



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment			
Site Name:	Fassaroe - Site 2		
Site Address:	Fassaroe Co. Wicklow		
Completed by:	Adrian Green	Version:	1
Date:	04-May-18		
Contaminant	Ammonia		
Target Concentration (C _T)	0.065	mg/l	Origin of C _T : Surface Water EQS & GW GTV

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

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

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant Target concentration C_T Ammonia 0.065 mg/l from Level 1 from Level 1

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

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

Standard entry

Input Parameters	Variable	Value	Unit	Source of parameter value
Infiltration	Inf	1.84E-04	m/d	
Area of contaminant source	A	4.21E+04	m ²	Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	3.40E+02	m		
Saturated aquifer thickness	da	3.00E+01	m		
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.00E+01	m/d		
Hydraulic gradient of water table	i	1.50E-01	fraction		
Width of contaminant source perpendicular to groundwater flow	w	1.35E+02	m		Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l		
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	3.00E+01	m		

Calculated Parameters

Dilution Factor	DF	7.22E+02		
Level 2 Remedial Target		4.69E+01	mg/l	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentrati
		or		
		0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Fassaroe - Site 2
Completed by:	Adrian Green
Date:	04-May-18
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	C _T	0.065	mg/l	from Level 1
Dilution Factor	DF	7.22E+02		from Level 2

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

Domenico - Steady state Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

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

Calculate for ionic organic chemicals (acids)

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd I/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc fraction

Organic carbon partition coefficient Koc I/kg

Sorption coefficient for related species K_{oc,n} 0.00E+00 I/kg

Sorption coefficient for ionised species K_{oc,i} 0.00E+00 I/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 0.00E+00 I/kg

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

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

Longitudinal dispersivity ax Enter value Calc value Xu & Eckstein

Transverse dispersivity az 0.00E+00 1.60E+00 5.59E-01 m

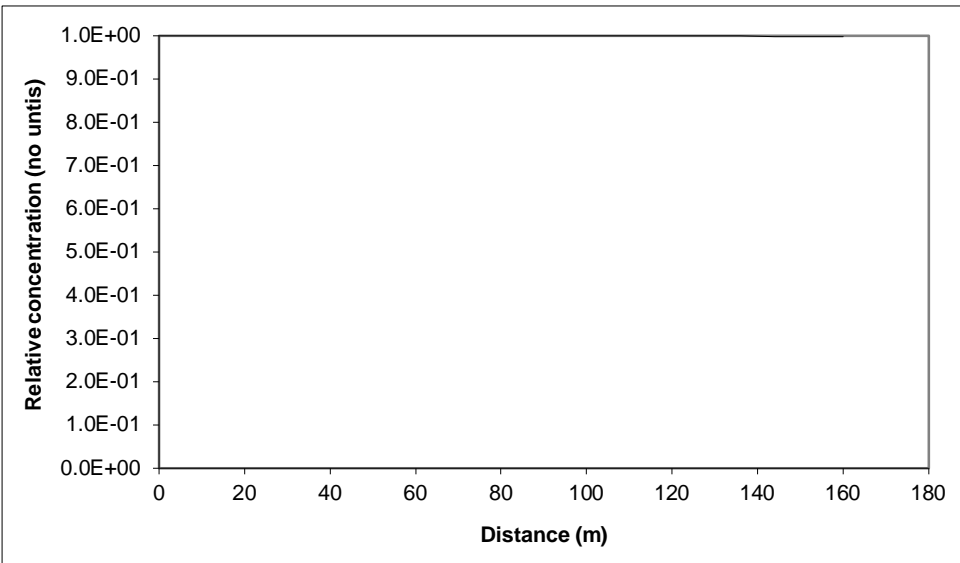
Vertical dispersivity ay 0.00E+00 1.60E-01 5.59E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	4.24E-01
8.0	1.00E+00	4.24E-01
16.0	1.00E+00	4.24E-01
24.0	1.00E+00	4.24E-01
32.0	1.00E+00	4.24E-01
40.0	1.00E+00	4.24E-01
48.0	1.00E+00	4.24E-01
56.0	1.00E+00	4.24E-01
64.0	1.00E+00	4.24E-01
72.0	1.00E+00	4.24E-01
80.0	1.00E+00	4.24E-01
88.0	1.00E+00	4.24E-01
96.0	1.00E+00	4.24E-01
104.0	1.00E+00	4.24E-01
112.0	1.00E+00	4.24E-01
120.0	9.99E-01	4.24E-01
128.0	9.99E-01	4.23E-01
136.0	9.99E-01	4.23E-01
144.0	9.98E-01	4.23E-01
152.0	9.98E-01	4.23E-01
160.0	9.97E-01	4.23E-01

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

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

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

Site being assessed:	Fassaroe - Site 2
Completed by:	Adrian Green
Date:	#####
Version:	1

Calculated Parameters Variable

Groundwater flow velocity	v	1.50E+01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.50E-01	fraction
Rate of contaminant flow due to retardation	u	1.50E+01	m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.97E-01	fraction
Attenuation factor (C ₀ /C _{ED})	AF	1.00E+00	fraction
Soil leachate concentration	Co	3.06E+02	

Remedial Targets

Level 3 Remedial Target	4.71E+01	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	160	m	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.97E-01	fraction Domenico - Steady state

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

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Ammonia		from Level 1
Target Concentration	C _T	6.50E-02	mg/l	from Level 1

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

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	4.24E-01	mg/l		Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days		
Calculated decay rate	λ	6.93E-100	days ⁻¹		
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.35E+02	m		
Plume thickness at source	Sy	2.98E+01	m		
Saturated aquifer thickness	da	3.00E+01	m		
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³		
Effective porosity of aquifer	n	1.00E-01	fraction		
Hydraulic gradient	i	1.50E-01	fraction		
Hydraulic conductivity of aquifer	K	1.00E+01	m/d		
Distance to compliance point	x	1.60E+02	m		
Distance (lateral) to compliance point perpendicular to flow direction	z		m		
Distance (depth) to compliance point perpendicular to flow direction	y		m		
Time since pollutant entered groundwater	t	7.30E+03	days		time variant options only
Parameters values determined from options					

Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	1.60E+01	m	see options
Transverse dispersivity	az	1.60E+00	m	see options
Vertical dispersivity	ay	1.60E-01	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.50E+01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Rate of contaminant flow due to retardation	u	1.50E+01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	4.23E-01	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	1.00E+00	

Remedial Targets

Remedial Target	6.52E-02	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			

Distance to compliance point 160 m

Concentration of contaminant at compliance point C_{ED}/C₀ 4.23E-01 mg/l Domenico - Steady state

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

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

User specified value for partition coefficient

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	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	0.00E+00 l/kg

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

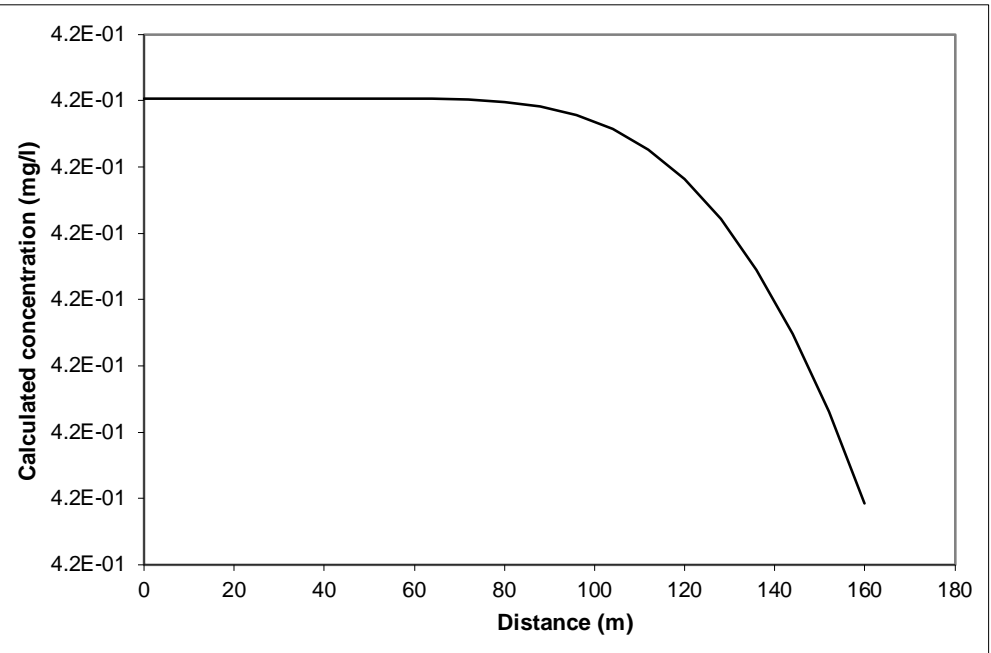
Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 1.60E+01	5.59E+00 m
Transverse dispersivity	az	0.00E+00	1.60E+00	5.59E-01 m
Vertical dispersivity	ay	0.00E+00	1.60E-01	5.59E-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(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

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Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance Concentration

	mg/l
0	4.2E-01
8.0	4.24E-01
16.0	4.24E-01
24.0	4.24E-01
32.0	4.24E-01
40.0	4.24E-01
48.0	4.24E-01
56.0	4.24E-01
64.0	4.24E-01
72.0	4.24E-01
80.0	4.24E-01
88.0	4.24E-01
96.0	4.24E-01
104.0	4.24E-01
112.0	4.24E-01
120.0	4.24E-01
128.0	4.23E-01
136.0	4.23E-01
144.0	4.23E-01
152.0	4.23E-01
160.0	4.23E-01

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

Note

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

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

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

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

Site being assessed:	Fassaroe - Site 2
Completed by:	Adrian Green
Date:	#####
Version:	1



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:	Fassaroe - Site 2		
Site Address:	Fassaroe Co. Wicklow		
Completed by:	Adrian Green	Version:	1
Date:	04-May-18		
Contaminant	Ammonia		
Target Concentration (C_T)	0.065	mg/l	Origin of C_T: Surface Water EQS & GW GTV

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

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

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

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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.

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant Target concentration C_T Ammonia 0.065 mg/l from Level 1 from Level 1

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

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

Standard entry

Input Parameters	Variable	Value	Unit	Source of parameter value
Infiltration	Inf	1.57E-03	m/d	
Area of contaminant source	A	4.21E+04	m ²	Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	3.40E+02	m		
Saturated aquifer thickness	da	3.00E+01	m		
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.00E+01	m/d		
Hydraulic gradient of water table	i	1.50E-01	fraction		
Width of contaminant source perpendicular to groundwater flow	w	1.35E+02	m		Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l		
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	3.00E+01	m		

Calculated Parameters

Dilution Factor	DF	8.53E+01		
Level 2 Remedial Target		5.54E+00	mg/l	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentrati
		or		
		0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Fassaroe - Site 2
Completed by:	Adrian Green
Date:	04-May-18
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	C _T	0.065	mg/l	from Level 1
Dilution Factor	DF	8.53E+01		from Level 2

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

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

Approach for simulating degradation of pollutants: Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil leachate concentration as mg/l			
Enter soil leachate concentration	306	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	
Effective porosity of aquifer	n	fraction	
Hydraulic gradient	i	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance to compliance point	x	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.52E+01 m/d
Retardation factor	Rf	1.00E+00 fraction
Decay rate used	λ	6.93E-100 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.52E-01 fraction
Rate of contaminant flow due to retardation	u	1.52E+01 m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.97E-01 fraction
Attenuation factor (C ₀ /C _{ED})	AF	1.00E+00 fraction
Soil leachate concentration	Co	3.06E+02

Remedial Targets

Level 3 Remedial Target	5.56E+00	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	160	m	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.97E-01	fraction Domenico - Steady state

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

Calculate for ionic organic chemicals (acids)

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc fraction

Organic carbon partition coefficient Koc l/kg

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 0.00E+00 l/kg

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

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

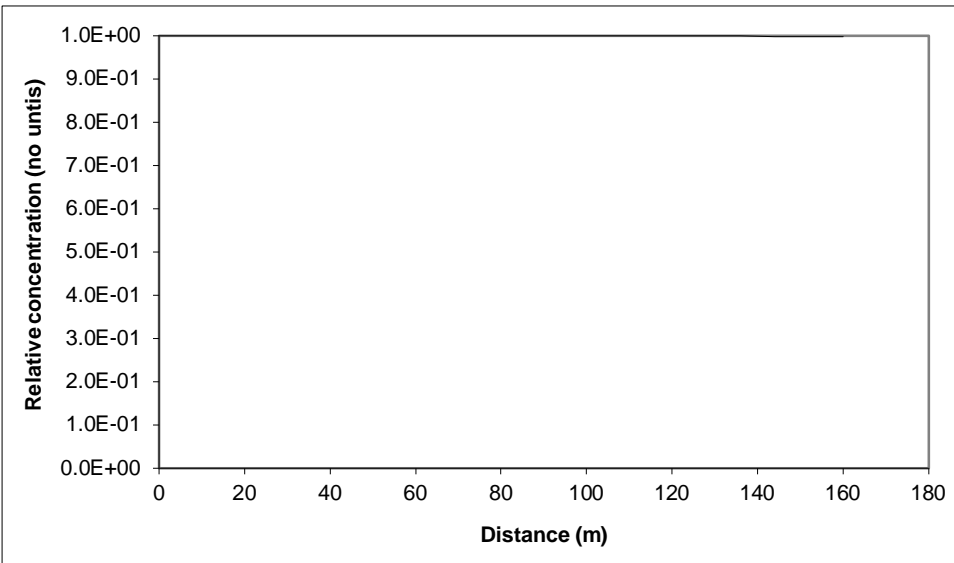
	Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	ax	0.00E+00	1.60E+01	5.59E+00 m
Transverse dispersivity	az	0.00E+00	1.60E+00	5.59E-01 m
Vertical dispersivity	ay	0.00E+00	1.60E-01	5.59E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	3.59E+00
8.0	1.00E+00	3.59E+00
16.0	1.00E+00	3.59E+00
24.0	1.00E+00	3.59E+00
32.0	1.00E+00	3.59E+00
40.0	1.00E+00	3.59E+00
48.0	1.00E+00	3.59E+00
56.0	1.00E+00	3.59E+00
64.0	1.00E+00	3.59E+00
72.0	1.00E+00	3.59E+00
80.0	1.00E+00	3.59E+00
88.0	1.00E+00	3.59E+00
96.0	1.00E+00	3.59E+00
104.0	1.00E+00	3.59E+00
112.0	1.00E+00	3.59E+00
120.0	9.99E-01	3.59E+00
128.0	9.99E-01	3.58E+00
136.0	9.99E-01	3.58E+00
144.0	9.98E-01	3.58E+00
152.0	9.98E-01	3.58E+00
160.0	9.97E-01	3.58E+00

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

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

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

Site being assessed: Fassaroe - Site 2
Completed by: Adrian Green
Date: #####
Version: 1

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

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Ammonia		from Level 1
Target Concentration	C _T	6.50E-02	mg/l	from Level 1

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

Domenico - Steady state

Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	3.06E+02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days	
Calculated decay rate	λ	6.93E-100	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.35E+02	m	
Plume thickness at source	Sy	2.98E+01	m	
Saturated aquifer thickness	da	3.00E+01	m	
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³	
Effective porosity of aquifer	n	1.00E-01	fraction	
Hydraulic gradient	i	1.50E-01	fraction	
Hydraulic conductivity of aquifer	K	1.00E+01	m/d	
Distance to compliance point	x	1.60E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	1.60E+01	m	see options
Transverse dispersivity	az	1.60E+00	m	see options
Vertical dispersivity	ay	1.60E-01	m	see options

Calculated Parameters

Groundwater flow velocity	v	1.50E+01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Rate of contaminant flow due to retardation	u	1.50E+01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	3.05E+02	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	1.00E+00	

Remedial Targets

Remedial Target	6.52E-02	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			

Distance to compliance point 160 m

Concentration of contaminant at compliance point C_{ED}/C₀ 3.05E+02 mg/l Domenico - Steady state

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

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

User specified value for partition coefficient

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	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	0.00E+00 l/kg

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

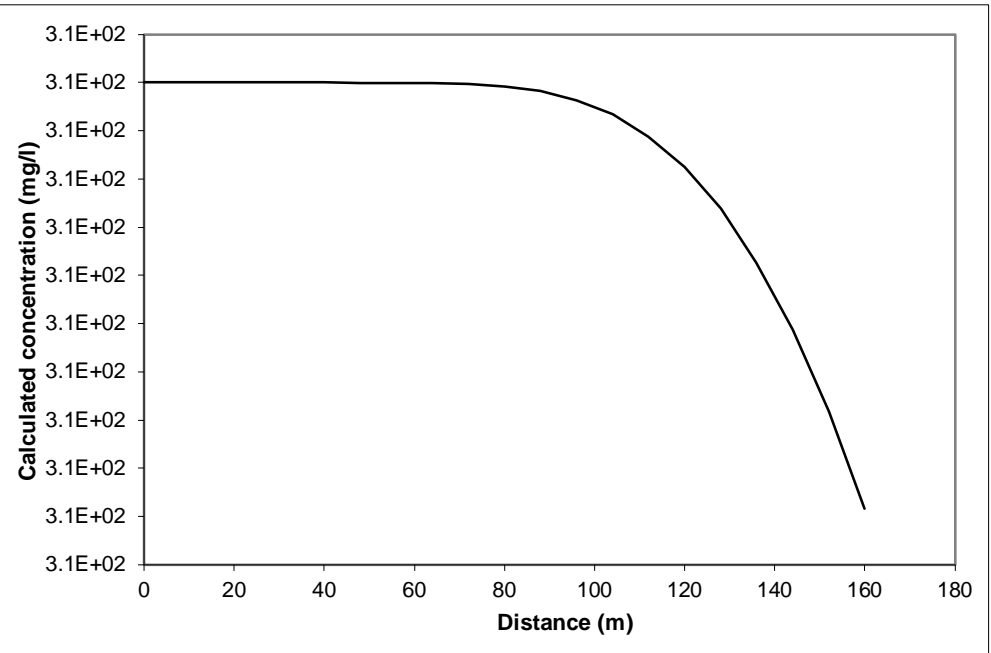
Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 1.60E+01	5.59E+00 m
Transverse dispersivity	az	0.00E+00	1.60E+00	5.59E-01 m
Vertical dispersivity	ay	0.00E+00	1.60E-01	5.59E-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(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

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Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance Concentration

	mg/l
0	3.1E+02
8.0	3.06E+02
16.0	3.06E+02
24.0	3.06E+02
32.0	3.06E+02
40.0	3.06E+02
48.0	3.06E+02
56.0	3.06E+02
64.0	3.06E+02
72.0	3.06E+02
80.0	3.06E+02
88.0	3.06E+02
96.0	3.06E+02
104.0	3.06E+02
112.0	3.06E+02
120.0	3.06E+02
128.0	3.06E+02
136.0	3.06E+02
144.0	3.05E+02
152.0	3.05E+02
160.0	3.05E+02

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

Note

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

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

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

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

Site being assessed:	Fassaroe - Site 2
Completed by:	Adrian Green
Date:	#####
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.

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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:	Fassaroe - Site 3a		
Site Address:	Fassaroe Co. Wicklow		
Completed by:	Adrioan Green	Version:	1
Date:	04-May-18		
Contaminant	Ammonia		
Target Concentration (C_T)	0.175	mg/l	Origin of C_T : Surface Water EQS & GW GTV

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant	Ammonia	from Level 1
Target concentration	0.175	from Level 1
	mg/l	

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

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

Input Parameters	Variable	Value	Unit	Source of parameter value
Standard entry	Infiltration	1.84E-04	m/d	
	Area of contaminant source	2.65E+04	m ²	Not used in calculation
Entry for groundwater flow below site	Length of contaminant source in direction of groundwater flow	2.19E+02	m	
	Saturated aquifer thickness	3.00E+01	m	
	Hydraulic Conductivity of aquifer in which dilution occurs	1.00E+01	m/d	
	Hydraulic gradient of water table	5.00E-02	fraction	
	Width of contaminant source perpendicular to groundwater flow	1.06E+02	m	Not used in calculation
	Background concentration of contaminant in groundwater beneath site	0.00E+00	mg/l	
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate		
	Enter mixing zone thickness		m	
	Calculated mixing zone thickness	2.33E+01	m	

Calculated Parameters

Dilution Factor	DF	2.90E+02		
Level 2 Remedial Target		5.08E+01	mg/l	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration
		or		
		0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Fassaroe - Site 3a
Completed by:	Adrioan Green
Date:	04-May-18
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	C _T	0.175	mg/l	from Level 1
Dilution Factor	DF	2.90E+02		from Level 2

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

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

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

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

Variable	Value	Unit	Source of parameter value
Soil leachate concentration as mg/l			
Enter soil leachate concentration	366	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	
Effective porosity of aquifer	n	fraction	
Hydraulic gradient	i	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance to compliance point	x	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Groundwater flow velocity	v	5.02E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	5.02E-02	fraction
Rate of contaminant flow due to retardation	u	5.02E+00	m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	1.00E+00	fraction
Attenuation factor (C ₀ /C _{ED})	AF	1.00E+00	fraction
Soil leachate concentration	Co	3.66E+02	

Remedial Targets

Level 3 Remedial Target	5.08E+01	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	96	m	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	1.00E+00	fraction

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

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

Calculate for ionic organic chemicals (acids)

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer foc fraction
Organic carbon partition coefficient Koc l/kg

Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{oc,n} l/kg
Sorption coefficient for ionised species K_{oc,i} l/kg
pH value pH
Acid dissociation constant pKa
Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 0.00E+00 l/kg

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

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

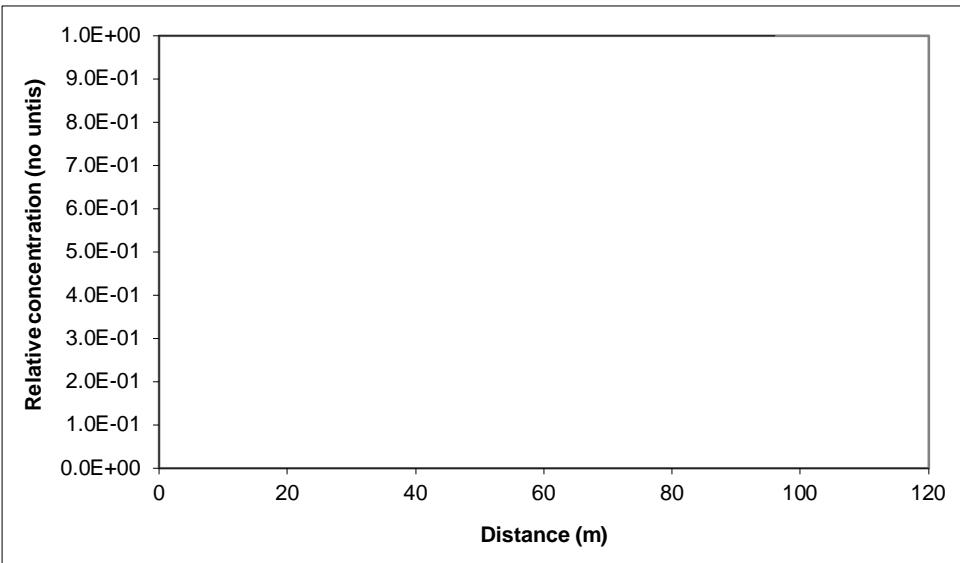
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity ax	0.00E+00	9.60E+00	4.33E+00 m
Transverse dispersivity az	0.00E+00	9.60E-01	4.33E-01 m
Vertical dispersivity ay	0.00E+00	9.60E-02	4.33E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	1.26E+00
4.8	1.00E+00	1.26E+00
9.6	1.00E+00	1.26E+00
14.4	1.00E+00	1.26E+00
19.2	1.00E+00	1.26E+00
24.0	1.00E+00	1.26E+00
28.8	1.00E+00	1.26E+00
33.6	1.00E+00	1.26E+00
38.4	1.00E+00	1.26E+00
43.2	1.00E+00	1.26E+00
48.0	1.00E+00	1.26E+00
52.8	1.00E+00	1.26E+00
57.6	1.00E+00	1.26E+00
62.4	1.00E+00	1.26E+00
67.2	1.00E+00	1.26E+00
72.0	1.00E+00	1.26E+00
76.8	1.00E+00	1.26E+00
81.6	1.00E+00	1.26E+00
86.4	1.00E+00	1.26E+00
91.2	1.00E+00	1.26E+00
96.0	1.00E+00	1.26E+00

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

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

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

Site being assessed: Fassarce - Site 3a
Completed by: Adrian Green
Date: #####
Version: 1

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Ammonia		from Level 1
Target Concentration	C _T	1.75E-01	mg/l	from Level 1

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

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 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 dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	3.66E+02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days	
Calculated decay rate	λ	6.93E-100	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.06E+02	m	
Plume thickness at source	Sy	2.39E+01	m	
Saturated aquifer thickness	da	3.00E+01	m	
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³	
Effective porosity of aquifer	n	1.00E-01	fraction	
Hydraulic gradient	i	5.00E-02	fraction	
Hydraulic conductivity of aquifer	K	1.00E+01	m/d	
Distance to compliance point	x	9.60E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	9.60E+00	m	see options
Transverse dispersivity	az	9.60E-01	m	see options
Vertical dispersivity	ay	9.60E-02	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	5.00E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Rate of contaminant flow due to retardation	u	5.00E+00	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	3.64E+02	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	1.01E+00	

Remedial Targets

Remedial Target	1.76E-01	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			

Distance to compliance point 96 m

Concentration of contaminant at compliance point C_{ED}/C₀ 3.64E+02 mg/l Domenico - Steady state

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

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

User specified value for partition coefficient

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	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	0.00E+00 l/kg

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

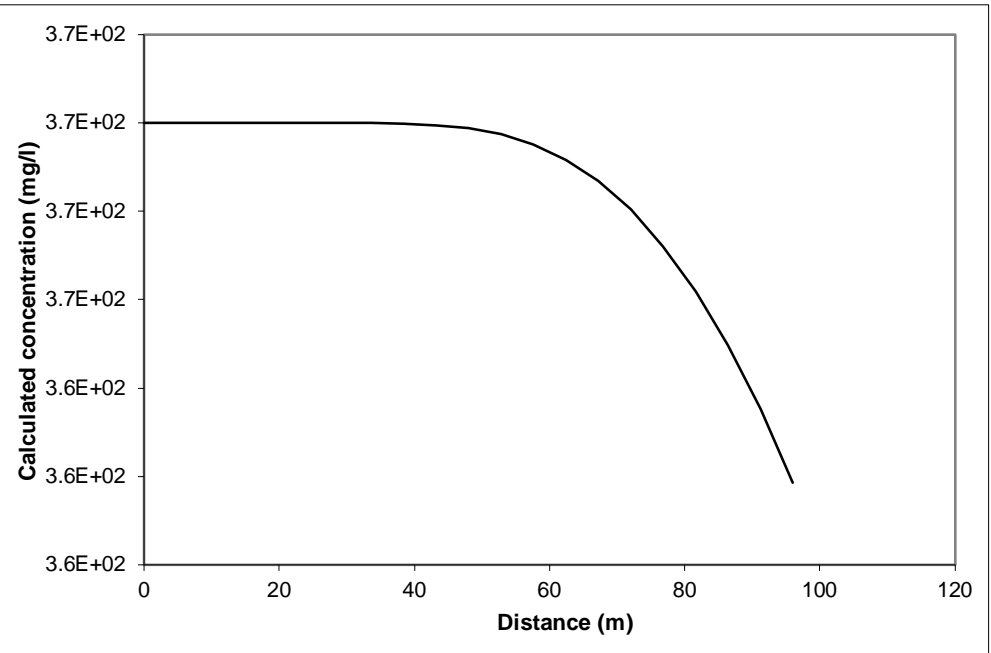
Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 9.60E+00	4.33E+00 m
Transverse dispersivity	az	0.00E+00	9.60E-01	4.33E-01 m
Vertical dispersivity	ay	0.00E+00	9.60E-02	4.33E-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(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

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Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance Concentration

mg/l

0	3.7E+02
4.8	3.66E+02
9.6	3.66E+02
14.4	3.66E+02
19.2	3.66E+02
24.0	3.66E+02
28.8	3.66E+02
33.6	3.66E+02
38.4	3.66E+02
43.2	3.66E+02
48.0	3.66E+02
52.8	3.66E+02
57.6	3.66E+02
62.4	3.66E+02
67.2	3.66E+02
72.0	3.66E+02
76.8	3.65E+02
81.6	3.65E+02
86.4	3.65E+02
91.2	3.64E+02
96.0	3.64E+02

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

Note

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

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

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

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

Site being assessed:	Fassaroe - Site 3a
Completed by:	Adrian Green
Date:	#####
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.

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

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

Details to be completed for each assessment			
Site Name:	Fassaroe - Site 3b		
Site Address:	Fassaroe Co. Wicklow		
Completed by:	Adrian Green	Version:	1
Date:	04-May-18		
Contaminant	Ammonia		
Target Concentration (C _T)	0.065	mg/l	Origin of C _T : Surface Water EQS & GW GTV

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant Target concentration C_T Ammonia 0.065 mg/l from Level 1 from Level 1

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

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

Standard entry

Input Parameters	Variable	Value	Unit	Source of parameter value
Infiltration	Inf	1.84E-04	m/d	
Area of contaminant source	A	6.60E+03	m ²	Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	8.50E+01	m		
Saturated aquifer thickness	da	3.50E+01	m		
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.00E+01	m/d		
Hydraulic gradient of water table	i	2.00E-02	fraction		
Width of contaminant source perpendicular to groundwater flow	w	6.50E+01	m		Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l		
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	9.07E+00	m		

Calculated Parameters

Dilution Factor	DF	1.17E+02		
Level 2 Remedial Target		7.62E+00 or 0.00E+00	mg/l or mg/kg	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Fassaroe - Site 3b
Completed by:	Adrian Green
Date:	04-May-18
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	C _T	0.065	mg/l	from Level 1
Dilution Factor	DF	1.17E+02		from Level 2

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

Domenico - Steady state Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil leachate concentration as mg/l			
Enter soil leachate concentration	567	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days
Calculated decay rate	λ	6.93E-100	days ⁻¹
Width of plume in aquifer at source	Sz	6.50E+01	m
Plume thickness in aquifer at source	Sy	9.07E+00	m
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³
Effective porosity of aquifer	n	1.00E-01	fraction
Hydraulic gradient	i	2.02E-02	fraction
Hydraulic conductivity of saturated aquifer	K	1.00E+01	m/d
Distance to compliance point	x	4.00E+02	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	7.30E+03	days
Parameters values determined from options			
Partition coefficient	Kd	0.00E+00	l/kg
Longitudinal dispersivity	ax	40.000	m
Transverse dispersivity	az	4.000	m
Vertical dispersivity	ay	0.400	m

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	2.02E+00 m/d
Retardation factor	Rf	1.00E+00
Decay rate used	λ	6.93E-100 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	2.02E-02
Rate of contaminant flow due to retardation	u	2.02E+00 m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	1.69E-01
Attenuation factor (C ₀ /C _{ED})	AF	5.93E+00
Soil leachate concentration	Co	5.67E+02

Remedial Targets

Level 3 Remedial Target	4.52E+01	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	400	m	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	1.69E-01	fraction

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

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

Calculate for ionic organic chemicals (acids)

Entry if specify partition coefficient (option) Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc fraction Organic carbon partition coefficient Koc l/kg

Entry for ionic organic chemicals (option) Sorption coefficient for related species K_{oc,n} 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 0.00E+00 l/kg

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

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

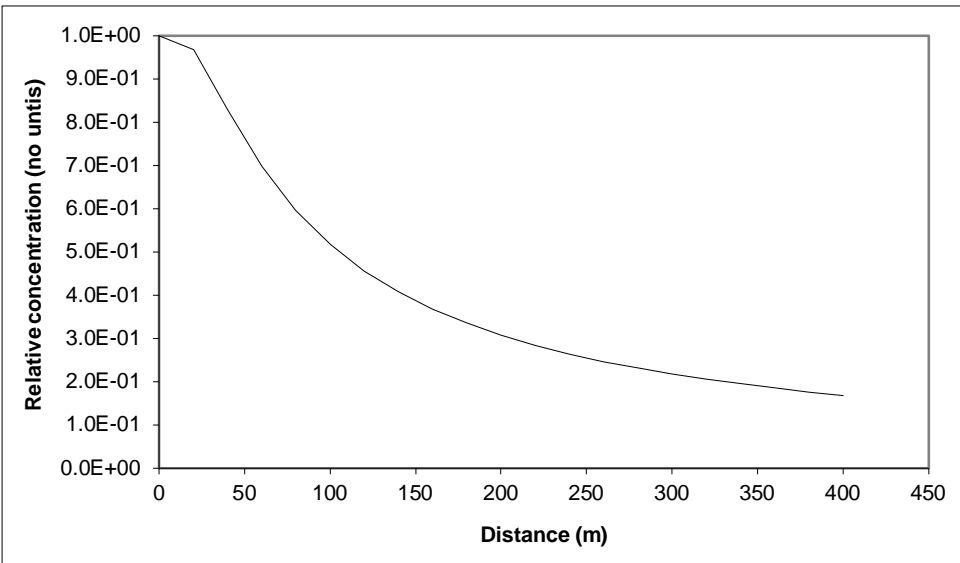
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity ax	0.00E+00	4.00E+01	8.39E+00 m
Transverse dispersivity az	0.00E+00	4.00E+00	8.35E-01 m
Vertical dispersivity ay	0.00E+00	4.00E-01	8.38E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	4.83E+00
20.0	9.67E-01	4.67E+00
40.0	8.30E-01	4.01E+00
60.0	6.98E-01	3.37E+00
80.0	5.95E-01	2.88E+00
100.0	5.17E-01	2.50E+00
120.0	4.56E-01	2.20E+00
140.0	4.07E-01	1.97E+00
160.0	3.67E-01	1.78E+00
180.0	3.35E-01	1.62E+00
200.0	3.07E-01	1.49E+00
220.0	2.84E-01	1.37E+00
240.0	2.64E-01	1.28E+00
260.0	2.47E-01	1.19E+00
280.0	2.31E-01	1.12E+00
300.0	2.18E-01	1.05E+00
320.0	2.06E-01	9.95E-01
340.0	1.95E-01	9.43E-01
360.0	1.85E-01	8.96E-01
380.0	1.77E-01	8.53E-01
400.0	1.69E-01	8.15E-01

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

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

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

Site being assessed:	Fassaroe - Site 3b
Completed by:	Adrian Green
Date:	#####
Version:	1

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Ammonia		from Level 1
Target Concentration	C _T	6.50E-02	mg/l	from Level 1

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

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 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 dissolved pollutants only

Source of parameter value				
Initial contaminant concentration in groundwater at plume core	C ₀	5.67E+02	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days	
Calculated decay rate	λ	6.93E-100	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.50E+01	m	
Plume thickness at source	Sy	9.66E+00	m	
Saturated aquifer thickness	da	3.50E+01	m	
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³	
Effective porosity of aquifer	n	1.00E-01	fraction	
Hydraulic gradient	i	2.00E-02	fraction	
Hydraulic conductivity of aquifer	K	1.00E+01	m/d	
Distance to compliance point	x	4.00E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	4.00E+01	m	see options
Transverse dispersivity	az	4.00E+00	m	see options
Vertical dispersivity	ay	4.00E-01	m	see options

Calculated Parameters

Groundwater flow velocity	v	2.00E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Rate of contaminant flow due to retardation	u	2.00E+00	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	5.24E+01	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	1.08E+01	

Remedial Targets

Remedial Target	7.03E-01	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			
Distance to compliance point	400	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	5.24E+01	mg/l Domenico - Steady state

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

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

User specified value for partition coefficient

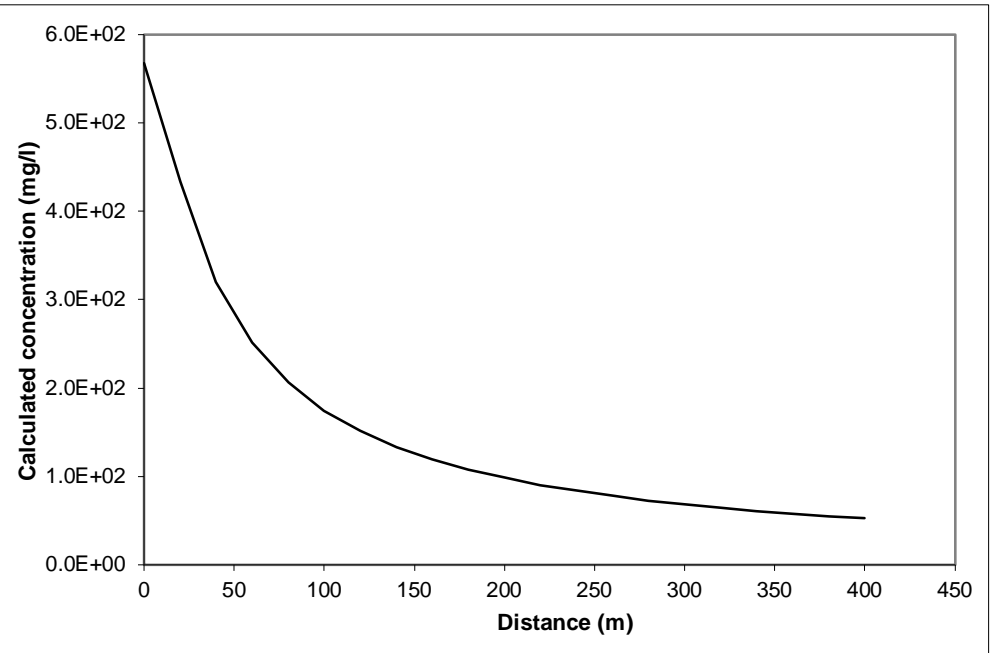
Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	0.00E+00 l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	fraction
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient 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	0.00E+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	4.00E+01 8.35E+00 m
Transverse dispersivity	az	0.00E+00	4.00E+00 8.35E-01 m
Vertical dispersivity	ay	0.00E+00	4.00E-01 8.35E-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			

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Calculated concentrations for distance-concentration graph

Domenico - Steady state
From calculation sheet

Distance	Concentration
	mg/l
0	5.7E+02
20.0	4.34E+02
40.0	3.20E+02
60.0	2.51E+02
80.0	2.06E+02
100.0	1.75E+02
120.0	1.51E+02
140.0	1.33E+02
160.0	1.19E+02
180.0	1.08E+02
200.0	9.84E+01
220.0	9.04E+01
240.0	8.37E+01
260.0	7.79E+01
280.0	7.28E+01
300.0	6.84E+01
320.0	6.45E+01
340.0	6.10E+01
360.0	5.78E+01
380.0	5.50E+01
400.0	5.24E+01

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

Note

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

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

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

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

Site being assessed:	Fassaroe - Site 3b
Completed by:	Adrian Green
Date:	#####
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.

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

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

Details to be completed for each assessment			
Site Name:	Fassaroe - Site 3b		
Site Address:	Fassaroe Co. Wicklow		
Completed by:	Adrian Green	Version:	1
Date:	04-May-18		
Contaminant	Ammonia		
Target Concentration (C_T)	0.065	mg/l	Origin of C_T: Surface Water EQS & GW GTV

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Ammonia
0.065

mg/l

from Level 1
from Level 1

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

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

Input Parameters

Variable

Value

Unit

Source of parameter value

Standard entry

Infiltration
Area of contaminant source

Inf
A

1.57E-03
6.60E+03

m/d
m²

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

8.50E+01
3.50E+01
1.00E+01
2.00E-02
6.50E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Not used in calculation

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

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
9.66E+00

m
m

Calculated Parameters

Dilution Factor	DF	1.55E+01
Level 2 Remedial Target		1.01E+00 or 0.00E+00
		mg/l mg/kg

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

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed:	Fassaroe - Site 3b
Completed by:	Adrian Green
Date:	04-May-18
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	C _T	0.065	mg/l	from Level 1
Dilution Factor	DF	1.55E+01		from Level 2

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

Domenico - Steady state Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil leachate concentration as mg/l			
Enter soil leachate concentration	567	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	
Effective porosity of aquifer	n	fraction	
Hydraulic gradient	i	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance to compliance point	x	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	2.14E+00 m/d
Retardation factor	Rf	1.00E+00 fraction
Decay rate used	λ	6.93E-100 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	2.14E-02 fraction
Rate of contaminant flow due to retardation	u	2.14E+00 m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	1.78E-01 fraction
Attenuation factor (C ₀ /C _{ED})	AF	5.61E+00 fraction
Soil leachate concentration	Co	5.67E+02

Remedial Targets

Level 3 Remedial Target	5.64E+00	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	400	m	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	1.78E-01	fraction Domenico - Steady state

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

Calculate for ionic organic chemicals (acids)

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc fraction

Organic carbon partition coefficient Koc l/kg

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 0.00E+00 l/kg

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

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

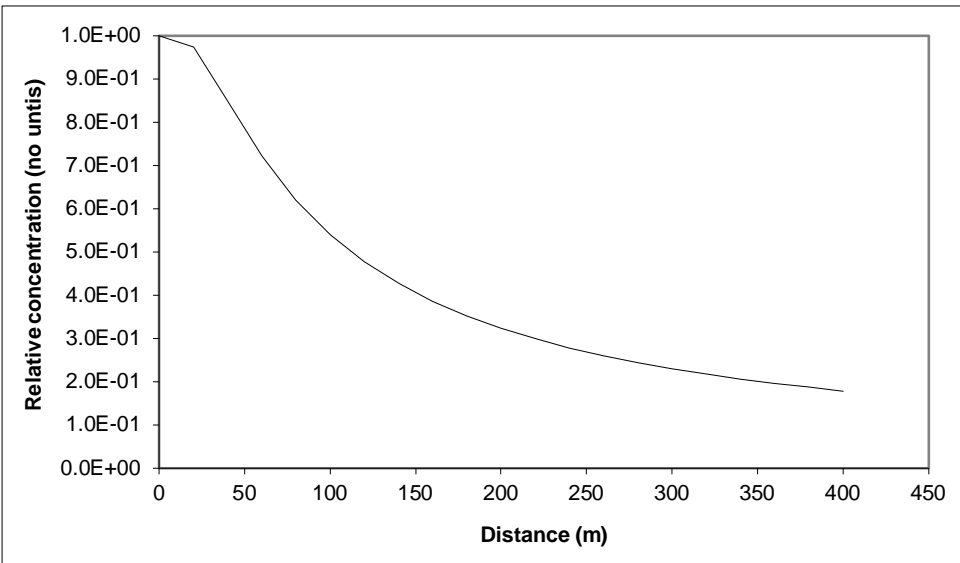
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity ax	0.00E+00	4.00E+01	8.39E+00 m
Transverse dispersivity az	0.00E+00	4.00E+00	8.35E-01 m
Vertical dispersivity ay	0.00E+00	4.00E-01	8.38E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	3.66E+01
20.0	9.74E-01	3.57E+01
40.0	8.49E-01	3.11E+01
60.0	7.21E-01	2.64E+01
80.0	6.19E-01	2.27E+01
100.0	5.39E-01	1.98E+01
120.0	4.77E-01	1.75E+01
140.0	4.27E-01	1.56E+01
160.0	3.86E-01	1.41E+01
180.0	3.52E-01	1.29E+01
200.0	3.24E-01	1.19E+01
220.0	2.99E-01	1.10E+01
240.0	2.79E-01	1.02E+01
260.0	2.60E-01	9.54E+00
280.0	2.44E-01	8.95E+00
300.0	2.30E-01	8.43E+00
320.0	2.18E-01	7.97E+00
340.0	2.06E-01	7.56E+00
360.0	1.96E-01	7.18E+00
380.0	1.87E-01	6.85E+00
400.0	1.78E-01	6.54E+00

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

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

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

Site being assessed: Fassaroe - Site 3b
Completed by: Adrian Green
Date: #####
Version: 1

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

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Ammonia		from Level 1
Target Concentration	C _T	6.50E-02	mg/l	from Level 1

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

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 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 dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	3.66E+01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days	
Calculated decay rate	λ	6.93E-100	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.50E+01	m	
Plume thickness at source	Sy	9.66E+00	m	
Saturated aquifer thickness	da	3.50E+01	m	
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³	
Effective porosity of aquifer	n	1.00E-01	fraction	
Hydraulic gradient	i	2.00E-02	fraction	
Hydraulic conductivity of aquifer	K	1.00E+01	m/d	
Distance to compliance point	x	4.00E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	4.00E+01	m	see options
Transverse dispersivity	az	4.00E+00	m	see options
Vertical dispersivity	ay	4.00E-01	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.00E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Rate of contaminant flow due to retardation	u	2.00E+00	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	3.38E+00	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	1.08E+01	

Remedial Targets

Remedial Target	7.03E-01	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			

Distance to compliance point 400 m

Concentration of contaminant at compliance point C_{ED}/C₀ 3.38E+00 mg/l Domenico - Steady state

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

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

User specified value for partition coefficient

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	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	0.00E+00 l/kg

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

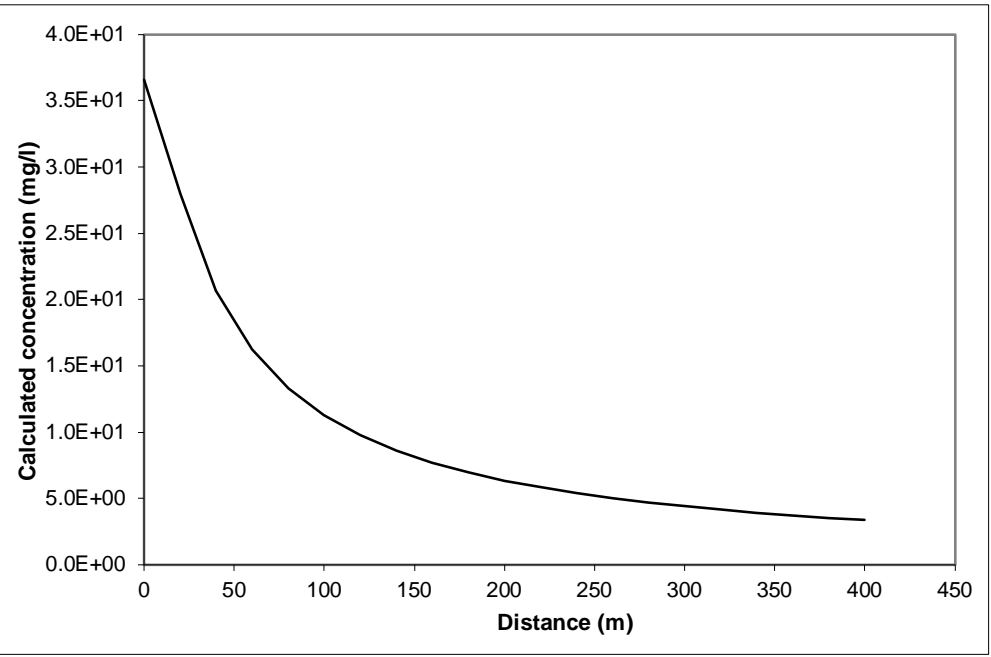
Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 4.00E+01	8.35E+00 m
Transverse dispersivity	az	0.00E+00	4.00E+00	8.35E-01 m
Vertical dispersivity	ay	0.00E+00	4.00E-01	8.35E-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(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

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Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance Concentration

	mg/l
0	3.7E+01
20.0	2.80E+01
40.0	2.07E+01
60.0	1.62E+01
80.0	1.33E+01
100.0	1.13E+01
120.0	9.75E+00
140.0	8.60E+00
160.0	7.69E+00
180.0	6.95E+00
200.0	6.35E+00
220.0	5.84E+00
240.0	5.40E+00
260.0	5.03E+00
280.0	4.70E+00
300.0	4.41E+00
320.0	4.16E+00
340.0	3.93E+00
360.0	3.73E+00
380.0	3.55E+00
400.0	3.38E+00

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

Note

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

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

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

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

Site being assessed:	Fassaroe - Site 3b
Completed by:	Adrian Green
Date:	#####
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.

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

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

Details to be completed for each assessment			
Site Name:	Fassaroe - Site 3c		
Site Address:	Fassaroe Co. Wicklow		
Completed by:	Adrian Green	Version:	1
Date:	04-May-18		
Contaminant	Ammonia		
Target Concentration (C_T)	0.065	mg/l	Origin of C_T: Surface Water EQS & GW GTV

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration
C_T
Ammonia
0.065
mg/l
from Level 1
from Level 1

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

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

Standard entry

Input Parameters	Variable	Value	Unit	Source of parameter value
Infiltration	Inf	1.84E-04	m/d	
Area of contaminant source	A	8.70E+03	m ²	Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	1.13E+02	m		
Saturated aquifer thickness	da	2.50E+01	m		
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.00E+01	m/d		
Hydraulic gradient of water table	i	1.20E-01	fraction		
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m		Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l		
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	1.20E+01	m		

Calculated Parameters

Dilution Factor	DF	6.94E+02		
Level 2 Remedial Target		4.51E+01 or 0.00E+00	mg/l mg/kg	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentrati For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Fassaroe - Site 3c
Completed by:	Adrian Green
Date:	04-May-18
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	C _T	0.065	mg/l	from Level 1
Dilution Factor	DF	6.94E+02		from Level 2

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

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

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil leachate concentration as mg/l			
Enter soil leachate concentration	203	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	
Effective porosity of aquifer	n	fraction	
Hydraulic gradient	i	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance to compliance point	x	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.20E+01 m/d
Retardation factor	Rf	1.00E+00 fraction
Decay rate used	λ	6.93E-100 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.20E-01 fraction
Rate of contaminant flow due to retardation	u	1.20E+01 m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.79E-01 fraction
Attenuation factor (C ₀ /C _{ED})	AF	1.02E+00 fraction
Soil leachate concentration	Co	2.03E+02

Remedial Targets

Level 3 Remedial Target	4.61E+01	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	90	m	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.79E-01	fraction Domenico - Steady state

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

Calculate for ionic organic chemicals (acids)

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc fraction

Organic carbon partition coefficient Koc l/kg

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 0.00E+00 l/kg

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

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

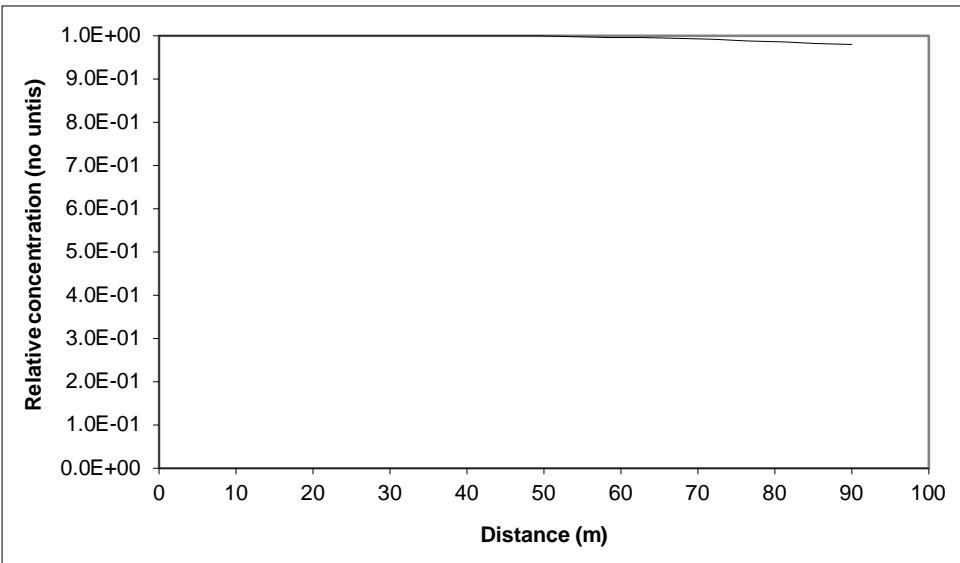
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity ax	0.00E+00	9.00E+00	4.18E+00 m
Transverse dispersivity az	0.00E+00	9.00E-01	4.18E-01 m
Vertical dispersivity ay	0.00E+00	9.00E-02	4.18E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	2.93E-01
4.5	1.00E+00	2.93E-01
9.0	1.00E+00	2.93E-01
13.5	1.00E+00	2.93E-01
18.0	1.00E+00	2.93E-01
22.5	1.00E+00	2.93E-01
27.0	1.00E+00	2.93E-01
31.5	1.00E+00	2.93E-01
36.0	1.00E+00	2.93E-01
40.5	1.00E+00	2.92E-01
45.0	9.99E-01	2.92E-01
49.5	9.98E-01	2.92E-01
54.0	9.98E-01	2.92E-01
58.5	9.96E-01	2.91E-01
63.0	9.95E-01	2.91E-01
67.5	9.93E-01	2.91E-01
72.0	9.91E-01	2.90E-01
76.5	9.88E-01	2.89E-01
81.0	9.85E-01	2.88E-01
85.5	9.82E-01	2.87E-01
90.0	9.79E-01	2.86E-01

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

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

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

Site being assessed: Fassaroe - Site 3c
Completed by: Adrian Green
Date: #####
Version: 1

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

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Ammonia		from Level 1
Target Concentration	C _T	6.50E-02	mg/l	from Level 1

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

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 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 dissolved pollutants only

Initial contaminant concentration in groundwater at plume core	C ₀	2.03E+02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days	
Calculated decay rate	λ	6.93E-100	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	
Plume thickness at source	Sy	1.21E+01	m	
Saturated aquifer thickness	da	2.50E+01	m	
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³	
Effective porosity of aquifer	n	1.00E-01	fraction	
Hydraulic gradient	i	1.20E-01	fraction	
Hydraulic conductivity of aquifer	K	1.00E+01	m/d	
Distance to compliance point	x	9.00E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only
Parameters values determined from options				

Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	9.00E+00	m	see options
Transverse dispersivity	az	9.00E-01	m	see options
Vertical dispersivity	ay	9.00E-02	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.20E+01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Rate of contaminant flow due to retardation	u	1.20E+01	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	1.73E+02	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	1.17E+00	

Remedial Targets

Remedial Target	7.63E-02	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			

Distance to compliance point 90 m

Concentration of contaminant at compliance point C_{ED}/C₀ 1.73E+02 mg/l Domenico - Steady state

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

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

User specified value for partition coefficient

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	fraction
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,i}	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	0.00E+00 l/kg

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

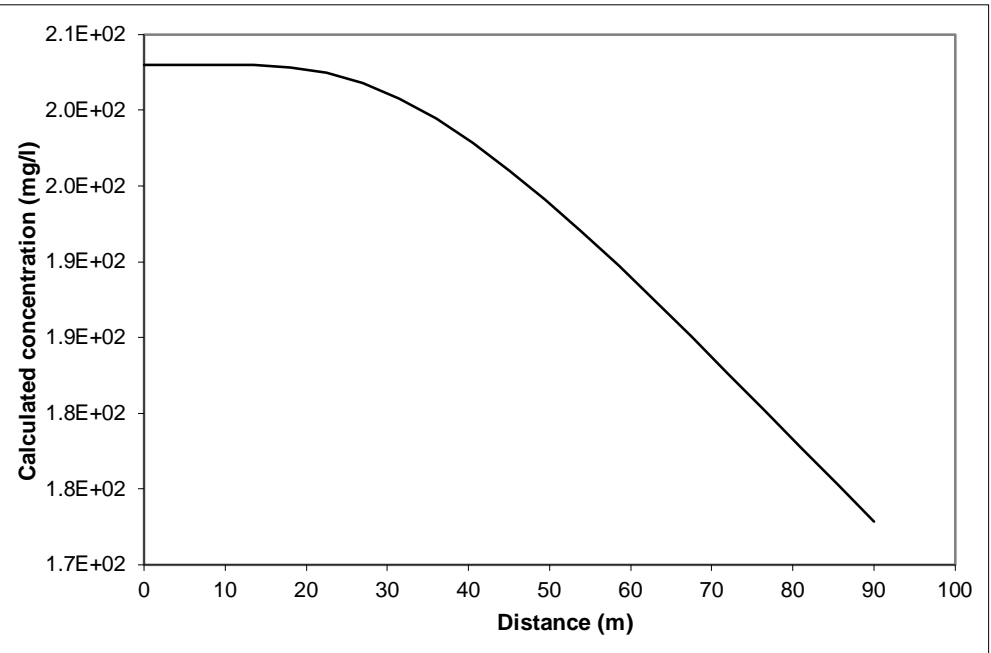
Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity	ax	Enter value 0.00E+00	Calc value Xu & Eckstein 9.00E+00	4.18E+00 m
Transverse dispersivity	az	0.00E+00	9.00E-01	4.18E-01 m
Vertical dispersivity	ay	0.00E+00	9.00E-02	4.18E-02 m

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

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Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance Concentration

	mg/l
0	2.0E+02
4.5	2.03E+02
9.0	2.03E+02
13.5	2.03E+02
18.0	2.03E+02
22.5	2.02E+02
27.0	2.02E+02
31.5	2.01E+02
36.0	1.99E+02
40.5	1.98E+02
45.0	1.96E+02
49.5	1.94E+02
54.0	1.92E+02
58.5	1.90E+02
63.0	1.87E+02
67.5	1.85E+02
72.0	1.83E+02
76.5	1.80E+02
81.0	1.78E+02
85.5	1.75E+02
90.0	1.73E+02

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

Note

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

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

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

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

Site being assessed:	Fassaroe - Site 3c
Completed by:	Adrian Green
Date:	#####
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.

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

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

Details to be completed for each assessment			
Site Name:	Fassaroe - Site 3c		
Site Address:	Fassaroe Co. Wicklow		
Completed by:	Adrian Green	Version:	1
Date:	04-May-18		
Contaminant	Ammonia		
Target Concentration (C_T)	0.065	mg/l	Origin of C_T: Surface Water EQS & GW GTV

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration C_T Ammonia 0.065 mg/l from Level 1 from Level 1

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

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

Standard entry

Input Parameters	Variable	Value	Unit	Source of parameter value
Infiltration	Inf	1.57E-03	m/d	
Area of contaminant source	A	8.70E+03	m ²	

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	1.13E+02	m	
Saturated aquifer thickness	da	2.50E+01	m	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.00E+01	m/d	
Hydraulic gradient of water table	i	1.20E-01	fraction	
Width of contaminant source perpendicular to groundwater flow	w	6.00E+01	m	
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	
		Calculate		
Enter mixing zone thickness	Mz		m	
Calculated mixing zone thickness	Mz	1.21E+01	m	

Not used in calculation

Calculated Parameters

Dilution Factor	DF	8.29E+01	
Level 2 Remedial Target		5.39E+00 or 0.00E+00	mg/l or mg/kg

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

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Fassaroe - Site 3c
Completed by:	Adrian Green
Date:	04-May-18
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	C _T	0.065	mg/l	from Level 1
Dilution Factor	DF	8.29E+01		from Level 2

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

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

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source of parameter value
Soil leachate concentration as mg/l			
Enter soil leachate concentration	203	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	days	
Calculated decay rate	λ	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	m	from Level 2
Plume thickness in aquifer at source	Sy	m	from Level 2
Bulk density of aquifer materials	ρ	g/cm ³	
Effective porosity of aquifer	n	fraction	
Hydraulic gradient	i	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	m/d	from Level 2
Distance to compliance point	x	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	m	
Distance (depth) to compliance point perpendicular to flow direction	y	m	
Time since pollutant entered groundwater	t	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.21E+01 m/d
Retardation factor	Rf	1.00E+00 fraction
Decay rate used	λ	6.93E-100 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	1.21E-01 fraction
Rate of contaminant flow due to retardation	u	1.21E+01 m/d
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.79E-01 fraction
Attenuation factor (C ₀ /C _{ED})	AF	1.02E+00 fraction
Soil leachate concentration	Co	2.03E+02

Remedial Targets

Level 3 Remedial Target	5.50E+00	mg/l	For comparison with measured pore water concentration.
Domenico - Steady state	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point	90	m	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.79E-01	fraction Domenico - Steady state

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

Calculate for ionic organic chemicals (acids)

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc fraction

Organic carbon partition coefficient Koc l/kg

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 l/kg

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

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

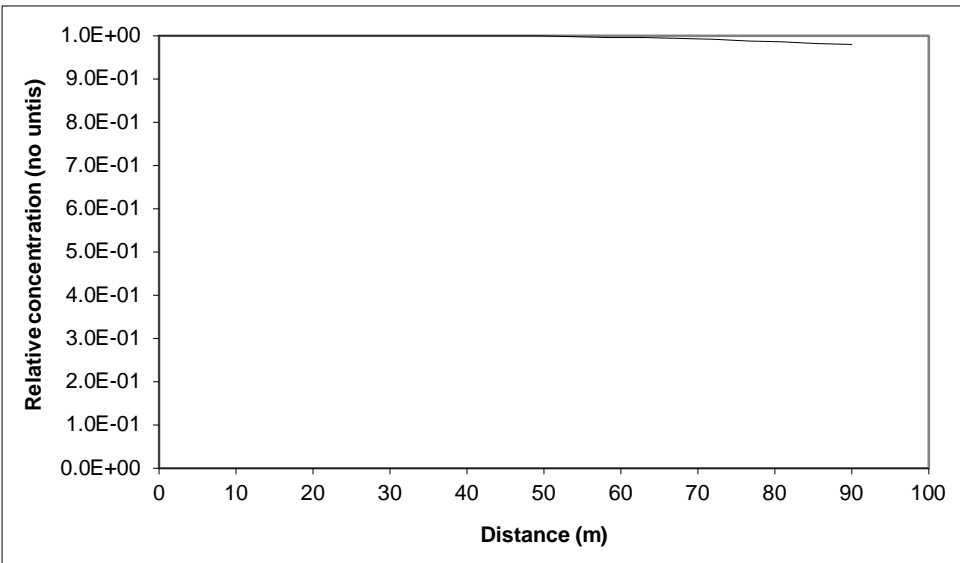
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity ax	0.00E+00	9.00E+00	4.18E+00 m
Transverse dispersivity az	0.00E+00	9.00E-01	4.18E-01 m
Vertical dispersivity ay	0.00E+00	9.00E-02	4.18E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	2.45E+00
4.5	1.00E+00	2.45E+00
9.0	1.00E+00	2.45E+00
13.5	1.00E+00	2.45E+00
18.0	1.00E+00	2.45E+00
22.5	1.00E+00	2.45E+00
27.0	1.00E+00	2.45E+00
31.5	1.00E+00	2.45E+00
36.0	1.00E+00	2.45E+00
40.5	1.00E+00	2.45E+00
45.0	9.99E-01	2.45E+00
49.5	9.98E-01	2.45E+00
54.0	9.98E-01	2.44E+00
58.5	9.96E-01	2.44E+00
63.0	9.95E-01	2.44E+00
67.5	9.93E-01	2.43E+00
72.0	9.91E-01	2.43E+00
76.5	9.88E-01	2.42E+00
81.0	9.86E-01	2.41E+00
85.5	9.82E-01	2.41E+00
90.0	9.79E-01	2.40E+00

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

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

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

Site being assessed:	Fassaroe - Site 3c
Completed by:	Adrian Green
Date:	#####
Version:	1

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

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Contaminant		Ammonia		from Level 1
Target Concentration	C _T	6.50E-02	mg/l	from Level 1

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

Domenico - Steady state Equations in HRA publication

Approach for simulating vertical dispersion: Simulate vertical dispersion in 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 dissolved pollutants only

Source of parameter value			
Initial contaminant concentration in groundwater at plume core	C ₀	2.04E+02	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days
Calculated decay rate	λ	6.93E-100	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m
Plume thickness at source	Sy	1.21E+01	m
Saturated aquifer thickness	da	2.50E+01	m
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³
Effective porosity of aquifer	n	1.00E-01	fraction
Hydraulic gradient	i	1.20E-01	fraction
Hydraulic conductivity of aquifer	K	1.00E+01	m/d
Distance to compliance point	x	9.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	7.30E+03	days
Parameters values determined from options			

Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	9.00E+00	m	see options
Transverse dispersivity	az	9.00E-01	m	see options
Vertical dispersivity	ay	9.00E-02	m	see options

Calculated Parameters

Groundwater flow velocity	v	1.20E+01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	6.93E-100	d ⁻¹
Rate of contaminant flow due to retardation	u	1.20E+01	m/d
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{ED}	1.74E+02	mg/l
Attenuation factor (two way vertical dispersion, CO/CED)	AF	1.17E+00	

Remedial Targets

Remedial Target	7.63E-02	mg/l	For comparison with measured groundwater concentration.
Domenico - Steady state			

Distance to compliance point 90 m

Concentration of contaminant at compliance point C_{ED}/C₀ 1.74E+02 mg/l Domenico - Steady state

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

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

User specified value for partition coefficient

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	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	0.00E+00 l/kg

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

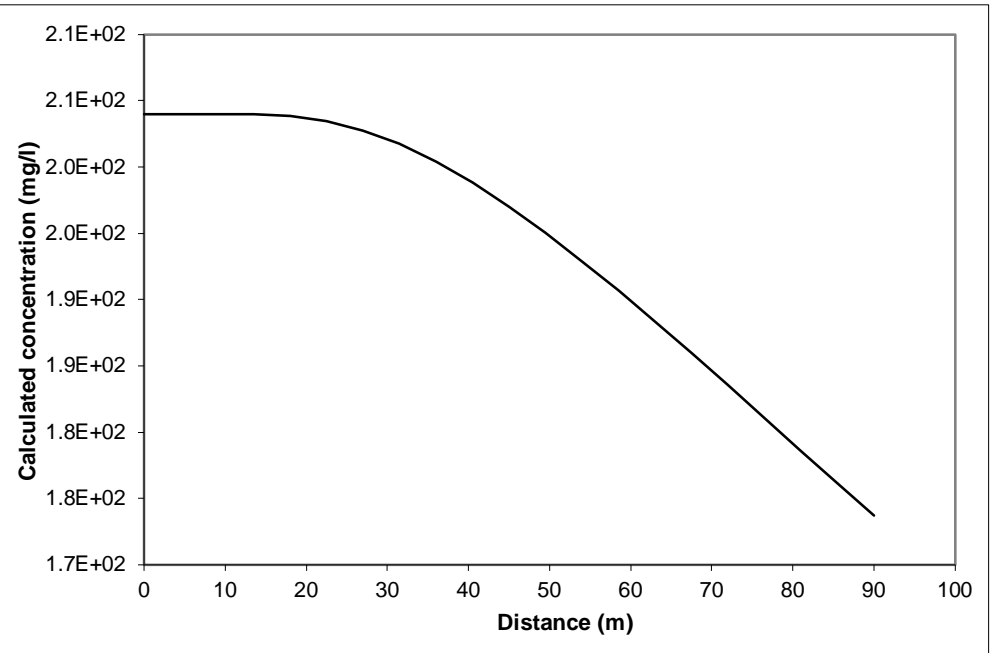
Dispersivities 10%, 1%, 0.1% of pathway length

	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax	0.00E+00	9.00E+00 4.18E+00 m
Transverse dispersivity	az	0.00E+00	9.00E-01 4.18E-01 m
Vertical dispersivity	ay	0.00E+00	9.00E-02 4.18E-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(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

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Calculated concentrations for distance-concentration graph

Domenico - Steady state

From calculation sheet

Distance Concentration

Distance	Concentration
	mg/l
0	2.0E+02
4.5	2.04E+02
9.0	2.04E+02
13.5	2.04E+02
18.0	2.04E+02
22.5	2.03E+02
27.0	2.03E+02
31.5	2.02E+02
36.0	2.00E+02
40.5	1.99E+02
45.0	1.97E+02
49.5	1.95E+02
54.0	1.93E+02
58.5	1.91E+02
63.0	1.88E+02
67.5	1.86E+02
72.0	1.84E+02
76.5	1.81E+02
81.0	1.79E+02
85.5	1.76E+02
90.0	1.74E+02

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

Note

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

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

The measured groundwater concentration should be compared

with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

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

Site being assessed:	Fassaroe - Site 3c
Completed by:	Adrian Green
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