimate the annual doses to residents of the two houses shown in Figure 2, assuming that each person spends 16 hours indoors and 8 hours outdoors (see Table 5) working in the field surrounding the house occupied by that person. **Each field is assumed to be 1 km by 1 km in area with the house at the North-east corner**.

For each house, drinking water is supplied from a well situated at the location of the house. Irrigation water is drawn from the river.

Requests to Modellers

1. It would be appreciated if the model calculations could be done four times, using the wind rose in Table 1 and then repeating the calculation with the wind rose rotated 90, 180 and 270 degrees.
2. Please use the data specified in the tables, as this will enable the model outputs to be directly compared with each other.
3. If local data are available, please repeat the calculations using those data and send in the results, as this will provide a measure of the sensitivity of the model being used to changes in input data.

Reference:

Yu, C., A.J. Zielen, J.-J. Cheng, D.J. LePoire, E. Gnanapragasam, S. Kamboj, J. Arnish, A. Wallo III, W.A. Williams,* and H. Peterson. *User's manual for RESRAD version 6.* Environmental Assessment Division; Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439; July 2001

Data Tables and Figures

Table 1: Annual wind rose data

Sector	Wind Direction	Frequency
		(%)
1	345° - < 15°	4.6
2	15° - < 45°	5.4
3	45° - < 75°	7.6
4	75° - < 105°	5.4
5	105° - < 135°	3.8
6	135° - < 165°	7.4
7	165° - < 195°	14.1
8	195° - < 225°	20.3
9	225° - < 255°	13.3
10	255° - < 285°	7.5
11	285° - < 315°	6
12	315° - < 345°	4.1

Table 2: Annual atmospheric stability and wind speed data

Pasquill stability category	Frequency	Mean Wind Speed
	(%)	(m s^{-1})
A	0.5	1
B	0.5	1.5
C	4	2.5
D	28	5
E	38	8
F	27	6
G	2	4

Table 3: River data

distance from edge of waste			300	m
flow rate			20	m^3 s^{-1}
depth	water column		2	m
	top sediment	thickness	0.2	m
		velocity	1	km y^{-1}
house #1	downstream distance		1000	m
	drinking water	well		
	irrigation water	river		
house #2	downstream distance		5000	m
	drinking water	well		
	irrigation water	river		

Table 4: Dietary data

drinking water	well		400	L y^{-1}
irrigation	river		1	L m^{-2} d^{-1} for 100 days
cattle	river		60	L d^{-1}
sheep	river		6	L d^{-1}
diet	fish		5	kg y^{-1}
	grains	+ grain products	80	kg y^{-1}
	fruits	+ juices	80	kg y^{-1}
	vegetables		70	kg y^{-1}
	meat	+ sausages	40	kg y^{-1}
	milk	+ milk products	90	kg y^{-1}
	root crops	without tubers	70	kg y^{-1}
	tubers		90	kg y^{-1}

Table 5: Occupancy data

indoors - sleeping	8	h
indoors - light exercise	8	h
outdoors - light exercise	4	h
outdoors - heavy exercise	4	h

Table 6: Cover data

depth	2	m
porosity	0.4	
effective porosity	0.2	
density	1.5	g cm^{-3}
rainfall	1	m a^{-1}
runoff coefficient[1]	0.2	
evapotranspiration coefficient	0.5	

1. see text.

Table 7: Waste data

length	1000	m
width	1000	m
depth	10	m
Ra-226	1	Bq g^{-1}
porosity	0.4	
effective porosity	0.2	
density	1.5	g cm^{-3}
moisture content	0.3	8 months
	0.1	4 months

Table 8: Unsaturated zone data

thickness	3	m
composition	sand	80 %
	clay	20 %
porosity	0.4	
effective porosity	0.2	

Table 9: Saturated zone data

thickness	10	m
sand	1	
porosity	0.4	
effective porosity	0.2	
Darcy velocity	0.1	m/day

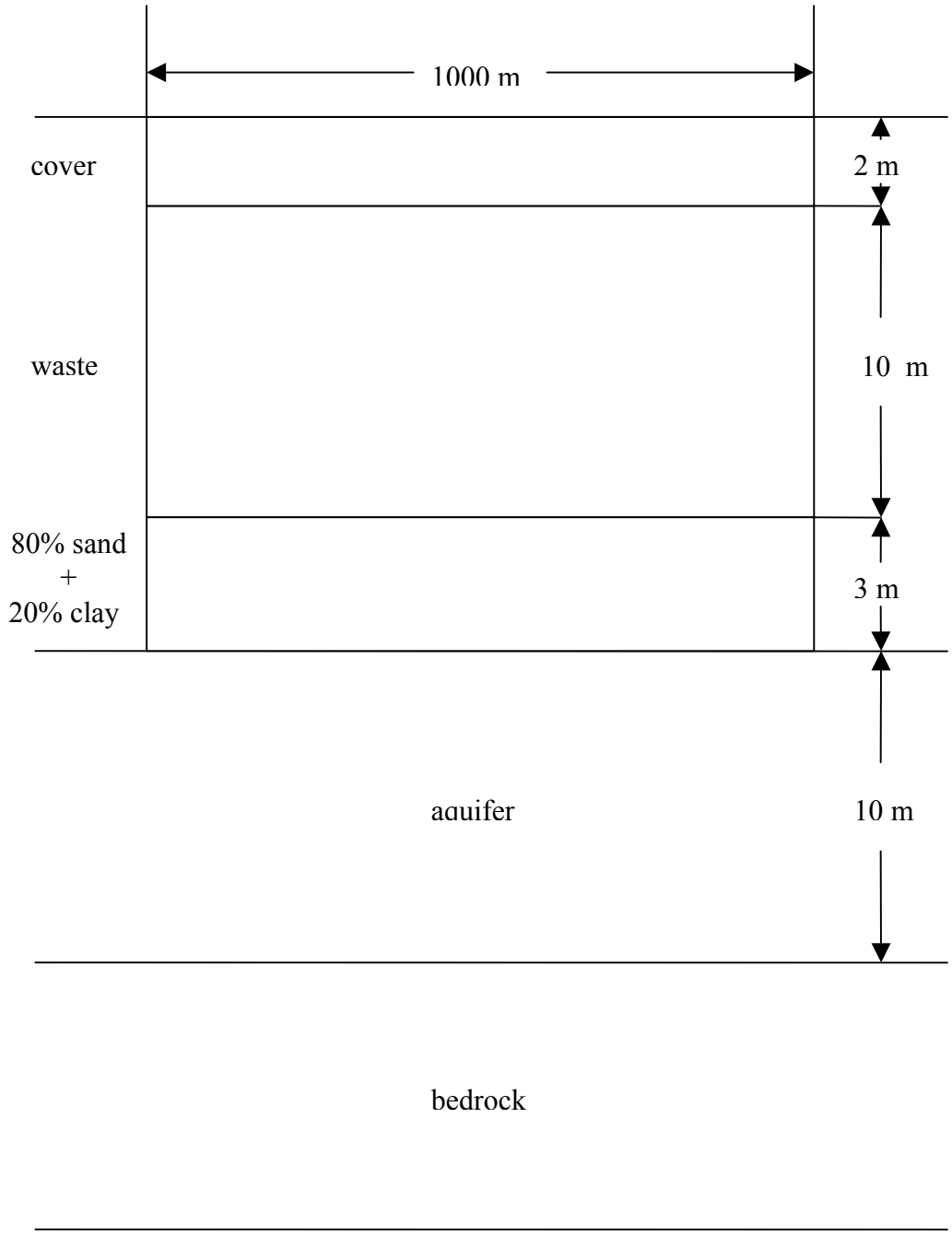

Fig. 1: Vertical scheme of the waste dump

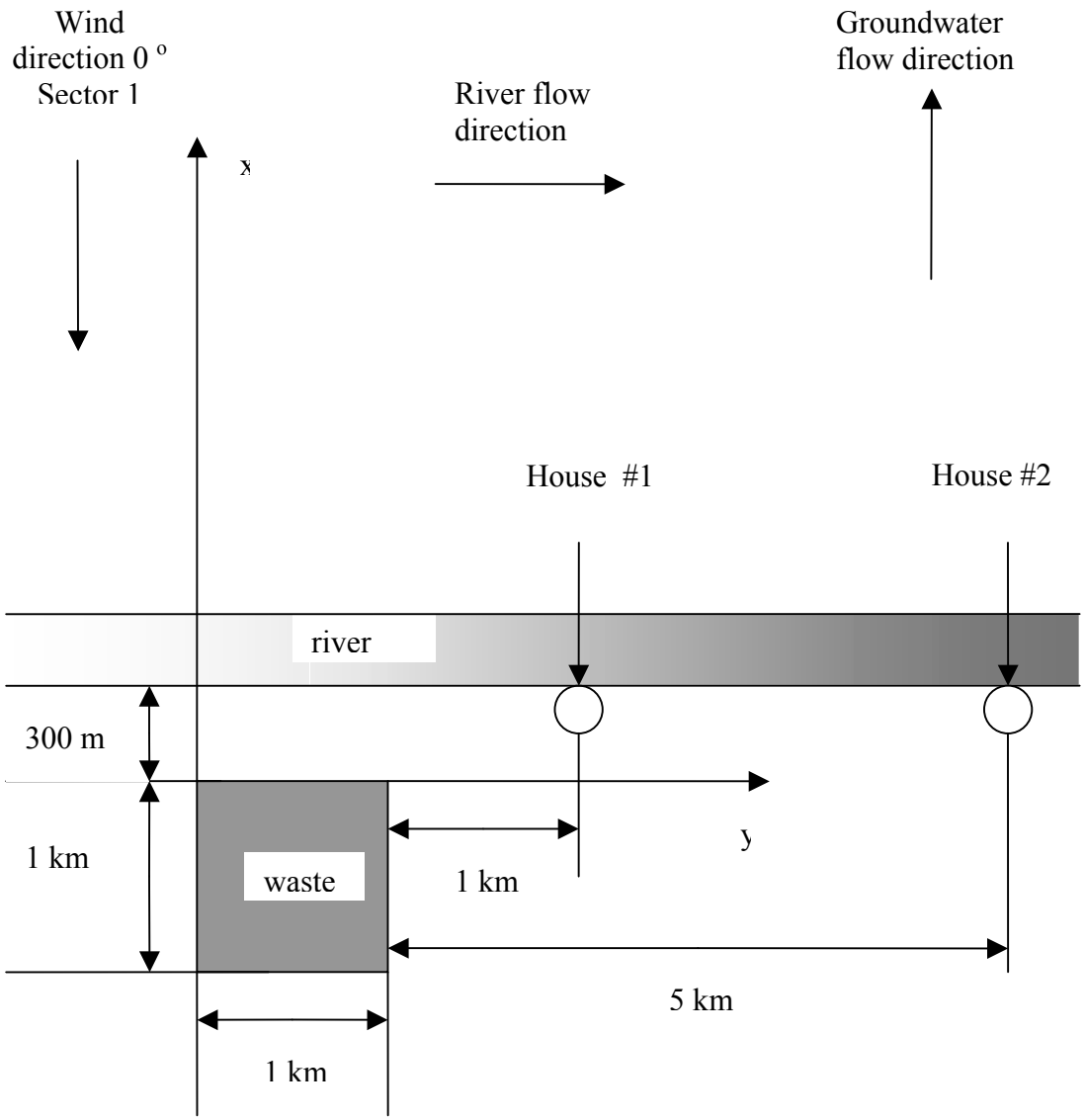

Fig. 2: Plan of the site