



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Kingsley Road		
Site Address:	18 Kingsley Road, Northenden, Wythenshawe, Manchester, M22 4NL		
Completed by:	Tim Rolfe		
Date:	23-Jan-24	Version:	0.01
Contaminant	PCE SS2a GWS2a		
Target Concentration (C_T)	0.005	mg/l	Origin of C_T: Half of DWQ/ EQS 0.01ug/l, combined with TCE

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration

C_T

PCE
0.005 mg/l

Input Parameters

Standard entry

Water filled soil porosity

θ_w

2.40E-01

fraction

Air filled soil porosity

θ_a

3.00E-01

fraction

Bulk density of soil zone material

ρ

1.18E+00

g/cm³

Henry's Law constant

H

3.16E-01

dimensionless

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

1.70E-02

fraction

Organic carbon partition coefficient

K_{oc}

2.69E+02

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

4.57E+00

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target

2.43E-02

mg/kg

(for comparison with soil analyses)

or

0.005

mg/l

(for comparison with leachate test results)

Site being assessed: Kingsley Road

Completed by: Tim Rolfe

Date: 23-Jan-24

Version: 0.01

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

PCE
0.005 mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

5.94E-04

m/d

Area of contaminant source

A

1.00E+02

m²

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

1.00E+01

m

Saturated aquifer thickness

da

3.80E+00

m

Hydraulic Conductivity of aquifer in which dilution occurs

K

9.80E-01

m/d

Hydraulic gradient of water table

i

3.77E-02

fraction

Width of contaminant source perpendicular to groundwater flow

w

1.00E+01

m

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Not used in calculation

Define mixing zone depth by specifying or calculating depth (using pull down list)

Specify

Enter mixing zone thickness

Mz

3.80E+00

m

Calculated mixing zone thickness

Mz

m

Calculated Parameters

Dilution Factor

DF

2.46E+01

Level 2 Remedial Target

1.23E-01

mg/l

or

5.98E-01

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Kingsley Road

Completed by: Tim Rolfe

Date: 23-Jan-24

Version: 0.01

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant	PCE			from Level 1
Target Concentration	C _T	0.005	mg/l	from Level 1
Dilution Factor	DF	2.46E+01		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value,)

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter soil concentration	15.78	mg/kg	
Half life for degradation of contaminant in water	5.00E+02	days	
Calculated decay rate	1.39E-03	days ⁻¹	calculated
Width of plume in aquifer at source	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	3.80E+00	m	from Level 2
Bulk density of aquifer materials	1.60E+00	g/cm ³	
Effective porosity of aquifer	1.50E-01		
Hydraulic gradient	3.93E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	9.80E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	4.57E+00	l/kg see options
Longitudinal dispersivity	ax	2.984	m see options
Transverse dispersivity	az	0.298	m see options
Vertical dispersivity	ay	0.000	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	v	2.57E-01	m/d
Retardation factor	Rf	4.98E+01	fraction
Decay rate used	λ	1.39E-03	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	3.93E-02	fraction
Rate of contaminant flow due to retardation	u	5.16E-03	m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	9.56E-05	fraction
Attenuation factor (C ₀ /C _{cp})	AF	1.05E+04	fraction
Calculated soil leachate concentration	Co	3.25E+00	mg/l

Remedial Targets

Level 3 Remedial Target	1.29E+03	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	6.26E+03	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	9.56E-05	fraction Domenico - Steady state

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	fraction
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
Acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	4.57E+00 l/kg

Define dispersivity (click brown cell and use pull down list)

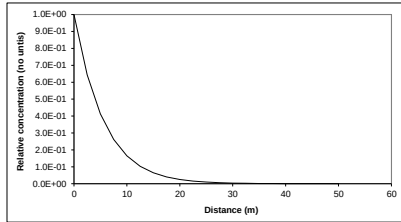
User defined values for dispersivity

Longitudinal dispersivity	ax	2.98E+00	5.90E-05	2.98E+02	m
Transverse dispersivity	az	2.98E-01	5.90E-01	2.98E-01	m
Vertical dispersivity	ay	1.00E-09	5.90E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀X)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concent distance-concentration graph

Domenico - Steady state	
From calculation sheet	
Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	6.44E-01
5.0	4.13E-01
7.5	2.62E-01
10.0	1.65E-01
12.5	1.03E-01
15.0	6.44E-02
17.5	4.02E-02
20.0	2.51E-02
22.5	1.57E-02
25.0	9.83E-03
27.5	6.16E-03
30.0	3.96E-03
32.5	2.42E-03
35.0	1.52E-03
37.5	9.59E-04
40.0	6.03E-04
42.5	3.80E-04
45.0	2.40E-04
47.5	1.51E-04
50.0	9.56E-05

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	PCE		from Level 1
Target Concentration	5.00E-03	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state	Equations in HRA publication
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Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value)

Initial contaminant concentration in groundwater at plume core	C ₀	3.07E+01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	5.00E+02	days	
Calculated decay rate	λ	1.39E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	
Plume thickness at source	Sy	3.80E+00	m	
Saturated aquifer thickness	da	3.80E+00	m	
Bulk density of aquifer materials	ρ	1.60E+00	g/cm ³	
Effective porosity of aquifer	n	1.50E-01	fraction	
Hydraulic gradient	i	3.77E-02	fraction	
Hydraulic conductivity of aquifer	K	9.80E-01	m/d	
Distance to compliance point	x	5.00E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	time variant options only

Parameters values determined from options			
Partition coefficient	Kd	4.57E+00	l/kg see options
Longitudinal dispersivity	ax	2.98E+00	m see options
Transverse dispersivity	az	2.98E-01	m see options
Vertical dispersivity	ay	1.00E-09	m see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	2.46E-01 m/d
Retardation factor	Rf	4.98E+01
Decay rate used	λ	1.39E-03 d ⁻¹
Rate of contaminant flow due to retardation	u	4.95E-03 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{0D}	2.23E-03 mg/l
Attenuation factor (one way vertical dispersion, COICED)	AF	1.38E+04

Remedial Targets

Remedial Target	6.89E+01	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	2.23E-03	mg/l Domenico - Steady state

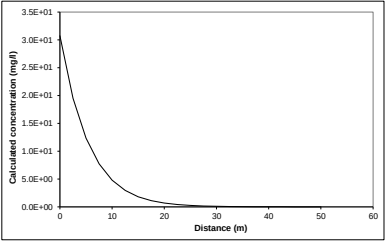
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals		
Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.70E-02 fraction
Organic carbon partition coefficient	Koc	2.69E+02 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{ov,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	4.57E+00 l/kg

Define dispersivity (click brown cell and use pull down list)

User defined values for dispersivity			
Longitudinal dispersivity	ax	2.98E+00	Calc value Xu & Eckstein 0.00E+00 2.98E+00 m
Transverse dispersivity	az	2.98E-01	0.00E-01 2.98E-01 m
Vertical dispersivity	ay	1.00E-09	0.00E-09 2.98E-09 m
Note values of dispersivity must be > 0			
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ λ) ^{0.44} ; az = ax/10, ay = ax/100 are assumed			



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Concentration
	mg/l
0	3.1E+01
2.5	1.95E+01
5.0	1.23E+01
7.5	7.73E+00
10.0	4.79E+00
12.5	2.96E+00
15.0	1.82E+00
17.5	1.12E+00
20.0	6.92E-01
22.5	4.27E-01
25.0	2.63E-01
27.5	1.63E-01
30.0	1.01E-01
32.5	6.23E-02
35.0	3.86E-02
37.5	2.40E-02
40.0	1.49E-02
42.5	9.25E-03
45.0	5.75E-03
47.5	3.58E-03
50.0	2.23E-03



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Kingsley Road		
Site Address:	18 Kingsley Road, Northenden, Wythenshawe, Manchester, M22 4NL		
Completed by:	Tim Rolfe		
Date:	23-Jan-24	Version:	0.01
Contaminant	TCE SS2a GWS2a		
Target Concentration (C_T)	0.005	mg/l	Origin of C_T: DWQ/ EQS 0.01 mg/l combined with PCE

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

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It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration

C_T

TCE
0.005 mg/l

Input Parameters

Standard entry

Water filled soil porosity
Air filled soil porosity
Bulk density of soil zone material
Henry's Law constant

Variable

Value

Unit

Source of parameter value

θ _w	2.40E-01	fraction
θ _a	3.00E-01	fraction
ρ	1.18E+00	g/cm ³
H	1.87E-01	dimensionless

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient. The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)
Organic carbon partition coefficient

f_{oc}

1.70E-02

fraction

K_{oc}

1.41E+02

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species
Sorption coefficient for ionised species
pH value
Acid dissociation constant
Fraction of organic carbon (in soil)

K_{oc,n}

l/kg

K_{oc,i}

l/kg

pH

pH units

pK_a

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

2.40E+00

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	1.32E-02	mg/kg	(for comparison with soil analyses)
	or		
	0.005	mg/l	(for comparison with leachate test results)

Site being assessed: Kingsley Road
Completed by: Tim Rolfe
Date: 23-Jan-24
Version: 0.01

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TCE
0.005 mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

5.94E-04

m/d

Area of contaminant source

A

1.00E+02

m²

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

1.00E+01

m

Saturated aquifer thickness

da

3.80E+00

m

Hydraulic Conductivity of aquifer in which dilution occurs

K

9.80E-01

m/d

Hydraulic gradient of water table

i

3.77E-02

fraction

Width of contaminant source perpendicular to groundwater flow

w

1.00E+01

m

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Not used in calculation

Define mixing zone depth by specifying or calculating depth (using pull down list)

Specify

Enter mixing zone thickness

Mz

3.80E+00

m

Calculated mixing zone thickness

Mz

m

Calculated Parameters

Dilution Factor

DF

2.46E+01

Level 2 Remedial Target

1.23E-01

mg/l

or

3.26E-01

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Kingsley Road

Completed by: Tim Rolfe

Date: 23-Jan-24

Version: 0.01

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		TCE		from Level 1
Target Concentration	C _T	0.005	mg/l	from Level 1
Dilution Factor	DF	2.46E+01		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state	Equations in HRA publication
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Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value,)

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter soil concentration	0.103	mg/kg	
Half life for degradation of contaminant in water	1.00E+03	days	
Calculated decay rate	6.93E-04	days ⁻¹	calculated
Width of plume in aquifer at source	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	3.80E+00	m	from Level 2
Bulk density of aquifer materials	1.60E+00	g/cm ³	
Effective porosity of aquifer	1.50E-01		
Hydraulic gradient	3.93E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	9.80E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.40E+00	l/kg see options
Longitudinal dispersivity	ax	2.984	m see options
Transverse dispersivity	az	0.298	m see options
Vertical dispersivity	ay	0.000	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	v	2.57E-01	m/d
Retardation factor	Rf	2.66E+01	fraction
Decay rate used	λ	6.93E-04	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	3.93E-02	fraction
Rate of contaminant flow due to retardation	u	9.66E-03	m/d
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	3.07E-02	fraction
Attenuation factor (C ₀ /C _{cp})	AF	3.25E+01	fraction
Calculated soil leachate concentration	Co	3.89E-02	mg/l

Remedial Targets

Level 3 Remedial Target	4.01E+00	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.06E+01	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{cp} /C ₀	3.07E-02	fraction Domenico - Steady state

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd		l/kg
----------------------------------	----	--	------

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer	foc	1.70E-02	fraction
Organic carbon partition coefficient	Koc	1.41E+02	l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction

Soil water partition coefficient	Kd	2.40E+00	l/kg
----------------------------------	----	----------	------

Define dispersivity (click brown cell and use pull down list)

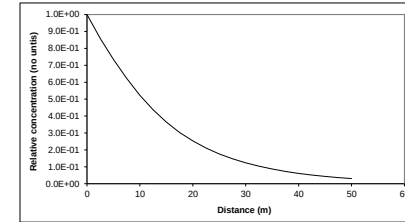
User defined values for dispersivity

	Enter value	Calc value	Xu & Eckstein		
Longitudinal dispersivity	ax	2.98E+00	5.90E-05	2.98E+02	m
Transverse dispersivity	az	2.98E-01	5.90E-01	2.98E-01	m
Vertical dispersivity	ay	1.00E-09	5.90E-02	2.98E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀X)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concent distance-concentration graph

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	8.59E-01
5.0	7.35E-01
7.5	6.23E-01
10.0	5.23E-01
12.5	4.37E-01
15.0	3.64E-01
17.5	3.03E-01
20.0	2.53E-01
22.5	2.11E-01
25.0	1.76E-01
27.5	1.47E-01
30.0	1.23E-01
32.5	1.03E-01
35.0	8.67E-02
37.5	7.28E-02
40.0	6.11E-02
42.5	5.14E-02
45.0	4.33E-02
47.5	3.65E-02
50.0	3.07E-02

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	TCE		from Level 1
Target Concentration	5.00E-03	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state	Equations in HRA publication
-------------------------	------------------------------

Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	4.03E-01	mg/l	
Half life for degradation of contaminant in water	1.00E+03	days	
Calculated decay rate	6.93E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	1.00E+01	m	
Plume thickness at source	3.80E+00	m	
Saturated aquifer thickness	3.80E+00	m	
Bulk density of aquifer materials	1.60E+00	g/cm ³	
Effective porosity of aquifer	1.50E-01	fraction	
Hydraulic gradient	3.77E-02	fraction	
Hydraulic conductivity of aquifer	9.80E-01	m/d	
Distance to compliance point	5.00E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only

Variable	Value	Unit	see options
Partition coefficient	2.40E+00	l/kg	
Longitudinal dispersivity	2.98E+00	m	
Transverse dispersivity	2.98E-01	m	
Vertical dispersivity	1.00E-09	m	

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	2.46E-01	m/d
Retardation factor	2.66E+01	fraction
Decay rate used	6.93E-04	d ⁻¹
Rate of contaminant flow due to retardation	9.27E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	1.11E-02	mg/l
Attenuation factor (one way vertical dispersion, COICED)	3.64E+01	

Remedial Targets

Remedial Target	1.82E-01	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	1.11E-02	mg/l Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

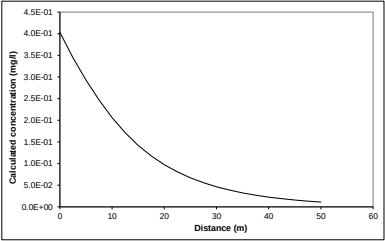
Select Method for deriving Partition Co-efficient (using pull down menu)

Variable	Value	Unit
Soil water partition coefficient	K _d	l/kg
Fraction of organic carbon in aquifer	f _{oc}	fraction
Organic carbon partition coefficient	K _{oc}	l/kg
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{ov,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	f _{oc}	fraction
Soil water partition coefficient	K _d	l/kg

Define dispersivity (click brown cell and use pull down list)

Variable	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity	2.98E+00	0.00E+00	m
Transverse dispersivity	2.98E-01	0.00E-01	m
Vertical dispersivity	1.00E-09	0.00E-09	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.44}; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.
By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.
Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Concentration
	mg/l
0	4.0E-01
2.5	3.44E-01
5.0	2.93E-01
7.5	2.47E-01
10.0	2.06E-01
12.5	1.71E-01
15.0	1.42E-01
17.5	1.18E-01
20.0	9.75E-02
22.5	8.09E-02
25.0	6.72E-02
27.5	5.59E-02
30.0	4.65E-02
32.5	3.88E-02
35.0	3.23E-02
37.5	2.70E-02
40.0	2.25E-02
42.5	1.89E-02
45.0	1.58E-02
47.5	1.32E-02
50.0	1.11E-02



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Kingsley Road		
Site Address:	18 Kingsley Road, Northenden, Wythenshawe, Manchester, M22 4NL		
Completed by:	Tim Rolfe		
Date:	23-Jan-24	Version:	0.01
Contaminant	cis12DCE SS2b GWS2b		
Target Concentration (C _T)	0.01	mg/l	Origin of C _T : DWQ/ EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration

C_T

cis12DCE
0.01 mg/l

Input Parameters

Standard entry

Water filled soil porosity

θ_w

2.40E-01

fraction

Air filled soil porosity

θ_a

3.00E-01

fraction

Bulk density of soil zone material

ρ

1.18E+00

g/cm³

Henry's Law constant

H

7.46E-02

dimensionless

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

1.70E-02

fraction

Organic carbon partition coefficient

K_{oc}

4.90E+01

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

8.33E-01

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target

1.06E-02

mg/kg

(for comparison with soil analyses)

or

0.01

mg/l

(for comparison with leachate test results)

Site being assessed: Kingsley Road

Completed by: Tim Rolfe

Date: 23-Jan-24

Version: 0.01

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentrationC_Tcis12DCE
0.01 mg/lfrom Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant sourceInf
A5.94E-04
2.50E+02m/d
m²

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow
Saturated aquifer thickness
Hydraulic Conductivity of aquifer in which dilution occurs
Hydraulic gradient of water table
Width of contaminant source perpendicular to groundwater flow
Background concentration of contaminant in groundwater beneath siteL
da
K
i
w
Cu2.50E+01
3.80E+00
9.80E-01
3.77E-02
1.00E+01
0.00E+00m
m
m/d
fraction
m
mg/l

Not used in calculation

Define mixing zone depth by specifying or calculating depth (using pull down list)

Enter mixing zone thickness
Calculated mixing zone thicknessMz
MzSpecify
3.80E+00m
m

Calculated Parameters

Dilution Factor

DF

1.05E+01

Level 2 Remedial Target

1.05E-01
or
1.10E-01mg/l
mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Kingsley Road
Completed by: Tim Rolfe
Date: 23-Jan-24
Version: 0.01

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		cis12DCE SS2b GWS2b		from Level 1
Target Concentration	C _T	0.01	mg/l	from Level 1
Dilution Factor	DF	1.05E+01		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state	Equations in HRA publication
-------------------------	------------------------------

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to pollutants in all phases (e.g. field derived value, i

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter soil concentration	0.036	mg/kg	
Half life for degradation of contaminant in water	1.00E+03	days	
Calculated decay rate	6.93E-04	days ⁻¹	calculated
Width of plume in aquifer at source	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	3.80E+00	m	from Level 2
Bulk density of aquifer materials	1.60E+00	g/cm ³	
Effective porosity of aquifer	1.50E-01	fraction	
Hydraulic gradient	4.17E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	9.80E-01	m/d	from Level 2
Distance to compliance point	2.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	8.33E-01	l/kg see options
Longitudinal dispersivity	ax	6.855	m see options
Transverse dispersivity	az	0.686	m see options
Vertical dispersivity	ay	0.000	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Groundwater flow velocity	v	2.72E-01	m/d
Retardation factor	Rf	9.89E+00	fraction
Decay rate used	λ	6.93E-04	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.17E-02	fraction
Rate of contaminant flow due to retardation	u	2.76E-02	m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	8.97E-04	fraction
Attenuation factor (C ₀ /C _{ED})	AF	1.11E+03	fraction
Calculated soil leachate concentration	Co	3.41E-02	mg/l

Remedial Targets

Level 3 Remedial Target	1.17E+02	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.23E+02	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	250	m	assumes Level 1 Remedial Target calculated from soil-water
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	8.97E-04	fraction Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.70E-02 fraction
Organic carbon partition coefficient	Koc	4.90E+01 l/kg
Sorption coefficient for related species	K _{OC,n}	l/kg
Sorption coefficient for ionised species	K _{OC,i}	l/kg
pH value	pH	
Acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	8.33E-01 l/kg

Define dispersivity (click brown cell and use pull down list)

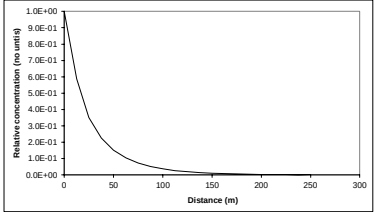
User defined values for dispersivity

Longitudinal dispersivity	ax	6.86E+00	6.86E+01	6.86E+00	m
Transverse dispersivity	az	6.86E-01	2.50E+00	6.86E-01	m
Vertical dispersivity	ay	1.00E-09	2.50E-01	6.86E-02	m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414} ; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	Relative concentration	Concentration
	(No units)	mg/l
0	1.0E+00	3.26E-03
12.5	5.88E-01	1.92E-03
25.0	3.51E-01	1.15E-03
37.5	2.26E-01	7.39E-04
50.0	1.52E-01	4.96E-04
62.5	1.05E-01	3.42E-04
75.0	7.33E-02	2.39E-04
87.5	5.19E-02	1.69E-04
100.0	3.71E-02	1.21E-04
112.5	2.67E-02	8.71E-05
125.0	1.93E-02	6.30E-05
137.5	1.40E-02	4.58E-05
150.0	1.02E-02	3.34E-05
162.5	7.50E-03	2.45E-05
175.0	5.50E-03	1.80E-05
187.5	4.05E-03	1.32E-05
200.0	2.99E-03	9.74E-06
212.5	2.21E-03	7.20E-06
225.0	1.63E-03	5.33E-06
237.5	1.21E-03	3.95E-06
250.0	8.97E-04	2.93E-06

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	chl2DCE SS2b GWS2b		from Level 1
Target Concentration	C _T 1.00E-02	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to pollutants in all phases (e.g. field derived value)

Initial contaminant concentration in groundwater at plume core	C ₀	9.97E-01	mg/l	
Half life for degradation of contaminant in water	t _{0.2}	1.00E+03	days	
Calculated decay rate	λ	6.93E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	
Plume thickness at source	Sy	3.80E+00	m	
Saturated aquifer thickness	da	3.80E+00	m	
Bulk density of aquifer materials	ρ	1.60E+00	g/cm ³	
Effective porosity of aquifer	n	1.50E-01	fraction	
Hydraulic gradient	i	3.77E-02	fraction	
Hydraulic conductivity of aquifer	K	9.80E-01	m/d	
Distance to compliance point	x	2.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	8.33E-01	l/kg	see options
Longitudinal dispersivity	ax	6.86E+00	m	see options
Transverse dispersivity	az	6.86E-01	m	see options
Vertical dispersivity	ay	1.00E-09	m	see options

Calculated Parameters

Groundwater flow velocity	v	2.46E-01	m/d
Retardation factor	Rf	9.89E+00	fraction
Decay rate used	λ	6.93E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	2.49E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	5.39E-04	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	1.85E+03	

Remedial Targets

Remedial Target	1.85E+01	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			
Distance to compliance point	250	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	5.39E-04	mg/l Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

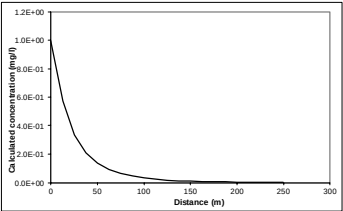
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd		l/kg
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)	foc	1.70E-02	fraction
Fraction of organic carbon in aquifer	foc	1.70E-02	fraction
Organic carbon partition coefficient	Koc	4.90E+01	l/kg
Entry for ionic organic chemicals (option)	K _{oc,n}		l/kg
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	8.33E-01	l/kg

Define dispersivity (click brown cell and use pull down list)

User defined values for dispersivity

Enter value	Calc value Xu & Eckstein	m
ax	6.86E+00	6.86E+00
az	6.86E-01	2.50E+00
ay	1.00E-09	1.60E-01
Longitudinal dispersivity	ax	6.86E+00
Transverse dispersivity	az	6.86E-01
Vertical dispersivity	ay	1.00E-09
Note values of dispersivity must be > 0		
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x		
Xu & Eckstein (1995) report ax = 0.83(log ₁₀ x) ^{2.414} ; az = ax/10, ay = ax/100 are assumed		



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

Calculated concentrations for distance-concentration graph

Domenico - Steady state
From calculation sheet

Distance	Concentration
	mg/l
0	1.0E+00
12.5	5.72E-01
25.0	3.33E-01
37.5	2.09E-01
50.0	1.37E-01
62.5	9.20E-02
75.0	6.28E-02
87.5	4.33E-02
100.0	3.02E-02
112.5	2.12E-02
125.0	1.49E-02
137.5	1.06E-02
150.0	7.54E-03
162.5	5.39E-03
175.0	3.85E-03
187.5	2.76E-03
200.0	1.99E-03
212.5	1.43E-03
225.0	1.03E-03
237.5	7.45E-04
250.0	5.39E-04



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Kingsley Road		
Site Address:	18 Kingsley Road, Northenden, Wythenshawe, Manchester, M22 4NL		
Completed by:	Tim Rolfe		
Date:	23-Jan-24	Version:	0.01
Contaminant	VC SS2a GWS2a		
Target Concentration (C _T)	0.0005	mg/l	Origin of C _T : DWQ/ EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration

C_T

Vinyl Chloride

0.0005

mg/l

Input Parameters

Standard entry

Water filled soil porosity

θ_w

2.40E-01

fraction

Air filled soil porosity

θ_a

3.00E-01

fraction

Bulk density of soil zone material

ρ

1.18E+00

g/cm³

Henry's Law constant

H

7.47E-01

dimensionless

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

1.70E-02

fraction

Organic carbon partition coefficient

K_{oc}

1.66E+01

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

2.82E-01

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target

3.38E-04

mg/kg

(for comparison with soil analyses)

or

0.0005

mg/l

(for comparison with leachate test results)

Site being assessed: Kingsley Road

Completed by: Tim Rolfe

Date: 23-Jan-24

Version: 0.01

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Vinyl Chloride
0.0005 mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

5.94E-04
1.00E+02

m/d
m²

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow
Saturated aquifer thickness
Hydraulic Conductivity of aquifer in which dilution occurs
Hydraulic gradient of water table
Width of contaminant source perpendicular to groundwater flow
Background concentration of contaminant in groundwater beneath site

L
da
K
i
w
Cu

1.00E+01
3.80E+00
9.80E-01
3.77E-02
1.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Not used in calculation

Define mixing zone depth by specifying or calculating depth (using pull down list)

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Specify
3.80E+00

m
m

Calculated Parameters

Dilution Factor

DF

2.46E+01

Level 2 Remedial Target

1.23E-02

mg/l

or

8.32E-03

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Kingsley Road
Completed by: Tim Rolfe
Date: 23-Jan-24
Version: 0.01

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant	VC SS2a GWS2a			from Level 1
Target Concentration	C _T	0.0005	mg/l	from Level 1
Dilution Factor	DF	2.46E+01		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to pollutants in all phases (e.g. field derived value).

Variable	Value	Unit	Source of parameter value
Soil concentration as mg/kg			
Enter source concentration	0.005	mg/kg	
Enter soil concentration	2.00E+02	days	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	
Effective porosity of aquifer	n	fraction	
Hydraulic gradient	i	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance to compliance point	x	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.82E-01	l/kg see options
Longitudinal dispersivity	ax	2.984	m see options
Transverse dispersivity	az	0.298	m see options
Vertical dispersivity	ay	0.000	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	2.57E-01 m/d
Retardation factor	Rf	4.01E+00 fraction
Decay rate used	λ	3.47E-03 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	3.93E-02 fraction
Rate of contaminant flow due to retardation	u	6.40E-02 m/d
Ratio of Compliance Point to Source Concentration	C _{CD} /C ₀	5.98E-02 fraction
Attenuation factor (C ₀ /C _{CD})	AF	1.67E+01 fraction
Calculated soil leachate concentration	Co	7.40E-03 mg/l

Remedial Targets

Level 3 Remedial Target	2.06E-01	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CD} /C ₀	5.98E-02 fraction	Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.70E-02 fraction

Organic carbon partition coefficient Koc 1.66E+01 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{ow,n} l/kg

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 2.82E-01 l/kg

Define dispersivity (click brown cell and use pull down list)

User defined values for dispersivity

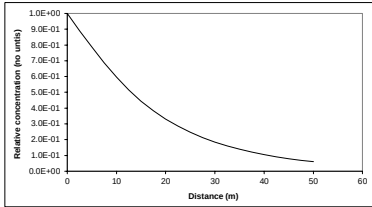
Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity ax	2.98E+00	6.00E-01 6.00E-01
Transverse dispersivity az	2.98E-01	6.00E-01 6.00E-01
Vertical dispersivity ay	1.00E-09	6.00E-02 6.00E-02

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Distance	concentration	Concentration
	(No units)	mg/l
0	1.0E+00	3.00E-04
2.5	8.88E-01	2.67E-04
5.0	7.86E-01	2.36E-04
7.5	6.88E-01	2.07E-04
10.0	5.97E-01	1.79E-04
12.5	5.16E-01	1.55E-04
15.0	4.44E-01	1.34E-04
17.5	3.83E-01	1.15E-04
20.0	3.30E-01	9.92E-05
22.5	2.85E-01	8.55E-05
25.0	2.46E-01	7.39E-05
27.5	2.12E-01	6.38E-05
30.0	1.84E-01	5.52E-05
32.5	1.59E-01	4.78E-05
35.0	1.38E-01	4.15E-05
37.5	1.20E-01	3.60E-05
40.0	1.04E-01	3.13E-05
42.5	9.05E-02	2.72E-05
45.0	7.87E-02	2.37E-05
47.5	6.86E-02	2.06E-05
50.0	5.98E-02	1.80E-05

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant	VC SS2a GWS2a	from Level 1
Target Concentration	C _T 5.00E-04	mg/l from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Domenico - Steady state	Equations in HRA publication
-------------------------	------------------------------

Approach for simulating vertical dispersion: Simulate vertical dispersion in 1 direction

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: Apply degradation rate to pollutants in all phases (e.g. field derived value)

Initial contaminant concentration in groundwater at plume core	C ₀	5.00E-03	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{0.5}	2.00E+02	days	
Calculated decay rate	λ	3.47E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	
Plume thickness at source	Sy	3.80E+00	m	
Saturated aquifer thickness	da	3.80E+00	m	
Bulk density of aquifer materials	ρ	1.60E+00	g/cm ³	
Effective porosity of aquifer	n	1.50E-01	fraction	
Hydraulic gradient	i	3.77E-02	fraction	
Hydraulic conductivity of aquifer	K	9.80E-01	m/d	
Distance to compliance point	x	5.00E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	2.82E-01	l/kg	see options
Longitudinal dispersivity	ax	2.98E+00	m	see options
Transverse dispersivity	az	2.98E-01	m	see options
Vertical dispersivity	ay	1.00E-09	m	see options

Calculated Parameters

Groundwater flow velocity	v	2.46E-01	m/d
Retardation factor	Rf	4.01E+00	fraction
Decay rate used	λ	3.47E-03	d ⁻¹
Rate of contaminant flow due to retardation	u	6.14E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	2.73E-04	mg/l
Attenuation factor (one way vertical dispersion, COICED)	AF	1.83E+01	

Remedial Targets

Remedial Target	9.15E-03	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			
Distance to compliance point	50	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	2.73E-04	mg/l Domenico - Steady state

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

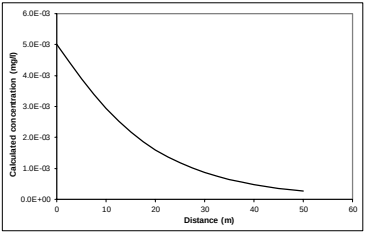
Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.70E-02 fraction
Organic carbon partition coefficient	Koc	1.66E+01 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	l/kg
Sorption coefficient for ionised species	K _{oc,i}	l/kg
pH value	pH	
acid dissociation constant	pKa	
Fraction of organic carbon in aquifer	foc	fraction
Soil water partition coefficient	Kd	2.82E-01 l/kg

Define dispersivity (click brown cell and use pull down list)

User defined values for dispersivity

Longitudinal dispersivity	ax	2.98E+00	Calc. value	Xu & Eckstein	m
Transverse dispersivity	az	2.98E-01	1.00E-01	2.98E-01	m
Vertical dispersivity	ay	1.00E-09	1.00E-02	2.98E-02	m

Note values of dispersivity must be > 0
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}, az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action. Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used

Site being assessed:	Kingsley Road
Completed by:	Tim Rolfe
Date:	#####
Version:	0.01

Calculated concentrations for distance-concentration graph

Domenico - Steady state	
From calculation sheet	
Distance	Concentration
	mg/l
0	5.0E-03
2.5	4.42E-03
5.0	3.89E-03
7.5	3.39E-03
10.0	2.93E-03
12.5	2.52E-03
15.0	2.16E-03
17.5	1.86E-03
20.0	1.59E-03
22.5	1.37E-03
25.0	1.18E-03
27.5	1.01E-03
30.0	8.71E-04
32.5	7.51E-04
35.0	6.49E-04
37.5	5.60E-04
40.0	4.85E-04
42.5	4.20E-04
45.0	3.63E-04
47.5	3.15E-04
50.0	2.73E-04