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.

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

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Fluoranthene**			
Target Concentration (C_T)	**0.004**	**mg/l**	**Origin of C_T:**	**DWS**

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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
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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.

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		**Fluoranthene**		from Level 1
Target Concentration	**C_T**	**4.00E-03**	mg/l	from Level 1

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

Ogata Banks — **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 va**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	1.10E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*See justification table*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E+00	m/d	*See justification table*
Distance to compliance point	x	1.37E+03	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.12E+04	l/kg	*see options*
Longitudinal dispersivity	ax	1.37E+02	m	*see options*
Transverse dispersivity	az	1.37E+01	m	*see options*
Vertical dispersivity	ay	1.37E+00	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-01	m/d
Retardation factor	Rf	2.43E+05	fraction
Decay rate used	λ	1.39E-04	d^{-1}
Rate of contaminant flow due to retardation	u	2.35E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**1373**	**m**	
Concentration of contaminant at compliance point	**C_{ED}/C_0**	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	1.82E+04	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	1.12E+04	l/kg

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

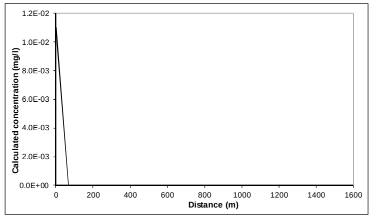
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.37E+02	1.31E+01	m
Transverse dispersivity	**az**	0.00E+00	1.37E+01	1.31E+00	m
Vertical dispersivity	**ay**	0.00E+00	1.37E+00	1.31E-01	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.1E-02**
68.7	**3.85E-22**
137.3	**1.25E-41**
206.0	**4.14E-61**
274.6	**1.40E-80**
343.3	**4.82E-100**
411.9	**1.68E-119**
480.6	**5.87E-139**
549.2	**2.07E-158**
617.9	**7.31E-178**
686.5	**2.60E-197**
755.2	**9.25E-217**
823.8	**3.30E-236**
892.5	**1.18E-255**
961.1	**4.25E-275**
1029.8	**1.53E-294**
1098.4	**0.00E+00**
1167.1	**0.00E+00**
1235.7	**0.00E+00**
1304.4	**0.00E+00**
1373.0	**0.00E+00**

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).

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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.

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Indeno(1,2,3-c,d)pyrene**			
Target Concentration (C_T)	**0.0001**	**mg/l**	**Origin of C_T:**	**DWS**

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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
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The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

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		**Indeno(1,2,3-c,d)pyrene**		from Level 1
Target Concentration	C_T	**1.00E-04**	mg/l	from Level 1

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

Ogata Banks — **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 va**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	1.28E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+04	days	*See justification table*
Calculated decay rate	λ	6.93E-05	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E+00	m/d	*See justification table*
Distance to compliance point	x	1.37E+03	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	5.37E+04	l/kg	*see options*
Longitudinal dispersivity	ax	1.37E+02	m	*see options*
Transverse dispersivity	az	1.37E+01	m	*see options*
Vertical dispersivity	ay	1.37E+00	m	*see options*

Calculated Parameters

	Variable	Value	Unit
Groundwater flow velocity	v	5.72E-01	m/d
Retardation factor	Rf	1.16E+06	fraction
Decay rate used	λ	6.93E-05	d^{-1}
Rate of contaminant flow due to retardation	u	4.92E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target	**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			

Distance to compliance point		**1373**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	8.71E+04	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	5.37E+04	l/kg

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

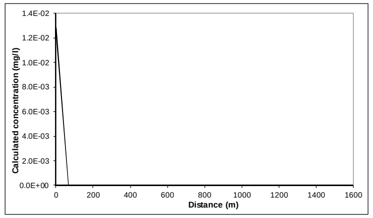
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.37E+02	1.31E+01	m
Transverse dispersivity	**az**	0.00E+00	1.37E+01	1.31E+00	m
Vertical dispersivity	**ay**	0.00E+00	1.37E+00	1.31E-01	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.3E-02**
68.7	**9.33E-33**
137.3	**6.28E-63**
206.0	**4.33E-93**
274.6	**3.05E-123**
343.3	**2.18E-153**
411.9	**1.58E-183**
480.6	**1.15E-213**
549.2	**8.40E-244**
617.9	**6.18E-274**
686.5	**4.56E-304**
755.2	**0.00E+00**
823.8	**0.00E+00**
892.5	**0.00E+00**
961.1	**0.00E+00**
1029.8	**0.00E+00**
1098.4	**0.00E+00**
1167.1	**0.00E+00**
1235.7	**0.00E+00**
1304.4	**0.00E+00**
1373.0	**0.00E+00**

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Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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Liability: The Environment Agency does not promise that the worksheet will provide any particular facilities or functions. You must ensure that the worksheet meets your needs and you remain solely responsible for the competent use of the worksheet. You are entirely responsible for the consequences of any use of the worksheet and the Agency provides no warranty about the fitness for purpose or performance of any part of the worksheet. We do not promise that the media will always be free from defects, computer viruses, software locks or other similar code or that the operation of the worksheet will be uninterrupted or error free. You should carry out all necessary virus checks prior to installing on your computing system.

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Naphthalene**			
Target Concentration (C_T)	**0.006**	**mg/l**	**Origin of C_T:**	**DWS**

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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
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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		Naphthalene		from Level 1
Target Concentration	C_T	6.00E-03	mg/l	from Level 1

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

Ogata Banks — 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

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	9.30E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+03	days	*See justification table*
Calculated decay rate	λ	6.93E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E+00	m/d	*See justification table*
Distance to compliance point	x	1.37E+03	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.98E+02	l/kg	*see options*
Longitudinal dispersivity	ax	1.37E+02	m	*see options*
Transverse dispersivity	az	1.37E+01	m	*see options*
Vertical dispersivity	ay	1.37E+00	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-01	m/d
Retardation factor	Rf	8.63E+03	fraction
Decay rate used	λ	6.93E-04	d^{-1}
Rate of contaminant flow due to retardation	u	6.63E-05	m/d
Contaminant concentration at cistance x, assuming one-way vertical dispersion	C_{ED}	1.17E-165	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**7.94E+162**	

Remedial Targets

Remedial Target	**4.76E+160**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**1373**	**m**	
Concentration of contaminant at compliance point c_{ED}/c_0	**1.17E-165**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

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	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	6.46E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	3.98E+02	l/kg

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

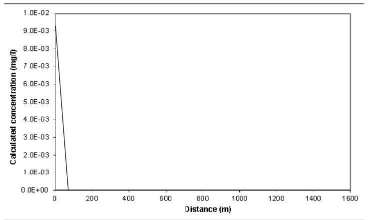
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.37E+02	1.31E+01	m
Transverse dispersivity	**az**	0.00E+00	1.37E+01	1.31E+00	m
Vertical dispersivity	**ay**	0.00E+00	1.37E+00	1.31E-01	

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

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Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Bames
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	9.3E-03
68.7	6.58E-11
137.3	4.31E-19
206.0	2.89E-27
274.6	1.98E-35
343.3	1.38E-43
411.9	9.74E-52
480.6	6.93E-60
549.2	4.97E-68
617.9	3.59E-76
686.5	2.60E-84
755.2	1.89E-92
823.8	1.38E-100
892.5	1.01E-108
961.1	7.37E-117
1029.8	5.41E-125
1098.4	3.97E-133
1167.1	2.92E-141
1235.7	2.15E-149
1304.4	1.59E-157
1373.0	1.17E-165

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.

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

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: **M54 M6 Link Road**
Site Address:

Completed by: **Gabriella Barnes**
Date: **02-Dec-19** **Version:** **1**

Contaminant **Nickel**
Target Concentration (C_T) **0.02** **mg/l** **Origin of C_T:** **DWS**

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 comparision 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.

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		Nickel		from Level 1
Target Concentration	C_T	**2.00E-02**	mg/l	from Level 1

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

Ogata Banks **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 va**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	2.32E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+09	days	*See justification table*
Calculated decay rate	λ	6.93E-10	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E+00	m/d	*See justification table*
Distance to compliance point	x	1.37E+03	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.00E+03	l/kg	*see options*
Longitudinal dispersivity	ax	1.37E+02	m	*see options*
Transverse dispersivity	az	1.37E+01	m	*see options*
Vertical dispersivity	ay	1.37E+00	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-01	m/d
Retardation factor	Rf	4.34E+04	fraction
Decay rate used	λ	6.93E-10	d^{-1}
Rate of contaminant flow due to retardation	u	1.32E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	6.56E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**3.54E+00**	

Remedial Targets

Remedial Target		**7.08E-02**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**1373**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**6.56E-03**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	2.00E+03	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	2.00E+03	l/kg

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

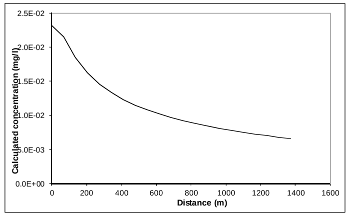
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.37E+02	1.31E+01	m
Transverse dispersivity	**az**	0.00E+00	1.37E+01	1.31E+00	m
Vertical dispersivity	**ay**	0.00E+00	1.37E+00	1.31E-01	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: M54 M6 Link Road
Completed by: Gabriella Barnes
Date: #########
Version: 1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**2.3E-02**
68.7	**2.15E-02**
137.3	**1.85E-02**
206.0	**1.62E-02**
274.6	**1.46E-02**
343.3	**1.33E-02**
411.9	**1.23E-02**
480.6	**1.15E-02**
549.2	**1.08E-02**
617.9	**1.02E-02**
686.5	**9.71E-03**
755.2	**9.25E-03**
823.8	**8.84E-03**
892.5	**8.47E-03**
961.1	**8.13E-03**
1029.8	**7.82E-03**
1098.4	**7.53E-03**
1167.1	**7.26E-03**
1235.7	**7.01E-03**
1304.4	**6.78E-03**
1373.0	**6.56E-03**

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.

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

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Phenanthrene**			
Target Concentration (C_T)	**0.004**	**mg/l**	**Origin of C_T:**	**DWS**

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 comparision 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.

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		**Phenanthrene**		from Level 1
Target Concentration	C_T	**4.00E-03**	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	8.38E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	2.50E+03	days	*See justification table*
Calculated decay rate	λ	2.77E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E+00	m/d	*See justification table*
Distance to compliance point	x	1.37E+03	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.39E+03	l/kg	*see options*
Longitudinal dispersivity	ax	1.37E+02	m	*see options*
Transverse dispersivity	az	1.37E+01	m	*see options*
Vertical dispersivity	ay	1.37E+00	m	*see options*

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	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	5.50E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	3.39E+03	l/kg

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

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.37E+02	1.31E+01	m
Transverse dispersivity	**az**	0.00E+00	1.37E+01	1.31E+00	m
Vertical dispersivity	**ay**	0.00E+00	1.37E+00	1.31E-01	

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x

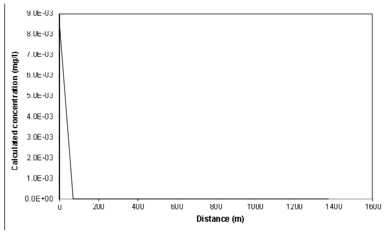
Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Calculated Parameters	Variable		
Groundwater flow velocity	v	5.72E-01	m/d
Retardation factor	Rf	7.35E+04	fraction
Decay rate used	λ	2.77E-04	d^{-1}
Rate of contaminant flow due to retardation	u	7.79E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	8.51E-305	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**9.84E+301**	

Remedial Targets

Remedial Target		**3.94E+299**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**1373**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**8.51E-305**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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.



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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	8.4E-03
68.7	6.63E-18
137.3	4.85E-33
206.0	3.63E-48
274.6	2.77E-63
343.3	2.15E-78
411.9	1.69E-93
480.6	1.34E-108
549.2	1.06E-123
617.9	8.48E-139
686.5	6.80E-154
755.2	5.47E-169
823.8	4.41E-184
892.5	3.57E-199
961.1	2.89E-214
1029.8	2.35E-229
1098.4	1.91E-244
1167.1	1.56E-259
1235.7	1.27E-274
1304.4	1.04E-289
1373.0	8.51E-305

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

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.

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

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Pyrene**			
Target Concentration (C_T)	**0.009**	**mg/l**	**Origin of C_T:**	**DWS**

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 comparision 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.
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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.

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		Pyrene		from Level 1
Target Concentration	C_T	9.00E-03	mg/l	from Level 1

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

Ogata Banks — **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 va**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	9.62E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	7.50E+03	days	*See justification table*
Calculated decay rate	λ	9.24E-05	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E+00	m/d	*See justification table*
Distance to compliance point	x	1.37E+03	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	9.98E+03	l/kg	*see options*
Longitudinal dispersivity	ax	1.37E+02	m	*see options*
Transverse dispersivity	az	1.37E+01	m	*see options*
Vertical dispersivity	ay	1.37E+00	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-01	m/d
Retardation factor	Rf	2.17E+05	fraction
Decay rate used	λ	9.24E-05	d^{-1}
Rate of contaminant flow due to retardation	u	2.64E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	4.95E-302	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.94E+299**	

Remedial Targets

Remedial Target		**1.75E+297**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**1373**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**4.95E-302**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	1.62E+04	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	9.98E+03	l/kg

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

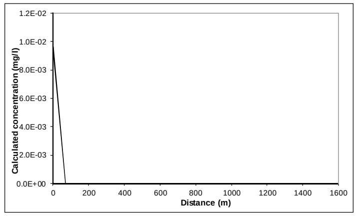
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.37E+02	1.31E+01	m
Transverse dispersivity	**az**	0.00E+00	1.37E+01	1.31E+00	m
Vertical dispersivity	**ay**	0.00E+00	1.37E+00	1.31E-01	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	9.6E-03
68.7	1.03E-17
137.3	1.02E-32
206.0	1.04E-47
274.6	1.08E-62
343.3	1.14E-77
411.9	1.22E-92
480.6	1.32E-107
549.2	1.43E-122
617.9	1.56E-137
686.5	1.72E-152
755.2	1.89E-167
823.8	2.09E-182
892.5	2.32E-197
961.1	2.57E-212
1029.8	2.86E-227
1098.4	3.18E-242
1167.1	3.55E-257
1235.7	3.96E-272
1304.4	4.43E-287
1373.0	4.95E-302

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).

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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.

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: **M54 M6 Link Road**
Site Address:

Completed by: **Gabriella Barnes**
Date: **02-Dec-19** **Version:** **1**

Contaminant **Xylene Total**
Target Concentration (C_T) **0.5** **mg/l** **Origin of C_T:** **DWS**

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 comparision 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.

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		**Xylene Total**		from Level 1
Target Concentration	C_T	**5.00E-01**	mg/l	from Level 1

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

Ogata Banks **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,**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	9.10E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+02	days	*See justification table*
Calculated decay rate	λ	1.39E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E+00	m/d	*See justification table*
Distance to compliance point	x	1.37E+03	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.79E+02	l/kg	*see options*
Longitudinal dispersivity	ax	1.37E+02	m	*see options*
Transverse dispersivity	az	1.37E+01	m	*see options*
Vertical dispersivity	ay	1.37E+00	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-01	m/d
Retardation factor	Rf	6.06E+03	fraction
Decay rate used	λ	1.39E-03	d^{-1}
Rate of contaminant flow due to retardation	u	9.44E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	3.61E-195	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**2.52E+193**	

Remedial Targets

Remedial Target		**1.26E+193**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**1373**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**3.61E-195**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	4.54E+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	2.79E+02	l/kg

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

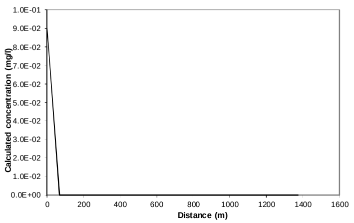
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.37E+02	1.31E+01	m
Transverse dispersivity	**az**	0.00E+00	1.37E+01	1.31E+00	m
Vertical dispersivity	**ay**	0.00E+00	1.37E+00	1.31E-01	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**9.1E-02**
68.7	**1.92E-11**
137.3	**3.76E-21**
206.0	**7.51E-31**
274.6	**1.54E-40**
343.3	**3.20E-50**
411.9	**6.74E-60**
480.6	**1.43E-69**
549.2	**3.07E-79**
617.9	**6.60E-89**
686.5	**1.43E-98**
755.2	**3.09E-108**
823.8	**6.73E-118**
892.5	**1.47E-127**
961.1	**3.21E-137**
1029.8	**7.03E-147**
1098.4	**1.54E-156**
1167.1	**3.38E-166**
1235.7	**7.44E-176**
1304.4	**1.64E-185**
1373.0	**3.61E-195**

Simulation Details

Project Number	60536736
Project Title	M54/M6 Link Road
Date	28-Nov-19

Simulation Details	Simulation detailing the potential contaminant concentration in groundwater affecting the surface watercourse Latherford Brook

0.087

LEVEL 3 (GROUNDWATER) ASSESSMENT - INPUTS & JUSTIFICATION

Project Number	60536736
Project Title	M54/M6 Link Road
Date	28-Nov-19

Simulation Details	Simulation detailing the potential contaminant concentration in groundwater affecting the surface watercourse Latherford Brook

Parameter	Units	Input Value(s)		Source / Justification
Infiltration	mm/year	14.4		Met Office - Based on unsurfaced ground wiith annual average rainfall of 57.5mm/year
Saturated aquifer thickness	m	30		Assumed thickness of bedrock aquifer
Bulk density of aquifer materials	g/cm^3	2.17		Average Value from geotechnical laboratory analysis over weathered bedrock and bedrock
Effective porosity of aquifer	fraction	0.1		Value for Sandstone from Domenico & Schwartz, 1990
Hydraulic gradient	fraction	0.012		Gradients taken from GW monitoring levels between BH18 and BH27
Hydraulic conductivity of aquifer	m/s	5.52E-06		Average value from geotechnical laboratory analysis
Hydraulic conductivity of aquifer	m/d	4.77E-01		Calculated in m/d
Fraction of Organic Carbon	fraction	0.616		Taken from chemical screening data
Distance to compliance point	m	139		BH21 closest borehole with exceedances south of Latherford Brook
Longitudinal dispersivity	m	13.9		10% of pathway length
Transverse dispersivity	m	1.39		1% of pathway length
Width of plume in aquifer at source	m	550.0	800.0	Width at BH03 and width at BH26 (Areas of maximum concentration)
Plume thickness at source	m	25		Assumed thickness of plume

CONTAMINANT SPECIFIC INPUTS

Project Number	60536736
Project Title	M54/M6 Link Road
Date	28-Nov-19

Simulation Details	Simulation detailing the potential contaminant concentration in groundwater affecting the surface watercourse Latherford Brook

Determinand	Henry's Law Constant	Source	Organic C - water partition coefficient (Koc)	Source	Soil-Water Partition Coefficient (Kd)	Source	Background Concentration in Groundwater	Source	Half-Life of Contaminant in Groundwater	Source	Initial contaminant concentration in groundwater	Source
	dimensionless		l/kg		l/kg		mg/l		days		mg/l	
Ethylbenzene (EQS)	1.39E-01	LQM/CIEH 2009, T	4.47E+02	Science Report – SC050021/SR7			0.01	Half of EQS value	5.0E+02	EA: The rationale for t	0.045	Chemical Sreening data
Xylene Total (EQS)	1.04E-01	LQM/CIEH 2009, T	4.54E+02	Science Report – SC050021/SR7			0.015	Half of EQS value	5.0E+02	EA: The rationale for t	0.091	Chemical Sreening data
Ammoniacal Nitrogen (EQS)					1.0	CONSIM	0.15	Half of EQS value	2.2E+03	EA: The rationale for t	5.46	Chemical Sreening data
Naphthalene (EQS)	6.62E-03	Science Report – S	6.46E+02	LQM/CIEH 2009, Trempérature corrected to 10oC			0.001	Half of EQS value	1.0E+03	EA: The rationale for t	0.00749	Chemical Sreening data
Anthracene (EQS)	1.81E-04	LQM/CIEH 2009, T	5.62E+03	LQM/CIEH 2009, Trempérature corrected to 10oC			0.0001	Half of EQS value	3.0E+03	URS/PAHs: The ration	0.00220	Chemical Sreening data
Fluoranthene (EQS)	6.29E-05	Science Report – S	1.82E+04	LQM/CIEH 2009, Trempérature corrected to 10oC			3.2E-06	Half of EQS value	5.0E+03	URS/PAHs: The ration	0.01100	Chemical Sreening data
Benzo(a) pyrene (EQS)	1.76E-06	Science Report – S	1.29E+05	LQM/CIEH 2009, Trempérature corrected to 10oC			0.000000085	Half of EQS value	1.0E+04	(3) URS/PAHs: The ra	0.0159	Chemical Sreening data
Benzo(g,h,i)perylene (EQS)	2.86E-06	LQM/CIEH 2009, T	4.17E+05	LQM/CIEH 2009, Trempérature corrected to 10oC			0.0000041	Half of EQS value	1.0E+04	(3) URS/PAHs: The ra	0.004	Chemical Sreening data
Benzo(b)fluoranthene (EQS)	2.05E-06	Science Report – S	1.05E+05	LQM/CIEH 2009, Trempérature corrected to 10oC			0.0000085	Half of EQS value	1.0E+04	(3) URS/PAHs: The ra	0.02450	Chemical Sreening data
Benzo(k)fluoranthene (EQS)	1.74E-06	Science Report – S	1.48E+05	LQM/CIEH 2009, Trempérature corrected to 10oC			0.0000085	Half of EQS value	1.0E+04	(3) URS/PAHs: The ra	0.00774	Chemical Sreening data
Phenol (EQS)	8.35E-06	Science Report – S	8.32E+01	Science Report – SC050021/SR7			0.00385	Half of EQS value	3.5E+02	EA: The rationale for t	0.08700	Chemical Sreening data
Bis(2-ethylhexyl) phthalate (EQS)	5.33E-05	h calc, compensate	8.74E+04	www.toxnet.nlm.nih.gov			0.00065	Half of EQS value	1.0E+04	URS/A&H: The rationa	0.12700	Chemical Sreening data
Cadmium (EQS)					2560.0	CLEA UK	0.00004	Half of EQS value	1.0E+09	URS CWRA DATABA	0.00461	Chemical Sreening data
Chromium (hexavalent) (EQS)					4800.0	CLEA UK	0.0017	Half of EQS value	1.0E+09	URS CWRA DATABA	0.02780	Chemical Sreening data
Copper (EQS)					35.0	CLEA UK	5.0E-04	Half of EQS value	1.0E+09	URS CWRA DATABA	0.01240	Chemical Sreening data
Nickel (EQS)					2000.0	CLEA UK	0.002	Half of EQS value	1.0E+09	URS CWRA DATABA	0.0232	Chemical Sreening data
Zinc (EQS)					36.0	2001, USEPA, Sup	0.00545	Half of EQS value	1.0E+09	URS CWRA DATABA	0.0401	Chemical Sreening data

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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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:	**M54 M6 Link Road**		
Site Address:			
Completed by:	**Gabriella Barnes**		
Date:	**02-Dec-19**	**Version:**	**1**
Contaminant	**Ammoniacal Nitrogen**		
Target Concentration (C_T)	**0.3 mg/l**	**Origin of C_T:**	**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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
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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		Ammoniacal Nitrogen		from Level 1
Target Concentration	C_T	3.00E-01	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	5.46E+00	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	2.19E+03	days	*See justification table*
Calculated decay rate	λ	3.17E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.00E+00	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	2.27E+01	fraction
Decay rate used	λ	3.17E-04	d^{-1}
Rate of contaminant flow due to retardation	u	2.52E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	5.95E-04	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**9.17E+03**	

Remedial Targets

Remedial Target		**2.75E+03**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**5.95E-04**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	1.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	0.00E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	1.00E+00	l/kg

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

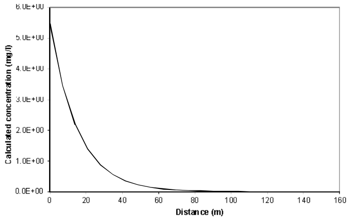
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	5.5E+00
7.0	3.46E+00
13.9	2.19E+00
20.9	1.39E+00
27.8	8.80E-01
34.8	5.58E-01
41.7	3.54E-01
48.7	2.24E-01
55.6	1.42E-01
62.6	9.00E-02
69.5	5.70E-02
76.5	3.61E-02
83.4	2.29E-02
90.4	1.45E-02
97.3	9.19E-03
104.3	5.83E-03
111.2	3.69E-03
118.2	2.34E-03
125.1	1.48E-03
132.1	9.40E-04
139.0	5.95E-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).

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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.

Liability: The Environment Agency does not promise that the worksheet will provide any particular facilities or functions. You must ensure that the worksheet meets your needs and you remain solely responsible for the competent use of the worksheet. You are entirely responsible for the consequences of any use of the worksheet and the Agency provides no warranty about the fitness for purpose or performance of any part of the worksheet. We do not promise that the media will always be free from defects, computer viruses, software locks or other similar code or that the operation of the worksheet will be uninterrupted or error free. You should carry out all necessary virus checks prior to installing on your computing system.

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:	M54 M6 Link Road			
Site Address:				
Completed by:	Gabriella Barnes			
Date:	02-Dec-19		**Version:**	1
Contaminant	Anthracene			
Target Concentration (C_T)	0.0001	mg/l	**Origin of C_T:**	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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
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R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Environment Agency

Input Parameters (using pull down menu)

Parameter	Variable	Value	Unit	Source
Contaminant		Anthracene		from Level 1
Target Concentration	C_T	1.00E-04	mg/l	from Level 1

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

Ogata Banks — 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 valu**

Parameter	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.20E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	3.00E+03	days	*See justification table*
Calculated decay rate	λ	2.31E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.46E+03	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

Parameter	Variable	Value	Unit
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	7.52E+04	fraction
Decay rate used	λ	2.31E-04	d^{-1}
Rate of contaminant flow due to retardation	u	7.61E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	2.86E-283	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**7.70E+279**	

Remedial Targets

Remedial Target		**7.70E+275**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**2.86E-283**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

Parameter	Variable	Value	Unit
Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	5.62E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	3.46E+03	l/kg

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

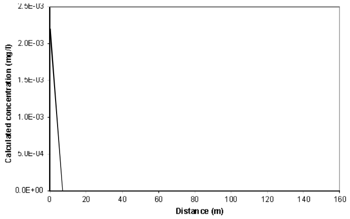
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	2.2E-03
7.0	2.23E-17
13.9	2.26E-31
20.9	2.29E-45
27.8	2.32E-59
34.8	2.35E-73
41.7	2.38E-87
48.7	2.41E-101
55.6	2.44E-115
62.6	2.47E-129
69.5	2.51E-143
76.5	2.54E-157
83.4	2.57E-171
90.4	2.61E-185
97.3	2.64E-199
104.3	2.68E-213
111.2	2.71E-227
118.2	2.75E-241
125.1	2.78E-255
132.1	2.82E-269
139.0	2.86E-283

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.

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

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:	M54 M6 Link Road		
Site Address:			
Completed by:	Gabriella Barnes		
Date:	02-Dec-19	**Version:**	1
Contaminant	Benzo(a)pyrene		
Target Concentration (C_T)	0.00000017 mg/l	**Origin of C_T:**	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 comparision 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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Input Parameters	Variable	Value	Unit	Source
Contaminant		Benzo(a)pyrene		from Level 1
Target Concentration	C_T	1.70E-07	mg/l	from Level 1

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

Ogata Banks — **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 valu

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.59E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+04	days	*See justification table*
Calculated decay rate	λ	6.93E-05	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	7.95E+04	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	1.72E+06	fraction
Decay rate used	λ	6.93E-05	d^{-1}
Rate of contaminant flow due to retardation	u	3.32E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	1.29E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	7.95E+04	l/kg

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

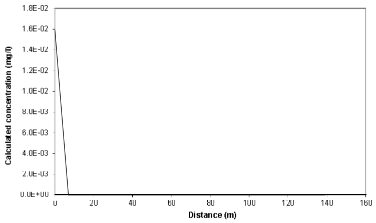
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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.

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	1.6E-02
7.0	2.06E-39
13.9	2.68E-76
20.9	3.47E-113
27.8	4.50E-150
34.8	5.84E-187
41.7	7.57E-224
48.7	9.82E-261
55.6	1.27E-297
62.6	0.00E+00
69.5	0.00E+00
76.5	0.00E+00
83.4	0.00E+00
90.4	0.00E+00
97.3	0.00E+00
104.3	0.00E+00
111.2	0.00E+00
118.2	0.00E+00
125.1	0.00E+00
132.1	0.00E+00
139.0	0.00E+00

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

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.

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

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:	M54 M6 Link Road			
Site Address:				
Completed by:	Gabriella Barnes			
Date:	02-Dec-19		Version:	1
Contaminant	Benzo(b)fluoranthene			
Target Concentration (C_T)	0.000017	mg/l	Origin of C_T:	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 comparision 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.

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		Benzo(b)fluoranthene		from Level 1
Target Concentration	C_T	1.70E-05	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	2.45E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+04	days	*See justification table*
Calculated decay rate	λ	6.93E-05	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	6.47E+04	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable	Value	Unit
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	1.40E+06	fraction
Decay rate used	λ	6.93E-05	d^{-1}
Rate of contaminant flow due to retardation	u	4.08E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target	**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**139**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

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	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	1.05E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	6.47E+04	l/kg

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

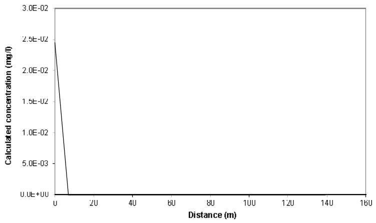
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**2.5E-02**
7.0	**1.32E-35**
13.9	**7.11E-69**
20.9	**3.83E-102**
27.8	**2.06E-135**
34.8	**1.11E-168**
41.7	**5.99E-202**
48.7	**3.23E-235**
55.6	**1.74E-268**
62.6	**9.36E-302**
69.5	**0.00E+00**
76.5	**0.00E+00**
83.4	**0.00E+00**
90.4	**0.00E+00**
97.3	**0.00E+00**
104.3	**0.00E+00**
111.2	**0.00E+00**
118.2	**0.00E+00**
125.1	**0.00E+00**
132.1	**0.00E+00**
139.0	**0.00E+00**

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

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.

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

Liability: The Environment Agency does not promise that the worksheet will provide any particular facilities or functions. You must ensure that the worksheet meets your needs and you remain solely responsible for the competent use of the worksheet. You are entirely responsible for the consequences of any use of the worksheet and the Agency provides no warranty about the fitness for purpose or performance of any part of the worksheet. We do not promise that the media will always be free from defects, computer viruses, software locks or other similar code or that the operation of the worksheet will be uninterrupted or error free. You should carry out all necessary virus checks prior to installing on your computing system.

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:	**M54 M6 Link Road**		
Site Address:			
Completed by:	Gabriella Barnes		
Date:	02-Dec-19	**Version:**	1
Contaminant	Benzo(g,h,i)perylene		
Target Concentration (C_T)	0.0000082 mg/l	**Origin of C_T:**	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 comparision 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.

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		**Benzo(g,h,i)perylene**		from Level 1
Target Concentration	C_T	**8.20E-06**	mg/l	from Level 1

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

Ogata Banks **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 valu**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	4.00E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+04	days	*See justification table*
Calculated decay rate	λ	6.93E-05	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.57E+05	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	5.57E+06	fraction
Decay rate used	λ	6.93E-05	d^{-1}
Rate of contaminant flow due to retardation	u	1.03E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	4.17E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	2.57E+05	l/kg

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

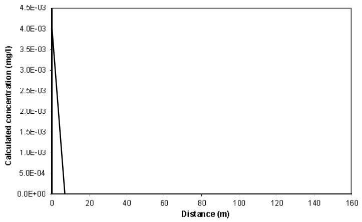
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	4.0E-03
7.0	1.57E-69
13.9	6.14E-136
20.9	2.41E-202
27.8	9.44E-269
34.8	0.00E+00
41.7	0.00E+00
48.7	0.00E+00
55.6	0.00E+00
62.6	0.00E+00
69.5	0.00E+00
76.5	0.00E+00
83.4	0.00E+00
90.4	0.00E+00
97.3	0.00E+00
104.3	0.00E+00
111.2	0.00E+00
118.2	0.00E+00
125.1	0.00E+00
132.1	0.00E+00
139.0	0.00E+00

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.

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

Liability: The Environment Agency does not promise that the worksheet will provide any particular facilities or functions. You must ensure that the worksheet meets your needs and you remain solely responsible for the competent use of the worksheet. You are entirely responsible for the consequences of any use of the worksheet and the Agency provides no warranty about the fitness for purpose or performance of any part of the worksheet. We do not promise that the media will always be free from defects, computer viruses, software locks or other similar code or that the operation of the worksheet will be uninterrupted or error free. You should carry out all necessary virus checks prior to installing on your computing system.

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:	M54 M6 Link Road			
Site Address:				
Completed by:	Gabriella Barnes			
Date:	02-Dec-19		Version:	1
Contaminant	Benzo(k)fluoranthene			
Target Concentration (C_T)	0.000017	mg/l	Origin of C_T:	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 comparision 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.

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		**Benzo(k)fluoranthene**		from Level 1
Target Concentration	C_T	**1.70E-05**	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	7.74E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+04	days	*See justification table*
Calculated decay rate	λ	6.93E-05	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	9.12E+04	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	1.98E+06	fraction
Decay rate used	λ	6.93E-05	d^{-1}
Rate of contaminant flow due to retardation	u	2.89E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target Ogata Banks	**No impact**	**mg/l**	For comparison with measured groundwater concentration.

Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	1.48E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	9.12E+04	l/kg

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

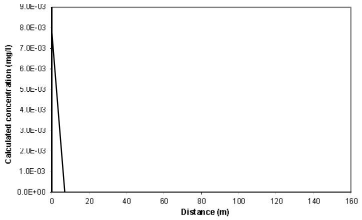
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	7.7E-03
7.0	2.35E-42
13.9	7.13E-82
20.9	2.16E-121
27.8	6.56E-161
34.8	1.99E-200
41.7	6.04E-240
48.7	1.83E-279
55.6	0.00E+00
62.6	0.00E+00
69.5	0.00E+00
76.5	0.00E+00
83.4	0.00E+00
90.4	0.00E+00
97.3	0.00E+00
104.3	0.00E+00
111.2	0.00E+00
118.2	0.00E+00
125.1	0.00E+00
132.1	0.00E+00
139.0	0.00E+00

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.

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

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:	M54 M6 Link Road			
Site Address:				
Completed by:	Gabriella Barnes			
Date:	02-Dec-19		**Version:**	1
Contaminant	Bis(2-ethylhexyl) phthalate			
Target Concentration (C_T)	0.0013	mg/l	**Origin of C_T:**	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 comparision 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.

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		**Bis(2-ethylhexyl) phthalate**		from Level 1
Target Concentration	C_T	**1.30E-03**	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	1.27E-01	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+04	days	*See justification table*
Calculated decay rate	λ	6.93E-05	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	5.39E+04	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	1.17E+06	fraction
Decay rate used	λ	6.93E-05	d^{-1}
Rate of contaminant flow due to retardation	u	4.90E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

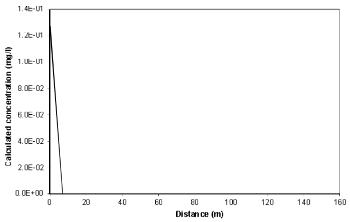
Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	8.74E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	5.39E+04	l/kg

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

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	1.3E-01
7.0	5.72E-32
13.9	2.57E-62
20.9	1.16E-92
27.8	5.22E-123
34.8	2.35E-153
41.7	1.06E-183
48.7	4.76E-214
55.6	2.14E-244
62.6	9.64E-275
69.5	4.34E-305
76.5	0.00E+00
83.4	0.00E+00
90.4	0.00E+00
97.3	0.00E+00
104.3	0.00E+00
111.2	0.00E+00
118.2	0.00E+00
125.1	0.00E+00
132.1	0.00E+00
139.0	0.00E+00

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.

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

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:	M54 M6 Link Road			
Site Address:				
Completed by:	Gabriella Barnes			
Date:	02-Dec-19		**Version:**	1
Contaminant	Cadmium			
Target Concentration (C_T)	0.00008	mg/l	**Origin of C_T:**	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 comparision 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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Environment Agency

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Cadmium		from Level 1
Target Concentration	C_T	8.00E-05	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	4.61E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+09	days	*See justification table*
Calculated decay rate	λ	6.93E-10	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.56E+03	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	5.56E+04	fraction
Decay rate used	λ	6.93E-10	d^{-1}
Rate of contaminant flow due to retardation	u	1.03E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	4.20E-03	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.10E+00**	

Remedial Targets

Remedial Target		**8.78E-05**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**4.20E-03**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	2.56E+03	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Organic carbon partition coefficient	Koc	0.00E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	2.56E+03	l/kg

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

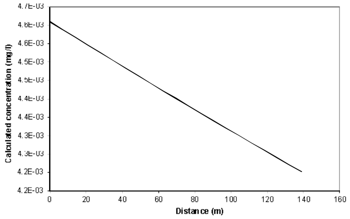
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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.

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	4.6E-03
7.0	4.59E-03
13.9	4.57E-03
20.9	4.55E-03
27.8	4.53E-03
34.8	4.50E-03
41.7	4.48E-03
48.7	4.46E-03
55.6	4.44E-03
62.6	4.42E-03
69.5	4.40E-03
76.5	4.38E-03
83.4	4.36E-03
90.4	4.34E-03
97.3	4.32E-03
104.3	4.30E-03
111.2	4.28E-03
118.2	4.26E-03
125.1	4.24E-03
132.1	4.22E-03
139.0	4.20E-03

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

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.

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

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:	**M54 M6 Link Road**		
Site Address:			
Completed by:	**Gabriella Barnes**		
Date:	**02-Dec-19**	**Version:**	**1**
Contaminant	**Chromium (hexavalent)**		
Target Concentration (C_T)	**0.0034 mg/l**	**Origin of C_T:**	**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 comparision 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.

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		Chromium (hexavalent)		from Level 1
Target Concentration	C_T	3.40E-03	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.78E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+09	days	*See justification table*
Calculated decay rate	λ	6.93E-10	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	4.80E+03	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	1.04E+05	fraction
Decay rate used	λ	6.93E-10	d^{-1}
Rate of contaminant flow due to retardation	u	5.50E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	2.34E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.19E+00**	

Remedial Targets

Remedial Target		**4.04E-03**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**2.34E-02**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	4.80E+03	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Organic carbon partition coefficient	Koc	0.00E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	4.80E+03	l/kg

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

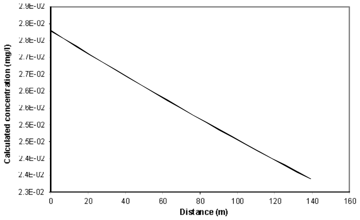
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration mg/l
0	2.8E-02
7.0	2.76E-02
13.9	2.73E-02
20.9	2.71E-02
27.8	2.69E-02
34.8	2.66E-02
41.7	2.64E-02
48.7	2.62E-02
55.6	2.59E-02
62.6	2.57E-02
69.5	2.55E-02
76.5	2.53E-02
83.4	2.51E-02
90.4	2.49E-02
97.3	2.46E-02
104.3	2.44E-02
111.2	2.42E-02
118.2	2.40E-02
125.1	2.38E-02
132.1	2.36E-02
139.0	2.34E-02

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

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.

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

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:	M54 M6 Link Road			
Site Address:				
Completed by:	Gabriella Barnes			
Date:	02-Dec-19		**Version:**	1
Contaminant	Copper			
Target Concentration (C_T)	0.001	mg/l	**Origin of C_T:**	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 comparision 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.

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		**Copper**		from Level 1
Target Concentration	C_T	**1.00E-03**	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	1.24E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+09	days	*See justification table*
Calculated decay rate	λ	6.93E-10	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.50E+01	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	7.61E+02	fraction
Decay rate used	λ	6.93E-10	d^{-1}
Rate of contaminant flow due to retardation	u	7.53E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.24E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.00E+00**	

Remedial Targets

Remedial Target		**1.00E-03**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**1.24E-02**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	3.50E+01	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Organic carbon partition coefficient	Koc	0.00E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	3.50E+01	l/kg

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

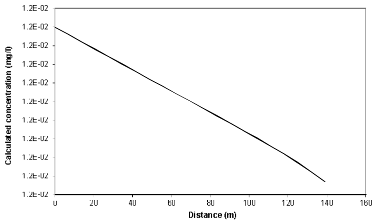
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	1.2E-02
7.0	1.24E-02
13.9	1.24E-02
20.9	1.24E-02
27.8	1.24E-02
34.8	1.24E-02
41.7	1.24E-02
48.7	1.24E-02
55.6	1.24E-02
62.6	1.24E-02
69.5	1.24E-02
76.5	1.24E-02
83.4	1.24E-02
90.4	1.24E-02
97.3	1.24E-02
104.3	1.24E-02
111.2	1.24E-02
118.2	1.24E-02
125.1	1.24E-02
132.1	1.24E-02
139.0	1.24E-02

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

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.

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

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:	M54 M6 Link Road			
Site Address:				
Completed by:	Gabriella Barnes			
Date:	02-Dec-19		**Version:**	1
Contaminant	Ethylbenzene			
Target Concentration (C_T)	0.02	mg/l	**Origin of C_T:**	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 comparision 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.

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		Ethylbenzene		from Level 1
Target Concentration	C_T	2.00E-02	mg/l	from Level 1

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

Ogata Banks — **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 valu**

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	4.50E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+02	days	*See justification table*
Calculated decay rate	λ	1.39E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.75E+02	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	5.98E+03	fraction
Decay rate used	λ	1.39E-03	d^{-1}
Rate of contaminant flow due to retardation	u	9.58E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.03E-194	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**4.37E+192**	

Remedial Targets

Remedial Target		**8.74E+190**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**1.03E-194**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	6.16E-01	fraction
Organic carbon partition coefficient	Koc	4.47E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$	0.00E+00	l/kg
Sorption coefficient for ionised species	$K_{oc,i}$	0.00E+00	l/kg
pH value	pH	0.00E+00	
acid dissociation constant	pKa	0.00E+00	
Fraction of organic carbon in aquifer	foc	0.00E+00	fraction
Soil water partition coefficient	Kd	2.75E+02	l/kg

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

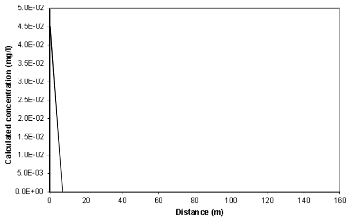
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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.

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	4.5E-02
7.0	1.05E-11
13.9	2.45E-21
20.9	5.72E-31
27.8	1.33E-40
34.8	3.11E-50
41.7	7.26E-60
48.7	1.69E-69
55.6	3.95E-79
62.6	9.23E-89
69.5	2.15E-98
76.5	5.02E-108
83.4	1.17E-117
90.4	2.74E-127
97.3	6.38E-137
104.3	1.49E-146
111.2	3.47E-156
118.2	8.11E-166
125.1	1.89E-175
132.1	4.41E-185
139.0	1.03E-194

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

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.

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

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Fluoranthene**			
Target Concentration (C_T)	**0.0000063**	**mg/l**	**Origin of C_T:**	**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 comparision 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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Parameter	Variable	Value	Unit	Source
Contaminant		Fluoranthene		from Level 1
Target Concentration	C_T	6.30E-06	mg/l	from Level 1

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

Ogata Banks — **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 va**

Parameter	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.10E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*See justification table*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.12E+04	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

Parameter	Variable	Value	Unit
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	2.43E+05	fraction
Decay rate used	λ	1.39E-04	d^{-1}
Rate of contaminant flow due to retardation	u	2.35E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target		No impact	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

Parameter	Variable	Value	Unit
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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	1.82E+04	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	1.12E+04	l/kg

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

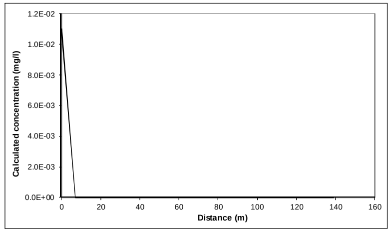
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.1E-02**
7.0	**3.15E-22**
13.9	**9.00E-42**
20.9	**2.57E-61**
27.8	**7.36E-81**
34.8	**2.10E-100**
41.7	**6.02E-120**
48.7	**1.72E-139**
55.6	**4.92E-159**
62.6	**1.41E-178**
69.5	**4.03E-198**
76.5	**1.15E-217**
83.4	**3.29E-237**
90.4	**9.42E-257**
97.3	**2.69E-276**
104.3	**7.71E-296**
111.2	**0.00E+00**
118.2	**0.00E+00**
125.1	**0.00E+00**
132.1	**0.00E+00**
139.0	**0.00E+00**

Environment Agency

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.

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

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: **M54 M6 Link Road**
Site Address:

Completed by: **Gabriella Barnes**
Date: **02-Dec-19** **Version:** **1**

Contaminant **Naphthalene**
Target Concentration (C_T) **0.002** **mg/l** **Origin of C_T:** **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 comparision 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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Parameter	Variable	Value	Unit	Source
Contaminant		Naphthalene		from Level 1
Target Concentration	C_T	2.00E-03	mg/l	from Level 1

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

Ogata Banks — **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 va**

Parameter	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	7.49E-03	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+03	days	*See justification table*
Calculated decay rate	λ	6.93E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.98E+02	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

Parameter	Variable	Value	Unit
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	8.63E+03	fraction
Decay rate used	λ	6.93E-04	d^{-1}
Rate of contaminant flow due to retardation	u	6.63E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	3.09E-166	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**2.43E+163**	

Remedial Targets

Remedial Target		**4.85E+160**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**3.09E-166**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	6.46E+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	3.98E+02	l/kg

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

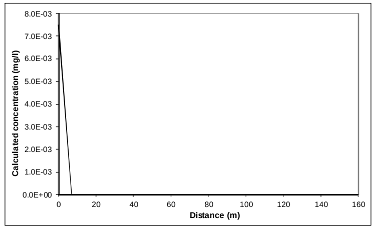
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration mg/l
0	7.5E-03
7.0	5.07E-11
13.9	3.44E-19
20.9	2.33E-27
27.8	1.58E-35
34.8	1.07E-43
41.7	7.23E-52
48.7	4.90E-60
55.6	3.32E-68
62.6	2.25E-76
69.5	1.52E-84
76.5	1.03E-92
83.4	6.98E-101
90.4	4.72E-109
97.3	3.20E-117
104.3	2.17E-125
111.2	1.47E-133
118.2	9.94E-142
125.1	6.73E-150
132.1	4.56E-158
139.0	3.09E-166

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.

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

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Nickel**			
Target Concentration (C_T)	**0.004**	**mg/l**	**Origin of C_T:**	**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 comparision 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.

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Environment Agency

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Nickel		from Level 1
Target Concentration	C_T	4.00E-03	mg/l	from Level 1

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

Ogata Banks — **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 va**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	2.32E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+09	days	*See justification table*
Calculated decay rate	λ	6.93E-10	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.00E+03	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	4.34E+04	fraction
Decay rate used	λ	6.93E-10	d^{-1}
Rate of contaminant flow due to retardation	u	1.32E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	2.16E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.08E+00**	

Remedial Targets

Remedial Target		**4.30E-03**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**2.16E-02**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	2.00E+03	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	2.00E+03	l/kg

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

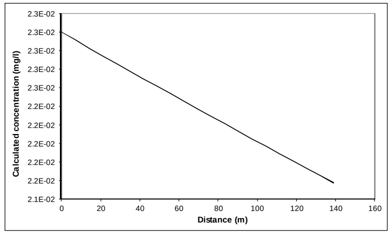
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Link Road
Completed by:	Gabriella Barnes
Date:	02/12/2019
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**2.3E-02**
7.0	**2.31E-02**
13.9	**2.30E-02**
20.9	**2.29E-02**
27.8	**2.29E-02**
34.8	**2.28E-02**
41.7	**2.27E-02**
48.7	**2.26E-02**
55.6	**2.25E-02**
62.6	**2.25E-02**
69.5	**2.24E-02**
76.5	**2.23E-02**
83.4	**2.22E-02**
90.4	**2.21E-02**
97.3	**2.21E-02**
104.3	**2.20E-02**
111.2	**2.19E-02**
118.2	**2.18E-02**
125.1	**2.17E-02**
132.1	**2.17E-02**
139.0	**2.16E-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.

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

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:	**M54 M6 Toll Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Phenol**			
Target Concentration (C_T)	**0.0077**	**mg/l**	**Origin of C_T:**	**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 comparision 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.

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		Phenol		from Level 1
Target Concentration	C_T	7.70E-03	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 2 directions**

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 va**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	8.70E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	3.50E+02	days	*See justification table*
Calculated decay rate	λ	1.98E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	5.13E+01	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable	Value	Unit
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	1.11E+03	fraction
Decay rate used	λ	1.98E-03	d^{-1}
Rate of contaminant flow due to retardation	u	5.14E-05	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{ED}	3.82E-100	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	**AF**	**2.28E+98**	

Remedial Targets

		Value	Unit	
Remedial Target		**1.76E+96**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**3.82E-100**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	8.32E+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	5.13E+01	l/kg

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

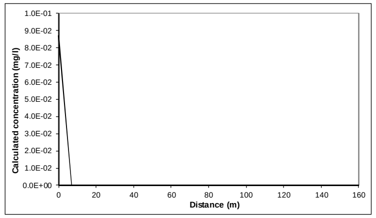
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed:	M54 M6 Toll Link Road
Completed by:	Gabriella Barnes
Date:	#########
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	8.7E-02
7.0	1.05E-06
13.9	1.28E-11
20.9	1.54E-16
27.8	1.87E-21
34.8	2.26E-26
41.7	2.74E-31
48.7	3.32E-36
55.6	4.01E-41
62.6	4.86E-46
69.5	5.87E-51
76.5	7.09E-56
83.4	8.56E-61
90.4	1.03E-65
97.3	1.25E-70
104.3	1.50E-75
111.2	1.81E-80
118.2	2.18E-85
125.1	2.63E-90
132.1	3.17E-95
139.0	3.82E-100

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.

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

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:	**M54 M6 Link Road**			
Site Address:				
Completed by:	**Gabriella Barnes**			
Date:	**02-Dec-19**		**Version:**	**1**
Contaminant	**Xylene Total**			
Target Concentration (C_T)	**0.03**	**mg/l**	**Origin of C_T:**	**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 comparision 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.

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		Xylene Total		from Level 1
Target Concentration	C_T	3.00E-02	mg/l	from Level 1

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

Ogata Banks — **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 va**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	9.10E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+02	days	*See justification table*
Calculated decay rate	λ	1.39E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.50E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	2.79E+02	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	6.06E+03	fraction
Decay rate used	λ	1.39E-03	d^{-1}
Rate of contaminant flow due to retardation	u	9.44E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	7.72E-196	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.18E+194**	

Remedial Targets

Remedial Target	**3.54E+192**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**139**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**7.72E-196**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

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	6.16E-01	fraction
Organic carbon partition coefficient	Koc	4.54E+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	2.79E+02	l/kg

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

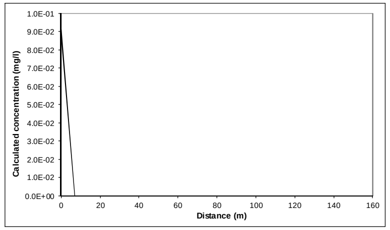
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: M54 M6 Link Road
Completed by: Gabriella Barnes
Date: 02/12/2019
Version: 1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration mg/l
0	9.1E-02
7.0	1.80E-11
13.9	3.56E-21
20.9	7.05E-31
27.8	1.40E-40
34.8	2.76E-50
41.7	5.47E-60
48.7	1.08E-69
55.6	2.14E-79
62.6	4.24E-89
69.5	8.38E-99
76.5	1.66E-108
83.4	3.28E-118
90.4	6.50E-128
97.3	1.29E-137
104.3	2.54E-147
111.2	5.03E-157
118.2	9.96E-167
125.1	1.97E-176
132.1	3.90E-186
139.0	7.72E-196

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.

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

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: **M54 M6 Link Road**
Site Address:

Completed by: **Gabriella Barnes**
Date: **02-Dec-19** **Version:** **1**

Contaminant **Zinc**
Target Concentration (C_T) **0.0109** **mg/l** **Origin of C_T:** **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 comparision 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.

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		Zinc		from Level 1
Target Concentration	C_T	**1.09E-02**	mg/l	from Level 1

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

Ogata Banks — **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 va**

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	4.01E-02	mg/l	*See justification table*
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+09	days	*See justification table*
Calculated decay rate	λ	6.93E-10	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+02	m	*See justification table*
Plume thickness at source	Sy	2.50E+01	m	*See justification table*
Saturated aquifer thickness	da	3.00E+01	m	*See justification table*
Bulk density of aquifer materials	ρ	2.17E+00	g/cm^3	*See justification table*
Effective porosity of aquifer	n	1.00E-01	fraction	*See justification table*
Hydraulic gradient	i	1.20E-02	fraction	*See justification table*
Hydraulic conductivity of aquifer	K	4.77E-01	m/d	*See justification table*
Distance to compliance point	x	1.39E+02	m	*See justification table*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	*See justification table*
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	*See justification table*
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.60E+01	l/kg	*see options*
Longitudinal dispersivity	ax	1.39E+01	m	*see options*
Transverse dispersivity	az	1.39E+00	m	*see options*
Vertical dispersivity	ay	1.39E-01	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	5.72E-02	m/d
Retardation factor	Rf	7.82E+02	fraction
Decay rate used	λ	6.93E-10	d^{-1}
Rate of contaminant flow due to retardation	u	7.32E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	4.00E-02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.00E+00**	

Remedial Targets

Remedial Target		**1.09E-02**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**139**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**4.00E-02**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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)

User specified value for partition coefficient

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd	3.60E+01	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	3.60E+01	l/kg

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

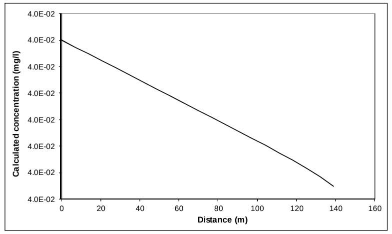
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	0.00E+00	1.39E+01	5.23E+00	m
Transverse dispersivity	**az**	0.00E+00	1.39E+00	5.23E-01	m
Vertical dispersivity	**ay**	0.00E+00	1.39E-01	5.23E-02	

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 desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than an alternative solution should be used

Site being assessed: M54 M6 Link Road
Completed by: Gabriella Barnes
Date: 02/12/2019
Version: 1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**4.0E-02**
7.0	**4.01E-02**
13.9	**4.01E-02**
20.9	**4.01E-02**
27.8	**4.01E-02**
34.8	**4.01E-02**
41.7	**4.01E-02**
48.7	**4.01E-02**
55.6	**4.01E-02**
62.6	**4.01E-02**
69.5	**4.01E-02**
76.5	**4.01E-02**
83.4	**4.01E-02**
90.4	**4.01E-02**
97.3	**4.01E-02**
104.3	**4.01E-02**
111.2	**4.01E-02**
118.2	**4.01E-02**
125.1	**4.01E-02**
132.1	**4.00E-02**
139.0	**4.00E-02**

Appendix E. Gas Monitoring Results

Gas and Groundwater Monitoring Results
M54-M6 Link Road
Highways England

Borehole Number	Date of monitoring	Baro. Pressure	Relative Pressure	Depth of Installation	Response Zone	Install Ref	Diameter	CH_4	CO_2	O_2	H_2S	CO	Gas Flow Rate	Water Level	GSV CH4	GSV CO2
								peak	peak	Min	peak	peak	peak			
		mbar	mbar	mbgl			mm	(%vol)	(%vol)	(%v)	(ppm)	(ppm)	(l/h)	(mbgl)		
BH03	11/07/2019			4.5	Made Ground											
	21/07/2019	995	0	4.5		1	50	10.7	1.6	10	0	80	0	DRY	0	0
	31/07/2019	1000	0	4.5		1	50	28.7	3.8	5.3	0	63	0	4.25	0	0
	06/08/2019	988	0	4.5		1	50	84.7	4.6	0	0	10	0	4.42	0	0
	20/08/2019			4.5			50	58.7	5.9	0.3	2	2000	2.1	4.48	1.2327	0.1239
	29/08/2019	1000	0.02	4.5		1	50	68.5	12.3	0.3	5	118	0.1	4.4	0.0685	0.0123
	06/09/2019	1003	0.17	4.5		1	50	75.3	17.7	0.7	6	24	0	4.46	0	0
	1			4.5				86.2	8.4	1.3	1	0	11.7	4.16	10.0854	0.9828
	2			4.5				0.9	0.1	21.3	0	0	0.1	0.62	0.0009	0.0001
	3			4.5				1.2	0.1	17.8	0	8	0.2	0.66	0.0024	0.0002
	Max (Min O2)							86.2	17.7	0	6	2000	11.7	4.48	10.0854	2.0709

BH04	11/07/2019			12.5	Weathered Bedrock											
	21/07/2019			12.5												
	31/07/2019	995	0	12.5		1	50	0	0	20.6	0	0	0	5.48	0	0
	06/08/2019	984	0	12.5		1	50	0	1.2	18.8	0	0	0	5.42	0	0
	20/08/2019	1008	0.14	12.5		1	50	0	0.1	21.2	0	1	0.2	5.45	0	0.0002
	29/08/2019	1001	0.07	12.5		1	50	0	6.2	13.6	0	4	0.2	5.42	0	0.0124
	06/09/2019	1002	0.1	12.5		1	50	0	0.7	12.9	0	0	0.1	5.48	0	0.0007
	1			12.5				0	0.1	21.2	0	0	0	5.22	0	0
	2			12.5				0	8.9	9.6	0	1	0.2	5.1	0	0.0178
	3			12.5				0.1	8.5	16.7	0	1	0.2	5.04	0.0002	0.017
	Max (Min O2)							0.1	8.9	9.6	0	4	0.2	5.48	0.0144	1.2816

BH05	11/07/2019			12	Weathered Bedrock											
	21/07/2019			12												
	31/07/2019	995	0	12		1	50	0	0	20.4	0	0	5.1	3.79	0	0
	06/08/2019	984	0	12		1	50	0	0	20.3	0	0	0	5.42	0	0
	20/08/2019	1008	0.16	12		1	50	0	0.1	20.9	0	0	0.4	3.73	0	0.0004
	29/08/2019	1001	0.03	12		1	50	0	0.1	20.6	0	4	0.2	3.7	0	0.0002
	06/09/2019	1002	0.1	12		1	50	0	0.1	20.5	0	1	0.1	3.72	0	0.0001
	1			12				0	1	19.7	0	1	-2	3.48	0	-0.02
	2			12				0.1	1.8	20.3	0	1	-0.5	3.41	-0.0005	-0.009
	3			12				0.1	0.4	21.7	0	1	0.3	3.27	0.0003	0.0012
	Max (Min O2)							0.1	1.8	19.7	0	4	5.1	5.42	0.0051	0.0918

BH06	11/07/2019			21	Superficial Deposits											
	21/07/2019			21												
	31/07/2019	995	0	21		1	50	0	0.4	18.3	0	12	5.7	3.52	0	0.0228
	06/08/2019	985	0	21		1	50	0	0.5	17.5	0	10	6.2	3.47	0	0.031
	20/08/2019	1008	0.09	21		1	50	0.1	0.9	16.6	0	20	0.1	8.4	0.0001	0.0009
	29/08/2019	1001	0.02	21		1	50	0.1	1	16.6	0	31	2.8	3.47	0.0028	0.028
	06/09/2019	1002	0.16	21		1	50	0.1	0.8	18.4	0	27	0	3.31	0	0
	1			21				0	3.4	12.1	2	99	1	3.22	0	0.034
	2			21				Gas Monitoring not needed.						3.13		
	3			21				Gas Monitoring not needed.						3.06		
	Max (Min O2)							0.1	3.4	12.1	2	99	6.2	8.4	0.0062	0

Gas and Groundwater Monitoring Results
M54-M6 Link Road
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BH07	11/07/2019			15.5	Superficial Deposits											
	21/07/2019			15.5												
	31/07/2019	996	0	15.5		1	50	0	0.2	13.6	0	63	0	6.45	0	0
	06/08/2019	985	0	15.5		1	50	0	0.2	12.5	0	53	0	6.44	0	0
	20/08/2019	1008	0.05	15.5		1	50	0.2	0.1	14.8	0	59	0.4	6.4	0.0008	0.0004
	29/08/2019	1001	0.02	15.5		1	50	0.2	0.1	13.5	0	78	0.1	6.4	0.0002	0.0001
	06/09/2019	1002	0.12	15.5		1	50	0	0	20.2	0	2	0.1	6.46	0	0
	1			15.5				0.9	0.1	12.4	0	5	0.1	5.15	0.0009	0.0001
	2			15.5				0.2	0.1	20.6	0	1	0.1	5.08	0.0002	0.0001
	3			15.5				0.1	0.1	21.4	0	1	0.3	5.03	0.0003	0.0003
	Max (Min O2)							0.9	0.2	12.4	0	78	0.4	6.46	0.0036	0.0008

BH08a	11/07/2019	1005	0.02	28.2	Bedrock	1	50	0.2	0.3	19.8	0	4	0.2	3.55	0.0004	0.0006
	21/07/2019	993	0	28.2		1	50	0	0.3	20.4	25	240	1.8	3.65	0	0.0054
	31/07/2019	993	0	28.2		1	50	0	0.4	20	0	67	3.5	3.64	0	0.014
	06/08/2019	987	0	28.2		1	50	0	0.5	19.8	0	32	2.5	3.65	0	0.0125
	20/08/2019	1005	0.03	28.2		1	50	0.1	0.6	19.7	1	0	2.7	3.6	0.0027	0.0162
	29/08/2019	1000	0.28	28.2		1	50	0	0.7	18.8	1	0	1.6	3.79	0	0.0112
	06/09/2019	1003	0.05	28.2		1	50	0.3	0.8	18.9	0	0	0.3	3.65	0.0009	0.0024
	1			28.2				0	2.1	18.9	0	0	0.1	3.1	0	0.0021
	2			28.2				Gas Monitoring not needed.						2.06		
	3			28.2				Gas Monitoring not needed.						3.01		
	Max (Min O2)							0.3	2.1	18.8	25	240	3.5		0.0105	0.0735

BH09	11/07/2019	994	0.1	27	Weathered Bedrock	1	50	4.4	2.1	11.5	1	66	0.1	9.28	0.0044	0.0021
	21/07/2019	994	0	27		1	50	0	0.3	19	0	13	0.4	9.25	0	0.0012
	31/07/2019	993	0	27		1	50	1.2	0.1	16.6	0	10	0.8	9.25	0.0096	0.0008
	06/08/2019	987	0	27		1	50	2	0.4	13.7	0	36	1.3	9.21	0.026	0.0052
	20/08/2019	1005	0.03	27		1	50	1.1	0.3	17.2	1	119	2.8	9.22	0.0308	0.0084
	29/08/2019	1000	0.03	27		1	50	2.7	0.8	13.1	2	293	3	9.17	0.081	0.024
	06/09/2019	1003	5.27	27		1	50	3.4	1.1	13.4	1	446	0.8	8.21	0.0272	0.0088
	1			27				7.1	0.1	10.3	5	21	14.4	8.91	1.0224	0.0144
	2			27				2.2	0.2	18.8	0	4	0.2	8.85	0.0044	0.0004
	3			27				2.8	0.1	19.7	0	4	0.2	8.83	0.0056	0.0002
	Max (Min O2)							7.1	2.1	10.3	5	446	14.4		1.0224	0.3024

BH10	11/07/2019	994	0.4	13.5	Superficial deposits	1	50	0	0.1	19.9	0	18	0.0	5.63	0	0
	21/07/2019	995	0	13.5		1	50	0	0.1	20.7	0	0	0	5.8	0	0
	31/07/2019	995	0	13.5		1	50	0	0	20.3	0	0	0	5.77	0	0
	06/08/2019	988	0	13.5		1	50	0	0.2	20.5	0	0	0	5.73	0	0
	20/08/2019	1005	0	13.5		1	50	0.1	0.1	19.5	0	0	0.1	8.69	0.0001	0.0001
	29/08/2019	1000	0.05	13.5		1	50	0	0.2	18.5	1	4	0.2	5.67	0	0.0004
	06/09/2019	1003	0.02	13.5		1	50	0	0.1	20.6	0	0	0.1	7.7	0	0.0001
	1			13.5				0	2.5	17.3	0	0	0.6	5.16	0	0.015
	2			13.5				0.1	2.8	19	0	0	-1.1	5.01	-0.0011	-0.0308
	3			13.5				0	2.1	19.2	0	0	-3.1	4.89	0	-0.0651
	Max (Min O2)							0.1	2.8	17.3	1	18	0.6		0.0006	0.0168

BH11	11/07/2019	995	0.03	14	Weathered Bedrock	1	50	0.1	0.1	20.6	0	1	0.3	4.59	0.0003	0.0003
	21/07/2019	995	0	14		1	50	0	0.1	20.9	0	0	0	4.6	0	0
	31/07/2019	993	0	14		1	50	0	0.2	20.4	0	12	0	4.33	0	0
	06/08/2019	988	3	14		1	50	0	0	20.2	0	0	0	4.88	0	0
	20/08/2019	1005	0.002	14		1	50	0.1	0.1	20.5	0	1	0.1	4.92	0.0001	0.0001
	29/08/2019	1001	0.02	14		1	50	0	0.1	19.6	0	2	0.2	4.87	0	0.0002
	06/09/2019	1004	0.03	14		1	50	0	0.2	20.8	0	0	0	4.9	0	0
	1			14				0	1.4	20.4	0	0	0.2		0	0.0028
	2			14				Couldn't get access as Mr Shacklock revoked access.								
	3			14				0.1	0.6	21.3	0	1	0.2		0.0002	0.0012
	4							0.3	0.4	21	0	4	0.3	4.13	0.0009	0.0012
	Max (Min O2)							0.3	1.4	19.6	0	12	0.3		0.0009	0.0042

BH12	11/07/2019			5	Superficial Deposits											
	21/07/2019			5												
	31/07/2019			5												
	06/08/2019	987	0	5		1	50	0	0	20.2	0	41	0	1.19	0	0
	20/08/2019	1006	0.05	5		1	50	0.1	0.1	20.9	0	3	0.1	0.27	0.0001	0.0001
	29/08/2019	1001	0.05	5		1	50	0	0	19.9	1	6	0.2	1.26	0	0
	06/09/2019	1004	0.07	5		1	50	0	0.1	20.9	0	1	0	1.4	0	0
	1			5				0	0.1	21.3	0	0		0.62	0	0
	2			5				Couldn't get access as Mr Shacklock revoked access.								
	3			5				0.1	0.2	21.5	0	1	0.2	0.62	0.0002	0.0004
	4			5				0.2	0.1	21	0	4			0	0
	Max (Min O2)							0.2	0.2	19.9	1	41	0.2		0.0004	0.0004

BH16	11/07/2019			12	Superficial Deposits												
	21/07/2019			12													
	31/07/2019			12													
	06/08/2019			12													
	20/08/2019	1008	0.1	12		1	50	0.1	0	20.4	0	18	0.5	8.68	0.0005	0	Water sample taken at 11.10m
	29/08/2019	1000	0.03	12		1	50	0.1	0	20.5	0	209	0.1	7.7	0.0001	0	
	06/09/2019	996	0.03	12		1	50	0.1	0	20.8	0	262	0.1	7.77	0.0001	0	
	1			12				0	0.1	21	0	8	0.2	6.99	0	0.0002	
	2			12				0.1	0.1	21.4	0	1	0.1	6.92	0.0001	0.0001	
	3			12				0.1	0.1	21.4	0	0	0.1	6.77	0.0001	0.0001	
	Max (Min O2)							0.1	0.1	20.4	0	262	0.5		0.0005	0.0005	

BH18	11/07/2019			12	Weathered Bedrock											
	21/07/2019	993	0	12		1	50	0	0	15.7	0	278	0	3.48	0	0
	31/07/2019	996	0	12		1	50	0	0	20.6	0	0	0	3.50	0	0
	06/08/2019	987	0	12		1	50	0	0	14.2	0	122	0	3.53	0	0
	20/08/2019	1006	0.03	12		1	50	0.1	0	21	0	1	0.1	3.5	0.0001	0
	29/08/2019	1000	0.33	12		1	50	0	0.1	16.7	0	17	0.1	3.5	0	0.0001
	06/09/2019	996	0.09	12		1	50	0	0.2	18	0	0	0	3.55	0	0
	1			12				0.6	1	19.6	0	0	0	2.24	0	0
	2			12				0.1	1.6	19.3	0	0	0.2	1.96	0.0002	0.0032
	3			12				0.2	1.6	19.3	0	1	3.3	1.55	0.0066	0.0528
	Max (Min O2)							0.6	1.6	14.2	0	278	3.3		0.0198	0.0528

Gas and Groundwater Monitoring Results
M54-M6 Link Road
Highways England

BH20	11/07/2019			15	Weathered Bedrock												
	21/07/2019	993	0	15		1	50	0	0	18	0	59	0	12.8	0	0	
	31/07/2019	995	0	15		1	50	0	0	20.6	0	0	0	12.2	0	0	
	06/08/2019	988	0	15		1	50	0	0	20.4	0	0	0	12.96	0	0	
	20/08/2019	1006	0.07	15		1	50	0.1	0	21.1	0	1	0.1	12.87	0.0001	0	
	29/08/2019	1001	0.09	15		1	50	0	0	18	0	19	0.2	12.23	0	0	
	06/09/2019	996	0.09	15		1	50	0	0.1	21	0	0	0.1	12.46	0	0.0001	
	1			15				0	2.2	19.2	0	0	0	2.24	0	0	
	2			15				0.1	3.1	18.9	0	0	0.2	1.96	0.0002	0.0062	
	3			15				0.1	2.9	18.8	0	1	3.3	1.55	0.0033	0.0957	
	Max (Min O2)							0.1	3.1	18	0	59	3.3		0.0033	0.1023	

BH21	11/07/2019			5	Superficial Deposits												
	21/07/2019			5													
	31/07/2019			5													
	06/08/2019			5													
	20/08/2019	1008	0.02	5		1	50	0.1	0	18.7	1	125	1.6	1.83	0.0016	0	Water sample taken at 4.40m
	29/08/2019	1001	0	5		1	50	0	0	18	1	366	0	1.99	0	0	
	06/09/2019	996	0.05	5		1	50	0.1	0	17.9	1	147	0.5	1.98	0.0005	0	
	1			5				0.6	1.3	15.9	0	4	-2.8	1.15	-0.0168	-0.0364	
	2			5				3.3	0.1	16.8	0	7	20.4	1.03	0.6732	0.0204	
	3			5				0.1	0.1	20	0	2	0.2	1.35	0.0002	0.0002	
	Max (Min O2)							3.3	1.3	15.9	1	366	20.4	1.99	0.6732	0.2652	

BH22A	11/07/2019			29	Bedrock												
	21/07/2019			29													
	31/07/2019			29													
	06/08/2019			29													
	20/08/2019			29		1	50							0			Low flow of water from top of standpipe.
	29/08/2019			29		1	50							0			
	06/09/2019			29		1	50							0			
	1			29				Artesian Water so couldn't do gas analysis.									
	2			29				Artesian Water so couldn't do gas analysis.									
	3			29				Artesian Water so couldn't do gas analysis.									
	Max (Min O2)																

BH24	11/07/2019			8	Superficial Deposits												
	21/07/2019	1001	0	8		1	50	0	1.8	7	0	114	0	4.05	0	0	
	31/07/2019	1003	0	8		1	50	0	4.2	6.5	0	10	0	4.06	0	0	
	06/08/2019	990	0	8		1	50	0	5.5	5.1	0	0	0	4.13	0	0	
	20/08/2019	1008	0.05	8		1	50	0.1	7.4	4.4	0	3	0	4.1	0	0	
	29/08/2019	1001	0.09	8		1	50	0.1	7.8	3.9	0	3	0	4.12	0	0	
	06/09/2019	997	0.09	8		1	50	0.1	7	4	0	1	0	4.06	0	0	
	1			8				0	8.1	6.8	0	9	3.8	3.28	0	0.3078	
	2			8				0	0.6	21.2	0	0	0.2	3.11	0	0.0012	
	3			8				0.1	1	21.2	0	1	0.2	3.01	0.0002	0.002	
	Max (Min O2)							0.1	8.1	3.9	0	114	3.8		0.0038	0.3078	

Gas and Groundwater Monitoring Results
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BH25	11/07/2019	1002	0	17	Superficial Deposits	1	50	0.1	0	19.1	1	197	0.3	7.41	0.0003	0
	21/07/2019	998	0	17		1	50	0	0	20.2	0	36	0	9.28	0	0
	31/07/2019	1002	0	17		1	50	0	0	18.8	0	26	0	8.62	0	0
	06/08/2019	990	0	17		1	50	0	0	14.2	0	10	0	9.03	0	0
	20/08/2019	1006	0	17		1	50	0.1	0	17.3	0	0	0	9.03	0	0
	29/08/2019	1000	0.02	17		1	50	0	0	15.2	0	0	0	8.94	0	0
	06/09/2019	997	0.02	17		1	50	0	0	13.8	0	0	0	9.03	0	0
	1			17				2.8	0.9	19.9	12	34	0	7.18	0	0
	2			17				5	0.3	18	1	10	-3.7	7.06	-0.185	-0.0111
	3			17				4.1	0.1	18.2	0	11	0.3	7.02	0.0123	0.0003
	Max (Min O2)							5	0.9	13.8	12	197	0.3		0.015	0.0027

BH26	11/07/2019			5	Superficial Deposits											
	21/07/2019			5												
	31/07/2019			5												
	06/08/2019	984	0	5		1	50	0	0	19.6	0	98	0	4.75	0	0
	20/08/2019	1008	0.14	5		1	50	0	0	19.7	1	169	0.1	4.84	0	0
	29/08/2019	1000	0.1	5		1	50	0.3	0	11.1	1	295	0.3	4.94	0.0009	0
	06/09/2019	997	0.1	5		1	50	0.3	0	15.5	1	185	0.1	4.87	0.0003	0
	1			5				0.9	0.1	8	0	11	0.1	4.76	0.0009	0.0001
	2			5				0.5	0.2	12	0	0	0.1	4.83	0.0005	0.0002
	3			5				0.5	0.2	11.9	0	1	0.3	5.01	0.0015	0.0006
	Max (Min O2)							0.9	0.2	8	1	295	0.3		0.0027	0.0006

BH27	11/07/2019			18	Weathered Bedrock											
	21/07/2019			18												
	31/07/2019	996	0	18		1	50	0	0	18.9	0	12	0	12.86	0	0
	06/08/2019	985	0	18		1	50	0	0.9	16.9	0	12	0	12.83	0	0
	20/08/2019	1008	0.1	18		1	50	0	0	20.1	0	140	0.1	12.99	0	0
	29/08/2019	1001	0.2	18		1	50	0	0	18.8	0	0	0.2	13.06	0	0
	06/09/2019	997	0.14	18		1	50	0	0.1	21.2	0	0	0.1	13.1	0	0.0001
	1			18												
	2			18				0.1	3.4	17.6	0	0	0.1	12.53	0.0001	0.0034
	3			18				0.1	1.5	19.5	0	1	0.1	12.48	0.0001	0.0015
	4			18				0.3	1.5	19	0	5	0.3	12.41	0.0009	0.0045
	Max (Min O2)							0.3	3.4	16.9	0	140	0.3	13.1	0.0009	0.0102