

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 e	ach assessment			Fortiegt	
Site Name: Site Address:	Fassaroe - Site 2 Fassaroe Co. Wick	low		Consent of COL	
Completed by:	Adrian Green			Cor	
Date:	04-May-18		Version:	1	
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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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

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

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

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

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

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

17/05/2018, 16:13 EA_Remedial_Targets_Worksheet Site 2_CAPPED_UPDATE 2018Introduction

Level 2 - Soil

Contaminant Target concentration	Cτ	Ammonia 0.065	mg/I	from Level 1 This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).
Input Parameters Standard entry	Variable	Value	Unit	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 contamiantion' (Environment Agency 2006) Source of parameter value
Infiltration Area of contaminant source	Inf A	1.84E-04 4.21E+04	m/d m ²	Not used in calculation
Area or contaminant source	~	4.212+04]	
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	 س
Hydraulic gradient of water table Width of contaminant source perpendicular to groundwater flow	ı w	1.50E-01 1.35E+02	fraction	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	m mg/l	Not used in calculation
	Ou	Calculate	iiig/i	
Define mixing zone depth by specifying or calculating depth (using pull down list) Enter mixing zone thickness	Mz	Calculate	m	The second se
Calculated mixing zone thickness	Mz	3.00E+01	m	edita ne
Calculated Parameters] m	A CONTRACTOR OF A CONTRACTOR O
Dilution Factor	DF	7.22E+02	Ç0'	
Level 2 Remedial Target		4.69E+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)	Сс	0.00E+00	mg/l	Site being assessed: Fassaroe - Site 2 Completed by: Adrian Green Date: 04-May-18
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0 Version: 1



Level 3 - Soil	See Note				
Input Parameters	Variable	Value	Unit	Source Ent	ter Calo
Contaminant		Ammonia		from Level 1	San
Target Concentration	Cτ	0.065	mg/l	from Level 1	
Dilution Factor	DF	7.22E+02	iiig/i	from Level 2	
		1.222702	J	Enti	rv il
Select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below).	nen on p	ull-down menu)	Soil	-
······································			/	1	
	Don	enico - Steady	state	Equations in HRA publication	ry to
				Frac	ction
Select nature of decay rate (click on brown cell below,	then on	pull-down mer	nu)	Orga	anic
Approach for simulating degradation of pollutants:	Apply de	gradation rate to	o dissolve	d pollutants only Entr	ry fo
				Sorp	-
	Variable	Value	Unit	Source of parameter value Sorp	-
Enter source concentration		1	eachate co	pncentration as mg/l pH v	
Enter soil leachate concentration		306	mg/l	Acid	
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days	Frac	ction
Calculated decay rate	λ	6.93E-100	days⁻¹	calculated	
Width of plume in aquifer at source	Sz	1.35E+02	m	from Level 2 Soil	wat
Plume thickness in aquifer at source	Sy	3.00E+01	m	from Level 2	
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³		
Effective porosity of aquifer	n	1.00E-01	fraction	Defi	ine
Hydraulic gradient	i	1.50E-01	fraction	from Level 2 (adjusted)	
Hydraulic conductivity of saturated aquifer	K	1.00E+01	m/d	from Level 2	
Distance to compliance point	х	1.60E+02	m		
Distance (lateral) to compliance point perpendicular to flow direction	Z		m	Lon	igitu
Distance (depth) to compliance point perpendicular to flow direction	У		m	Trai	nsv
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only Vert	tica
Parameters values determined from options			•	Note	e va
Partition coefficient	Kd	0.00E+00	l/kg	see options	
Longitudinal dispersivity	ax	16.000	m	see options Xu &	& E0
Transverse dispersivity	az	1.600	m	see options	
Vertical dispersivity	ay	0.160	m	see options	
Parameter values should be checked against Level 1 and 2				Note	~
Calculated Parameters	Variabla			This	
Calculated Farameters	Valiable			degr	
Groundwater flow velocity	v	1.50E+01	m/d	degr	
Retardation factor	Řf	1.00E+00	fraction	degr	
Decay rate used	λ	6.93E-100	d ⁻¹	alter	rnati
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 concentr	
Domenico - Steady state		or		This assumes Level 1 Remedial Target is based on	
		0.00E+00	mg/kg	For comparison with measured soil concentration. T	
Distance to compliance point		160	m	assumes Level 1 Remedial Target calculated from s	soil-
Potio of Compliance Daint to Course Concertation	0 10		fuention	partitioning equation.	
Ratio of Compliance Point to Source Concentration	U_{ED}/U_0	9.97E-01	traction	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



method of defining partition co-efficient (using pull down list) Iculate for ionic organic chemicals (acids)

if specify partition coefficient (option)			
ater partition coefficient	Kd		l/kg
for non-polar organic chemicals (option	on)		
on of organic carbon in aquifer	foc		fraction
ic carbon partition coefficient	Koc		l/kg
for ionic organic chemicals (option)		-	_
on coefficient for related species	K _{oc,n}	0.00E+00	l/kg
on coefficient for ionised species	K _{oc,i}	0.00E+00	l/kg
lue	pН	0.00E+00	
lissociation constant	pKa	0.00E+00	
on of organic carbon in aquifer	foc	0.00E+00	fraction
			-
ater partition coefficient	Kd	0.00E+00	l/kg

dispersivity (click brown cell and use pull down list) Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	_
itudinal dispersivity	ax	0.00E+00	1.60E+01	5.59E+00	m
sverse dispersivity	az	0.00E+00	1.60E+00	5.59E-01	m
cal dispersivity	ay	0.00E+00	1.60E-01	5.59E-02	m

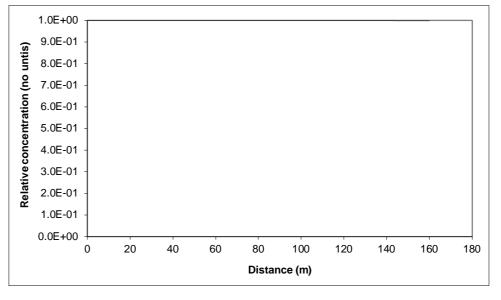
alues of dispersivity must be > 0

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

orksheet should be used if pollutant transport and dation is best described by a first order reaction. If dation is best desribed by an electron limited lation such as oxidation by O_2 , NO_3 , SO_4 etc than and tive solution should be used

on. arget Concentration.

-water



Note: 'Relative concentration' is the ratio of calculated concentation 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.

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 (relative) concentrations for distance-concentration graph

Domenico - Steady state						
From calcu	lation sheet					
	Relative					
Distance	concentration	Concentration				
	(No units)	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				

Level 3 - Groundwater	See Note			
Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	_	6.50E-02	mg/l	from Level 1
Select analytical solution (click on brown cell below, the	en on pu	ll-down menu)		1
	Don	nenico - Steady	state	Equations in HRA publication
Approach for simulating vertical dispersion:		Simulate v	ertical dis	spersion in 1 direction
Select nature of decay rate (click on brown cell below, t	hen on p	ull-down menu)		
Approach for simulating degradation of pollutants:	Apply de	gradation rate to	dissolved	d pollutants only
	0		•	Source of parameter value
Initial contaminant concentration in groundwater at plume core		4.24E-01	mg/l	
Half life for degradation of contaminant in water		1.00E+99	days	
Calculated decay rate		6.93E-100	days⁻¹	
Width of plume in aquifer at source (perpendicular to flow)		1.35E+02	m	
Plume thickness at source		2.98E+01	m	
Saturated aquifer thickness		3.00E+01	m	
Bulk density of aquifer materials	-	1.50E+00	g/cm ³	
Effective porosity of aquifer		1.00E-01	fraction	
Hydraulic gradient		1.50E-01	fraction	
Hydraulic conductivity of aquifer		1.00E+01	m/d	
Distance to compliance point		1.60E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction			m	
Distance (depth) to compliance point perpendicular to flow direction			m	
Time since pollutant entered groundwater Parameters values determined from options	t	7.30E+03	days	time variant options only
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity		1.60E+01	m	see options
Transverse dispersivity		1.60E+00	m	see options
Vertical dispersivity	ay	1.60E-01	m	see options
Calculated Parameters	Variable			
Groundwater flow velocity		1.50E+01	m/d	
Retardation factor		1.00E+00	fraction	
Decay rate used		6.93E-100	d ⁻¹	
Rate of contaminant flow due to retardation		1.50E+01	m/d	
ntaminant concentration at distance x, assuming one-way vertical dispersion		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 groundwate

 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
_	

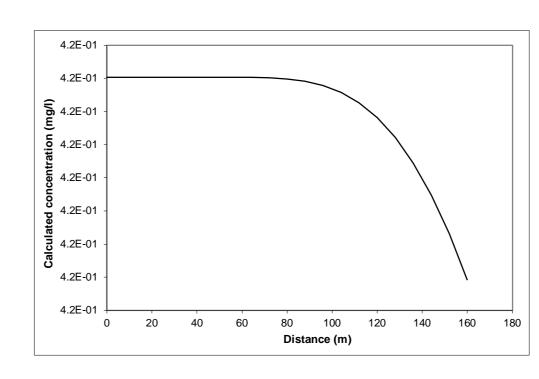
Entry if specify partition coefficient (op	tion)		
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (optic	on)		_
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pН		
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



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

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



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

Note

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

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

The measured groundwater concentration should be compared

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

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

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

ter concentration.

Calculated concentrations for distance-concentration graph

Domenico - Steady state				
From calculati	on 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



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Details to be completed for e	ach assessment			Former	
Site Name: Site Address:	Fassaroe - Site 2 Fassaroe Co. Wickle	ow		Consent of con	
Completed by:	Adrian Green			Corr	
Date:	04-May-18		Version:	1	
Contaminant	Ammonia				
Target Concentration (C _T)	0.065 r	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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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

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

17/05/2018, 16:12 EA_Remedial_Targets_Worksheet Site 2_UPDATE 2018Introduction

Level 2 - Soil

Contaminant Target concentration	Cτ	Ammonia 0.065	mg/I	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 contamiantion' (Environment Agency 2006)
Standard and a	Variable	Value	Unit	Source of parameter value
Standard entry Infiltration	Inf	1.57E-03	m/d	
Area of contaminant source	A	4.21E+04	m ²	Not used in calculation
		11212101]	
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	A DEC.
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	and the second s
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate		Res ^{co} ited t
Enter mixing zone thickness	Mz		m	M. P. roll
Calculated mixing zone thickness	Mz	3.00E+01	m	- De OMIC
Oslavis(ad Damana (and] m	Politic State
Calculated Parameters			asent O	
Dilution Factor	DF	8.53E+01	Colt	
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	J	
		0.00E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1
				Remedial Target calculated from soil-water
Additional option				
Additional option Calculation of impact on receptor				
				Site being assessed: Fassaroe - Site 2
Concentration of contaminant in contaminated discharge (entering receptor)	Сс	0.00E+00	mg/l	Completed by: Adrian Green
				Date: 04-May-18
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0 Version: 1



Level 3 - Soil	See Note				
Input Parameters	Variable	Value	Unit	Source	Enter Cal
Contaminant		Ammonia		from Level 1	Cal
Target Concentration	Cτ	0.065	mg/l	from Level 1	
Dilution Factor	DF	8.53E+01	iiig/i	from Level 2	
		0.332701	J		Entry it
Select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below).	nen on p	ull-down menu)		Soil wat
	· ·		,]	
	Dom	nenico - Steady	state	Equations in HRA publication	Entry f
	_				Fraction
Select nature of decay rate (click on brown cell below,					Organic
Approach for simulating degradation of pollutants:	Apply de	egradation rate to	o dissolve	d pollutants only	Entry f
					Sorption
	Variable	Value	Unit	Source of parameter value	Sorptior
Enter source concentration		1	1	oncentration as mg/l	pH valu
Enter soil leachate concentration Half life for degradation of contaminant in water	t _{1/2}	306	mg/l days		Acid dis Fractior
-		1.00E+99 6.93E-100	days ⁻¹	calculated	Taction
Calculated decay rate	λ Sz	1.35E+02		from Level 2	Soil wat
Width of plume in aquifer at source		3.00E+01	m	from Level 2	SUII Wai
Plume thickness in aquifer at source Bulk density of aquifer materials	Sy	1.50E+00	m g/cm ³		
Effective porosity of aquifer	ρ n	1.00E-01	fraction		Define
Hydraulic gradient		1.52E-01	fraction	from Level 2 (adjusted)	Denne
Hydraulic conductivity of saturated aquifer	ĸ	1.00E+01	m/d	from Level 2	
Distance to compliance point		1.60E+02	m		
Distance (lateral) to compliance point perpendicular to flow direction		1.002102	m		Longitu
Distance (depth) to compliance point perpendicular to flow direction	y		m		Transv
Time since pollutant entered groundwater		7.30E+03	days	time variant options only	Vertica
Parameters values determined from options					Note va
Partition coefficient	Kd	0.00E+00	l/kg	see options	
Longitudinal dispersivity	ax	16.000	m	see options	Xu & Eo
Transverse dispersivity	az	1.600	m	see options	
Vertical dispersivity	ay	0.160	m	see options	
Parameter values should be checked against Level 1 and 2					Nata
Calculated Parameters	Variable				Note This wo
Calculated Falameters	variable				degrada
Groundwater flow velocity	v	1.52E+01	m/d		degrada
Retardation factor	Rf	1.00E+00	fraction		degrada
Decay rate used	λ	6.93E-100	d ⁻¹		alternati
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		9.97E-01	fraction		
Attenuation factor (C ₀ /C _{ED})	AF	1.00E+00	fraction		
Soil leachate concentration	Co	3.06E+02			
Remedial Targets			ma/l		noontrati-
Level 3 Remedial Target Domenico - Steady state		5.56E+00 or	mg/l	For comparison with measured pore water con This assumes Level 1 Remedial Target is bas	
Domenico - Steady state		0.00E+00	mg/kg	For comparison with measured soil concentra	
Distance to compliance point		160	mg/kg	assumes Level 1 Remedial Target calculated	
		100		partitioning equation.	1011 3011-
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



method of defining partition co-efficient (using pull down list) Iculate for ionic organic chemicals (acids)

if specify partition coefficient (option)			
ater partition coefficient	Kd		l/kg
for non-polar organic chemicals (option	on)		
on of organic carbon in aquifer	foc		fraction
ic carbon partition coefficient	Koc		l/kg
for ionic organic chemicals (option)		-	_
on coefficient for related species	K _{oc,n}	0.00E+00	l/kg
on coefficient for ionised species	K _{oc,i}	0.00E+00	l/kg
lue	pН	0.00E+00	
lissociation constant	pKa	0.00E+00	
on of organic carbon in aquifer	foc	0.00E+00	fraction
			-
ater partition coefficient	Kd	0.00E+00	l/kg

dispersivity (click brown cell and use pull down list) Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	_
itudinal dispersivity	ax	0.00E+00	1.60E+01	5.59E+00	m
sverse dispersivity	az	0.00E+00	1.60E+00	5.59E-01	m
cal dispersivity	ay	0.00E+00	1.60E-01	5.59E-02	m

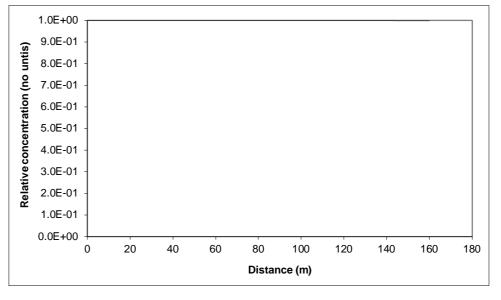
alues of dispersivity must be > 0

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

orksheet should be used if pollutant transport and dation is best described by a first order reaction. If dation is best desribed by an electron limited lation such as oxidation by O_2 , NO_3 , SO_4 etc than and tive solution should be used

on. arget Concentration.

-water



Note: 'Relative concentration' is the ratio of calculated concentation 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.

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 (relative) concentrations for distance-concentration graph

Domenico - Steady state						
From calcu	lation sheet					
	Relative					
Distance	concentration	Concentration				
	(No units)	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				

Level 3 - Groundwater	See Note			
Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	Cτ	6.50E-02	mg/l	from Level 1
Select analytical solution (click on brown cell below, the	an on nu	ll-down menu)		
ociect analytical solution (click on brown cen below, the		, i	ctoto	Equations in LIDA publication
	DOI	nenico - Steady	SIGIE	Equations in HRA publication
Approach for simulating vertical dispersion:		Simulate v	ertical dis	persion in 1 direction
Select nature of decay rate (click on brown cell below, t	hen on p	oull-down menu)		
Approach for simulating degradation of pollutants:	Apply de	egradation rate to	dissolved	•
	C	0.005.00	1	Source of parameter value
Initial contaminant concentration in groundwater at plume core		3.06E+02	mg/l	
Half life for degradation of contaminant in water		1.00E+99	days days ⁻¹	
Calculated decay rate		6.93E-100 1.35E+02		
Width of plume in aquifer at source (perpendicular to flow) Plume thickness at source		2.98E+01	m	
Saturated aquifer thickness	-	3.00E+01	m m	
Bulk density of aquifer materials		1.50E+00	g/cm ³	
Effective porosity of aquifer	-	1.00E-01	fraction	
Hydraulic gradient		1.50E-01	fraction	
Hydraulic conductivity of aquifer		1.00E+01	m/d	
Distance to compliance point		1.60E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction			m	
Distance (depth) to compliance point perpendicular to flow direction			m	
Time since pollutant entered groundwater Parameters values determined from options	t	7.30E+03	days	time variant options only
Partition coefficient		0.00E+00	1/1/4	and options
Longitudinal dispersivity		1.60E+01	l/kg	see options see options
Transverse dispersivity		1.60E+00	m m	see options
Vertical dispersivity		1.60E-01	m	see options
Calculated Parameters	Variable			
Groundwater flow velocity	v	1.50E+01	m/d	
Retardation factor		1.00E+00	fraction	
Decay rate used	λ	6.93E-100	d ⁻¹	
Rate of contaminant flow due to retardation		1.50E+01	m/d	
Contaminant concentration at distance x, assuming one-way vertical dispersion		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 groundwat

Domenico - Steady state Distance to compliance point 160 m Concentration of contaminant at compliance point C_{ED}/C_0 3.05E+02 mg/I 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

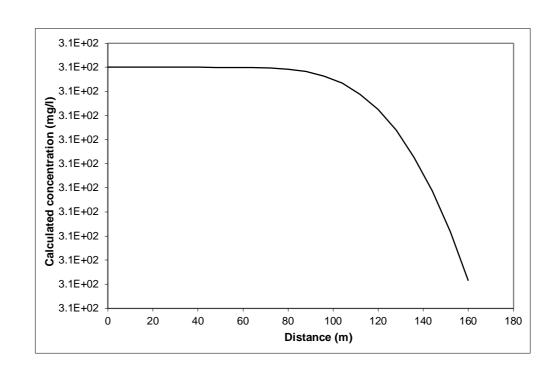
Entry if specify partition coefficient (option	on)		
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (o	ption)		_
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)		_
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
_pH value	pН		
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



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

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



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

Note

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

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

The measured groundwater concentration should be compared

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

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

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

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

ter concentration.

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



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 e	ach assessment			Fortingt
Site Name: Site Address:	Fassaroe - Site 3a Fassaroe Co. Wickle	ow		Consent of cort
Completed by:	Adrioan Green			Corr
Date:	04-May-18		Version:	1
Contaminant	Ammonia			
Target Concentration (C _T)	0.175 r	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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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

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

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

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

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

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

17/05/2018, 16:16 EA_Remedial_Targets_Worksheet Site 3A_CAPPED_UPDATE 2018Introduction

Level 2 - Soil

Contaminant Target concentration	Cτ	Ammonia 0.175	mg/l	from Level 1This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore waterfrom Level 1(mg/l).
Input Parameters	Variable	Value	Unit	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 contamiantion' (Environment Agency 2006) Source of parameter value
Standard entry			.	
Infiltration	Inf	1.84E-04	m/d m ²	
Area of contaminant source	A	2.65E+04	_ m⁻	Not used in calculation
Entry for groundwater flow below site				
Length of contaminant source in direction of groundwater flow	L	2.19E+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	5.00E-02	fraction	19 ⁵⁰
Width of contaminant source perpendicular to groundwater flow	W	1.06E+02	m	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	and and and
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate		DOSE REAL
Enter mixing zone thickness	Mz		m	and Private
Calculated mixing zone thickness	Mz	2.33E+01	m	- O ^C O ^M O
Calculated Parameters] m	R ^{yther}
Dilution Factor	DF	2.90E+02	0	
Level 2 Remedial Target		5.08E+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				Site being assessed: Fassaroe - Site 3a
Concentration of contaminant in contaminated discharge (entering receptor)	Сс	0.00E+00	mg/l	Site being assessed. Passarbe - Site sa Completed by: Adrioan Green Date: 04-May-18
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0 Version: 1



Level 3 - Soil	See Note				
Input Parameters	Variable	Value	Unit	Source	Enter Cal
Contaminant		Ammonia		from Level 1	Cal
Target Concentration	Cτ	0.175	mg/l	from Level 1	
Dilution Factor	DF	2.90E+02	ing/i	from Level 2	
	21		1		Entry if
Select analytical solution (click on brown cell below, the	nen on p	ull-down menu)		Soil wat
]	Entry fe
	Dom	nenico - Steady	state	Equations in HRA publication	-
					Fraction
Select nature of decay rate (click on brown cell below,					Organic
Approach for simulating degradation of pollutants:	Apply de	egradation rate to	o pollutant	ts in all phases (e.g. field derived value,	
	Variable	Value	11	Source of nonomotor value	Sorption
	Variable	Value	Unit	Source of parameter value oncentration as mg/l	Sorptior pH valu
Enter source concentration Enter soil leachate concentration		366	1		Acid dis
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	mg/l days		Fraction
Calculated decay rate	λ	6.93E-100	days ⁻¹	calculated	
Width of plume in aquifer at source	Sz	1.06E+02	m	from Level 2	Soil wat
Plume thickness in aquifer at source	Sy	2.33E+01	l m	from Level 2	Son wat
Bulk density of aquifer materials	-	1.50E+00	g/cm ³		1
Effective porosity of aquifer	ρ n	1.00E-01	fraction		Define
Hydraulic gradient	i	5.02E-02	fraction	from Level 2 (adjusted)	Denne
Hydraulic conductivity of saturated aquifer	ĸ	1.00E+01	m/d	from Level 2	
Distance to compliance point	x	9.60E+01	m		1
Distance (lateral) to compliance point perpendicular to flow direction	z	5.00E101	m		Longitu
Distance (depth) to compliance point perpendicular to flow direction	y y		m		Transv
Time since pollutant entered groundwater		7.30E+03	days	time variant options only	Vertica
Parameters values determined from options					Note va
Partition coefficient	Kd	0.00E+00	l/kg	see options	
Longitudinal dispersivity	ax	9.600	m	see options	Xu & Eo
Transverse dispersivity	az	0.960	m	see options	
Vertical dispersivity	ay	0.096	m	see options	
Parameter values should be checked against Level 1 and 2	-		-		
					Note
Calculated Parameters	Variable				This wo degrada
					degrada
Groundwater flow velocity	V	5.02E+00	m/d		degrada
Retardation factor	Rf	1.00E+00 6.93E-100	fraction d ⁻¹		alternati
Decay rate used Hydraulic gradient used in aquifer flow down-gradient	λ 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 cor	
Domenico - Steady state		or		This assumes Level 1 Remedial Target is base	
		0.00E+00	mg/kg	For comparison with measured soil concentrat	
Distance to compliance point		96	m	assumes Level 1 Remedial Target calculated f	rom soil-
	A 16		f	partitioning equation.	
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	1.00E+00	traction	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



method of defining partition co-efficient (using pull down list) Iculate for ionic organic chemicals (acids)

if specify partition coefficient (option)			
ater partition coefficient	Kd		l/kg
for non-polar organic chemicals (option	on)		
on of organic carbon in aquifer	foc		fraction
ic carbon partition coefficient	Koc		l/kg
for ionic organic chemicals (option)		-	_
on coefficient for related species	K _{oc,n}	0.00E+00	l/kg
on coefficient for ionised species	K _{oc,i}	0.00E+00	l/kg
lue	pН	0.00E+00	
lissociation constant	pKa	0.00E+00	
on of organic carbon in aquifer	foc	0.00E+00	fraction
			-
ater partition coefficient	Kd	0.00E+00	l/kg

dispersivity (click brown cell and use pull down list) Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
itudinal dispersivity	ax	0.00E+00	9.60E+00	4.33E+00	m
sverse dispersivity	az	0.00E+00	9.60E-01	4.33E-01	m
cal dispersivity	ay	0.00E+00	9.60E-02	4.33E-02	m

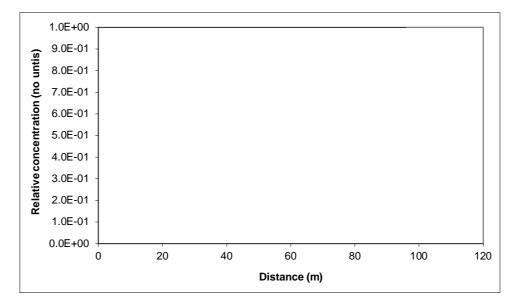
alues of dispersivity must be > 0

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

orksheet should be used if pollutant transport and dation is best described by a first order reaction. If dation is best desribed by an electron limited lation such as oxidation by O_2 , NO_3 , SO_4 etc than and tive solution should be used

on. arget Concentration.

-water



Note: 'Relative concentration' is the ratio of calculated concentation 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.

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 3a
Completed by:	Adrioan Green
Date:	########
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Domenico	- Steady state	
From calcu	lation sheet	
	Relative	
Distance	concentration	Concentration
	(No units)	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

Level 3 - Groundwater	See Note			
Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	CT	1.75E-01	mg/l	from Level 1
Select analytical solution (click on brown cell below, the	en on pu	ll-down menu)		
		nenico - Steady	state	Equations in HRA publication
Approach for simulating vertical dispersion:		Simulate ve	ertical dis	persion in 2 directions
Select nature of decay rate (click on brown cell below, the second s	hen on p	oull-down menu)		
Approach for simulating degradation of pollutants:	Apply de	egradation rate to	dissolved	d pollutants only
	-		-	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀	3.66E+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	1.06E+02	m	
Plume thickness at source	Sy	2.39E+01	m	
Saturated aquifer thickness	da	3.00E+01	m Jan	
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	Х	9.60E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction	Z		m	
Distance (depth) to compliance point perpendicular to flow direction	У		m	
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only
Parameters values determined from options			1	
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 groundwate

 Remedial Target
 1.76E-01
 mg/l
 For comparison with measured groundw

 Domenico - Steady state
 Distance to compliance point
 96
 m

 Concentration of contaminant at compliance point
 CeD/Co
 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

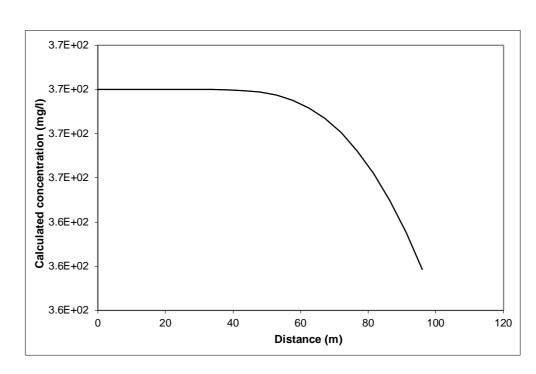
Entry if specify partition coefficient (option	on)		
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (o	ption)		
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option	l)		_
Sorption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



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

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



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

Note

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

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

The measured groundwater concentration should be compared

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

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

Site being assessed:	Fassaroe - Site 3a
Completed by:	Adrioan Green
Date:	########
Version:	1

ter concentration.

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



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 e	ach assessment			Fortight	
Site Name: Site Address:	Fassaroe - Site 3b Fassaroe Co. Wickl	ow		Consent of cort	
Completed by:	Adrian Green			Cot	
Date:	04-May-18		Version:	1	
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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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

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

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

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

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

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

17/05/2018, 16:19 EA_Remedial_Targets_Worksheet Site 3B_CAPPED_UPDATE 2018Introduction

Level 2 - Soil

Contaminant Target concentration	Cτ	Ammonia 0.065	mg/l	from Level 1This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore waterfrom Level 1(mg/l).
Input Parameters	Variable	Value	Unit	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 contamiantion' (Environment Agency 2006) Source of parameter value
Standard entry Infiltration	Inf	1.84E-04	m/d	
Area of contaminant source	A	6.60E+03	m ²	Not used in calculation
		0.002.00	J	
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	and the second sec
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate		and the state of the
Enter mixing zone thickness	Mz		m	A PARTICIPAL CONTRACTOR OF A
Calculated mixing zone thickness	Mz	9.07E+00	m	Sector Same
Calculated Parameters			m fo	
Dilution Factor	DF	1.17E+02	0	
Level 2 Remedial Target		7.62E+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 Concentrati
				Remedial Target calculated from soil-water
Additional option Calculation of impact on receptor				Site being assessed: Fassaroe - Site 3b
Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	Completed by: Adrian Green Date: 04-May-18
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	



Level 3 - Soil	See Note				
Input Parameters	Variable	Value	Unit	Source	Enter
Contaminant		Ammonia		from Level 1	Cal
	Cτ		/	from Level 1	
Target Concentration	DF	0.065	mg/l		
Dilution Factor	DF	1.17E+02]	from Level 2	Entry it
Select analytical solution (click on brown cell below, tl	nen on p	ull-down menu)		Soil wat
]	Entry f
	Dom	nenico - Steady	state	Equations in HRA publication	-
Colort notices of decouverts (alials on brown call below	then en	well down wood			Fraction
Select nature of decay rate (click on brown cell below,				d vellutevte enlu	Organic
Approach for simulating degradation of pollutants:	Αρριγ αε	gradation rate to	o alssolve	d pollutants only	Entry fo Sorption
	Variable	Value	Unit	Source of parameter value	Sorption
Enter source concentration	Variable			oncentration as mg/l	pH valu
Enter soil leachate concentration		567	mg/l		Acid dis
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days		Fraction
Calculated decay rate	λ	6.93E-100	days ⁻¹	calculated	J
Width of plume in aquifer at source	Sz	6.50E+01	m	from Level 2	Soil wat
Plume thickness in aquifer at source	Sy	9.07E+00	m	from Level 2	
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³		1
Effective porosity of aquifer	n	1.00E-01	fraction		Define
Hydraulic gradient	i	2.02E-02	fraction	from Level 2 (adjusted)]
Hydraulic conductivity of saturated aquifer	K	1.00E+01	m/d	from Level 2	
Distance to compliance point	х	4.00E+02	m		1
Distance (lateral) to compliance point perpendicular to flow direction	z		m		Longitu
Distance (depth) to compliance point perpendicular to flow direction	У		m		Transv
Time since pollutant entered groundwater		7.30E+03	days	time variant options only	Vertica
Parameters values determined from options			J		Note va
Partition coefficient	Kd	0.00E+00	l/kg	see options	
Longitudinal dispersivity	ax	40.000	m	see options	Xu & Eo
Transverse dispersivity	az	4.000	m	see options	
Vertical dispersivity	ay	0.400	m	see options	
Parameter values should be checked against Level 1 and 2					Note
Calculated Parameters	Variable				This wo
Calculated Falameters	Valiable				degrada
Groundwater flow velocity	v	2.02E+00	m/d		degrada
Retardation factor	Rf	1.00E+00	fraction		degrada
Decay rate used	λ	6.93E-100	d ⁻¹		alternati
Hydraulic gradient used in aquifer flow down-gradient	i	2.02E-02	fraction		
Rate of contaminant flow due to retardation	u	2.02E+00	m/d		
Ratio of Compliance Point to Source Concentration		1.69E-01	fraction		
Attenuation factor (C_0/C_{ED})	AF	5.93E+00	fraction		
Soil leachate concentration	Co	5.67E+02			
Remedial Targets		4 505 .04	m a/l	Ear comparison with management areas water	oontrot!
Level 3 Remedial Target		4.52E+01	mg/l	For comparison with measured pore water con	
Domenico - Steady state		or 0.00E+00	mg/kg	This assumes Level 1 Remedial Target is base For comparison with measured soil concentrat	
Distance to compliance point		400	m m	assumes Level 1 Remedial Target calculated f	
				partitioning equation.	-011-001-
Ratio of Compliance Point to Source Concentration	C _{FD} /C₀	1.69E-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



method of defining partition co-efficient (using pull down list) Iculate for ionic organic chemicals (acids)

<i>if specify partition coefficient (option)</i> ater partition coefficient	Kd		l/kg
for non-polar organic chemicals (option	on)		
on of organic carbon in aquifer	foc		fraction
ic carbon partition coefficient	Koc		l/kg
for ionic organic chemicals (option)		-	_
on coefficient for related species	K _{oc,n}	0.00E+00	l/kg
on coefficient for ionised species	K _{oc,i}	0.00E+00	l/kg
ue	pН	0.00E+00	1
issociation constant	pKa	0.00E+00	
on of organic carbon in aquifer	foc	0.00E+00	fraction
			-
ater partition coefficient	Kd	0.00E+00	l/kg

dispersivity (click brown cell and use pull down list) Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	_
itudinal dispersivity	ax	0.00E+00	4.00E+01	8.35E+00	m
sverse dispersivity	az	0.00E+00	4.00E+00	8.35E-01	m
cal dispersivity	ay	0.00E+00	4.00E-01	8.35E-02	m

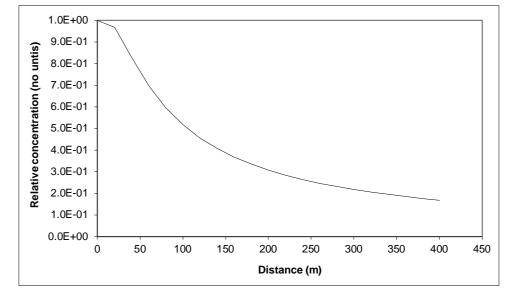
alues of dispersivity must be > 0

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

orksheet should be used if pollutant transport and dation is best described by a first order reaction. If dation is best desribed by an electron limited dation such as oxidation by O_2 , NO_3 , SO_4 etc than and tive solution should be used

on. arget Concentration.

-water



Note: 'Relative concentration' is the ratio of calculated concentation 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.

0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0 200.0 220.0 240.0 260.0 280.0 300.0 320.0 340.0

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

Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state From calculation sheet Relative Distance concentration Concentration (No units) mg/l 1.0E+00 4.83E+00 9.67E-01 4.67E+00 8.30E-01 4.01E+00 6.98E-01 3.37E+00 5.95E-01 2.88E+00 5.17E-01 2.50E+00 2.20E+00 4.56E-01 4.07E-01 1.97E+00 3.67E-01 1.78E+00 3.35E-01 1.62E+00 3.07E-01 1.49E+00 2.84E-01 1.37E+00 2.64E-01 1.28E+00 2.47E-01 1.19E+00 2.31E-01 1.12E+00 2.18E-01 1.05E+00 2.06E-01 9.95E-01 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

Level 3 - Groundwater	See Note			
Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	Cτ	6.50E-02	mg/l	from Level 1
Select analytical solution (click on brown cell below, the		, i		1
	Don	nenico - Steady	state	Equations in HRA publication
Approach for simulating vertical dispersion:		Simulate ve	ertical dis	persion in 2 directions
Select nature of decay rate (click on brown cell below, t	hen on p	oull-down menu))	
Approach for simulating degradation of pollutants:	Apply de	egradation rate to	dissolved	d pollutants only
	0	_	1 .	Source of parameter value
Initial contaminant concentration in groundwater at plume core		5.67E+02	mg/l	
Half life for degradation of contaminant in water		1.00E+99	days	
Calculated decay rate		6.93E-100	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)		6.50E+01	m	
Plume thickness at source	,	9.66E+00	m	
Saturated aquifer thickness		3.50E+01	m	
Bulk density of aquifer materials	-	1.50E+00	g/cm ³	
Effective porosity of aquifer		1.00E-01	fraction	
Hydraulic gradient		2.00E-02	fraction	
Hydraulic conductivity of aquifer		1.00E+01	m/d	
Distance to compliance point		4.00E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction			m	
Distance (depth) to compliance point perpendicular to flow direction	•	7.005.00	m	ling waring antique anti-
Time since pollutant entered groundwater Parameters values determined from options		7.30E+03	days	time variant options only
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		2.00E+00	m/d	
Retardation factor		1.00E+00	fraction	
Decay rate used		6.93E-100	d ⁻¹	
Rate of contaminant flow due to retardation		2.00E+00	m/d	
Contaminant concentration at distance x, assuming two-way vertical dispersion		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 groundwate

 Domenico - Steady state
 400
 m

 Distance to compliance point
 400
 m

 Concentration of contaminant at compliance point
 Concentration
 Concentration

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

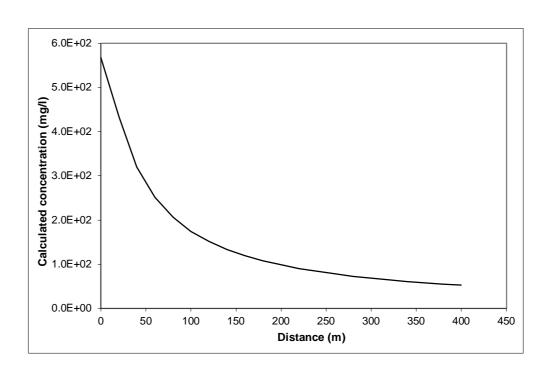
Entry if specify partition coefficient (optio	n)		
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (op	otion)	-	_
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option))		-
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pН		
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



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

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



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

Note

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

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

The measured groundwater concentration should be compared

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

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

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

ter concentration.

Calculated concentrations for distance-concentration graph

Domenico - Steady stateFrom calculation sheetDistanceConcentration

	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



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

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

Details to be completed for e	ach assessment			Fortight	
Site Name: Site Address:	Fassaroe - Site 3b Fassaroe Co. Wickl	ow		Consent of cort	
Completed by:	Adrian Green			Cot	
Date:	04-May-18		Version:	1	
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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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

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

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

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

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

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

17/05/2018, 16:18 EA_Remedial_Targets_Worksheet Site 3B_UPDATE 2018Introduction

Level 2 - Soil

Contaminant Target concentration	Cτ	Ammonia 0.065	mg/l	from Level 1This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore waterfrom Level 1(mg/l).
Input Parameters	Variable	Value	Unit	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 contamiantion' (Environment Agency 2006) Source of parameter value
Standard entry Infiltration	Inf	1.57E-03]/d	
Area of contaminant source	A	6.60E+03	m/d m ²	Not used in calculation
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	0.002100	]	
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	К	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	and the second s
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate		Research the second
Enter mixing zone thickness	Mz		m	A R P TON
Calculated mixing zone thickness	Mz	9.66E+00	m	ale of the
Calculated Parameters			m fo	and the second sec
Dilution Factor	DF	1.55E+01	0	
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 Concentrati
				Remedial Target calculated from soil-water
Additional option Calculation of impact on receptor				Site being assessed: Fassaroe - Site 3b
Concentration of contaminant in contaminated discharge (entering receptor)	Сс	0.00E+00	mg/l	Site being assessed.     Passarbe - Site 30       Completed by:     Adrian Green       Date:     04-May-18
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0 Version: 1



Level 3 - Soil	See Note				
Input Parameters	Variable	Value	Unit	Source Ent	ter Calo
Contaminant		Ammonia		from Level 1	Jan
Target Concentration	Cτ	0.065	ma/l	from Level 1	
Dilution Factor	DF	1.55E+01	mg/l	from Level 2	
Dilution Factor	ы	1.552+01	J	Entr	rv it
Select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below).	nen on p	ull-down menu	I)	Soil	-
			<u>,</u>	1	
	Dom	nenico - Steady	state	Equations in HRA publication	ут
				Frac	tior
Select nature of decay rate (click on brown cell below,				Orga	
Approach for simulating degradation of pollutants:	Apply de	gradation rate to	o dissolve		-
	.,			Sorp	
	Variable	Value	Unit	Source of parameter value Sorp	
Enter source concentration		1		pH v	
Enter soil leachate concentration Half life for degradation of contaminant in water	t _{1/2}	567	mg/l days	Acid Frac	
		1.00E+99 6.93E-100	days ⁻¹	calculated	,uoi
Calculated decay rate Width of plume in aquifer at source	λ Sz	6.50E+01	m	from Level 2 Soil	wof
Plume thickness in aquifer at source	Sz Sy	9.66E+00	m	from Level 2	wai
Bulk density of aquifer materials	ρ	1.50E+00	g/cm ³		
Effective porosity of aquifer	n n	1.00E-01	fraction	Defi	ne
Hydraulic gradient	i	2.14E-02	fraction	from Level 2 (adjusted)	
Hydraulic conductivity of saturated aquifer	К	1.00E+01	m/d	from Level 2	
Distance to compliance point	x	4.00E+02	m		
Distance (lateral) to compliance point perpendicular to flow direction	z		m	Long	gitı
Distance (depth) to compliance point perpendicular to flow direction	У		m	Tran	-
Time since pollutant entered groundwater		7.30E+03	days	time variant options only Vert	lica
Parameters values determined from options			-	Note	e va
Partition coefficient	Kd	0.00E+00	l/kg	see options	
Longitudinal dispersivity	ax	40.000	m	see options Xu 8	ξΕα
Transverse dispersivity	az	4.000	m	see options	
Vertical dispersivity	ay	0.400	m	see options	
Parameter values should be checked against Level 1 and 2				Note	<u> </u>
Calculated Parameters	Variahlo			This	
	Variable			degr	
Groundwater flow velocity	v	2.14E+00	m/d	degr	
Retardation factor	Rf	1.00E+00	fraction	degr	
Decay rate used	λ	6.93E-100	d ⁻¹	alter	nati
Hydraulic gradient used in aquifer flow down-gradient	i	2.14E-02	fraction		
Rate of contaminant flow due to retardation	u C /C	2.14E+00	m/d		
Ratio of Compliance Point to Source Concentration		1.78E-01	fraction		
Attenuation factor (C ₀ /C _{ED} ) Soil leachate concentration	AF Co	<b>5.61E+00</b> 5.67E+02	fraction		
Remedial Targets	00	J. J. L I UZ			
Level 3 Remedial Target		5.64E+00	mg/l	For comparison with measured pore water concentr	ratic
Domenico - Steady state		or		This assumes Level 1 Remedial Target is based on	
		0.00E+00	mg/kg	For comparison with measured soil concentration. T	
Distance to compliance point		400	m	assumes Level 1 Remedial Target calculated from s	
				partitioning equation.	
Ratio of Compliance Point to Source Concentration		1.78E-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



### method of defining partition co-efficient (using pull down list) Iculate for ionic organic chemicals (acids)

<i>if specify partition coefficient (option)</i> ater partition coefficient	Kd		l/kg
for non-polar organic chemicals (option	on)		
on of organic carbon in aquifer	foc		fraction
ic carbon partition coefficient	Koc		l/kg
for ionic organic chemicals (option)			_
on coefficient for related species	K _{oc,n}	0.00E+00	l/kg
on coefficient for ionised species	K _{oc,i}	0.00E+00	l/kg
ue	pН	0.00E+00	1
issociation constant	pKa	0.00E+00	1
on of organic carbon in aquifer	foc	0.00E+00	fraction
			-
ater partition coefficient	Kd	0.00E+00	l/kg

#### dispersivity (click brown cell and use pull down list) Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Xu & Eckstein		
itudinal dispersivity	ax	0.00E+00	4.00E+01	8.35E+00	m
sverse dispersivity	az	0.00E+00	4.00E+00	8.35E-01	m
cal dispersivity	ay	0.00E+00	4.00E-01	8.35E-02	m

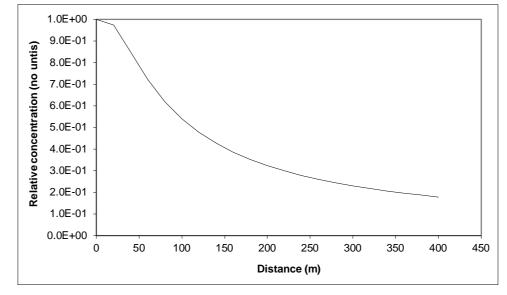
alues of dispersivity must be > 0

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

orksheet should be used if pollutant transport and dation is best described by a first order reaction. If dation is best desribed by an electron limited dation such as oxidation by  $O_2$ ,  $NO_3$ ,  $SO_4$  etc than and tive solution should be used

on. arget Concentration.

-water



Note: 'Relative concentration' is the ratio of calculated concentation 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.

0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0 200.0 220.0 240.0 260.0 280.0 300.0 320.0 340.0 360.0 380.0

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

### Calculated (relative) concentrations for distance-concentration graph

#### Domenico - Steady state From calculation sheet Relative Distance concentration Concentration (No units) mg/l 1.0E+00 3.66E+01 9.74E-01 3.57E+01 8.49E-01 3.11E+01 7.21E-01 2.64E+01 6.19E-01 2.27E+01 5.39E-01 1.98E+01 4.77E-01 1.75E+01 4.27E-01 1.56E+01 3.86E-01 1.41E+01 3.52E-01 1.29E+01 3.24E-01 1.19E+01 2.99E-01 1.10E+01 2.79E-01 1.02E+01 2.60E-01 9.54E+00 2.44E-01 8.95E+00 2.30E-01 8.43E+00 2.18E-01 7.97E+00 2.06E-01 7.56E+00 1.96E-01 7.18E+00 1.87E-01 6.85E+00 400.0 1.78E-01 6.54E+00

Level 3 - Groundwater	See Note			
Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	Cτ	6.50E-02	mg/l	from Level 1
Select analytical solution (click on brown cell below, the	n on nu	ll-down menu)		
Celect analytical solution (click on brown cell below, the		nenico - Steady	state	Equations in HRA publication
Approach for simulating vertical dispersion:				persion in 2 directions
Approach for simulating ventical dispersion.		Sinuate ve		
Select nature of decay rate (click on brown cell below, the	-			
Approach for simulating degradation of pollutants:	Apply de	gradation rate to	dissolved	• •
	C ₀	3.66E+01		Source of parameter value
Initial contaminant concentration in groundwater at plume core	00 t _{1/2}		mg/l	
Half life for degradation of contaminant in water		1.00E+99	days days ⁻¹	
Calculated decay rate	λ	6.93E-100		
Width of plume in aquifer at source (perpendicular to flow) Plume thickness at source	Sz	6.50E+01	m	
Saturated aquifer thickness	Sy da	9.66E+00 3.50E+01	m	
Bulk density of aquifer materials		1.50E+01	m g/cm ³	
Effective porosity of aquifer	ρ n	1.00E-01	fraction	
Hydraulic gradient	n i	2.00E-01	fraction	
Hydraulic conductivity of aquifer	ĸ	1.00E+01	m/d	
Distance to compliance point	x	4.00E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	1.002102	m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater Parameters values determined from options	t	7.30E+03	days	time variant options only
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	4.00E+00	m w	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	
ontaminant 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 groundwate

Domenico - Steady state 400 Distance to compliance point m Concentration of contaminant at compliance point  $C_{ED}/C_0$ 3.38E+00 mg/I 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

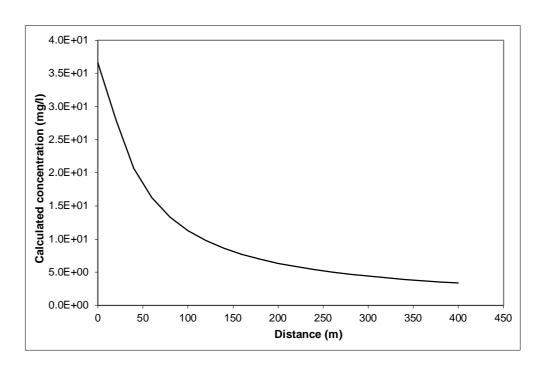
Entry if specify partition coefficient (optic	on)		
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (or	otion)	-	
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)	)		
Sorption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



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

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



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

#### Note

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

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

The measured groundwater concentration should be compared

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

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

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

ter concentration.

#### 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



#### **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. All rights reserved. You will not modify, reverse compile or otherwise dis-assemble the worksheet.

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

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

Details to be completed for e	ach assessment			Forminght	
Site Name: Site Address:	Fassaroe - Site 3c Fassaroe Co. Wickl	low		Consent of Cont	
Completed by:	Adrian Green			Con	
Date:	04-May-18		Version:	1	
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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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

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

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

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

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

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

17/05/2018, 16:22 EA Remedial Targets Worksheet Site 3C CAPPED UPDATE 2018Introduction

Level 2 - Soil

Contaminant Target concentration	Cτ	Ammonia 0.065	mg/l	from Level 1This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore waterfrom Level 1(mg/l).
Input Parameters	Variable	Value	Unit	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 contamiantion' (Environment Agency 2006) Source of parameter value
Infiltration	Inf	1.84E-04	m/d	
Area of contaminant source	А	8.70E+03	m ²	Not used in calculation
Entry for groundwater flow below site Length of contaminant source in direction of groundwater flow	1	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	. 19 ⁵⁰
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	all's and
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate		and the second
Enter mixing zone thickness	Mz		m	The red.
Calculated mixing zone thickness	Mz	1.20E+01	m	Je Salte
Calculated Parameters			m Fo	p ^{yright}
Dilution Factor	DF	6.94E+02	0	
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				
				Site being assessed:     Fassaroe - Site 3c
Concentration of contaminant in contaminated discharge (entering receptor)	Сс	0.00E+00	mg/l	Completed by: Adrian Green
				Date: 04-May-18
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0 Version: 1



Level 3 - Soil	See Note				
Input Parameters	Variable	Value	Unit	Source E	inter Cale
Contaminant		Ammonia		from Level 1	
Target Concentration	CT	0.065	mg/l	from Level 1	
Dilution Factor	DF	6.94E+02		from Level 2	
			-	E	ntry if
Select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below, the select analytical solution (click on brown cell below) and the select analytical solution (click on brown cell below).	h <mark>en on p</mark>	ull-down menu	)	_ Si	oil wat
	Dom	nenico - Steady	state	Equations in HKA publication	<b>intry fo</b>
Select nature of decay rate (click on brown cell below,	then on	null-down mer	) )		rganic
Approach for simulating degradation of pollutants:		•			nganic intry fe
Approach for simulating degradation of politicants.			0 41330100		orptior
	Variable	Value	Unit		orptior
Enter source concentration					H valu
Enter soil leachate concentration		203	mg/l		cid dis
Half life for degradation of contaminant in water		1.00E+99	days		raction
Calculated decay rate	λ	6.93E-100	days ⁻¹	calculated	
Width of plume in aquifer at source		6.00E+01	m	from Level 2 So	oil wat
Plume thickness in aquifer at source	Sy	1.20E+01	m	from Level 2	
Bulk density of aquifer materials	-	1.50E+00	g/cm ³		
Effective porosity of aquifer		1.00E-01	fraction	D	efine
Hydraulic gradient	i	1.20E-01	fraction	from Level 2 (adjusted)	
Hydraulic conductivity of saturated aquifer	K	1.00E+01	m/d	from Level 2	
Distance to compliance point	х	9.00E+01	m		
Distance (lateral) to compliance point perpendicular to flow direction	Z		m	L	ongitu
Distance (depth) to compliance point perpendicular to flow direction	У		m	Т	ransv
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only	ertica
Parameters values determined from options			-	N	ote va
Partition coefficient		0.00E+00	l/kg	see options	
Longitudinal dispersivity	ax	9.000	m	see options X	u & Eo
Transverse dispersivity		0.900	m	see options	
Vertical dispersivity	ay	0.090	m	see options	
Parameter values should be checked against Level 1 and 2 Calculated Parameters	Variable			IT	ote his wo
					egrada
Groundwater flow velocity		1.20E+01	m/d		egrada egrada
Retardation factor		1.00E+00	fraction		ternati
Decay rate used		6.93E-100	d ⁻¹		
Hydraulic gradient used in aquifer flow down-gradient Rate of contaminant flow due to retardation		1.20E-01 1.20E+01	fraction m/d		
Ratio of Compliance Point to Source Concentration		9.79E-01	fraction		
Attenuation factor (C ₀ /C _{ED} )		1.02E+00	fraction		
Soil leachate concentration		2.03E+02			
Remedial Targets					
Level 3 Remedial Target		4.61E+01	mg/l	For comparison with measured pore water conce	ntratio
Domenico - Steady state		or		This assumes Level 1 Remedial Target is based	on Tar
		0.00E+00	mg/kg	For comparison with measured soil concentration	ı. This
Distance to compliance point		90	m	assumes Level 1 Remedial Target calculated from	n soil-
Ratio of Compliance Point to Source Concentration	C _{ED} /C ₀	9.79E-01	fraction	partitioning equation. 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



#### method of defining partition co-efficient (using pull down list) Iculate for ionic organic chemicals (acids)

if specify partition coefficient (option)			<b>.</b>
ater partition coefficient	Kd		l/kg
for non-polar organic chemicals (opti	on)		
on of organic carbon in aquifer	foc		fraction
ic carbon partition coefficient	Koc		l/kg
for ionic organic chemicals (option)		-	
on coefficient for related species	K _{oc,n}	0.00E+00	l/kg
on coefficient for ionised species	K _{oc,i}	0.00E+00	l/kg
lue	pН	0.00E+00	
lissociation constant	pKa	0.00E+00	
on of organic carbon in aquifer	foc	0.00E+00	fraction
			_
ater partition coefficient	Kd	0.00E+00	l/kg

#### dispersivity (click brown cell and use pull down list) Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	_
itudinal dispersivity	ax	0.00E+00	9.00E+00	4.18E+00	m
sverse dispersivity	az	0.00E+00	9.00E-01	4.18E-01	m
cal dispersivity	ау	0.00E+00	9.00E-02	4.18E-02	m

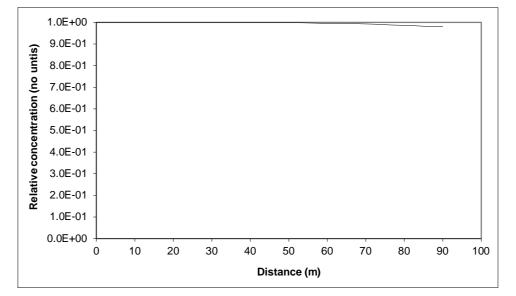
alues of dispersivity must be > 0

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

orksheet should be used if pollutant transport and dation is best described by a first order reaction. If dation is best desribed by an electron limited lation such as oxidation by  $O_2$ ,  $NO_3$ ,  $SO_4$  etc than and tive solution should be used

on. arget Concentration.

-water



Note: 'Relative concentration' is the ratio of calculated concentation 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.

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

#### Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state									
From calculation sheet									
Relative									
Distance	concentration	Concentration							
	(No units)	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							

Level 3 - Groundwater	See Note	•		
Input Parameters (using pull down menu	) Variable	Value	Unit	Source
Contaminan	ıt	Ammonia		from Level 1
Target Concentration	n C _T	6.50E-02	mg/l	from Level 1
Select analytical solution (click on brown cell below, th	en on pu	ll-down menu)		
	Dor	nenico - Steady	state	Equations in HRA publication
Approach for simulating vertical dispersion:		Simulate ve	rtical dis	persion in 2 directions
Select nature of decay rate (click on brown cell below,		,		
Approach for simulating degradation of pollutants:	Apply de	egradation rate to	dissolved	•
	C	0.005.00		Source of parameter value
Initial contaminant concentration in groundwater at plume core		2.03E+02	mg/l	
Half life for degradation of contaminant in wate		1.00E+99	days	
Calculated decay rate		6.93E-100	days⁻¹	
Width of plume in aquifer at source (perpendicular to flow		6.00E+01	m	
Plume thickness at source		1.21E+01	m	
Saturated aquifer thickness		2.50E+01	m g/cm ³	
Bulk density of aquifer materials	-	1.50E+00		
Effective porosity of aquife		1.00E-01	fraction	
Hydraulic gradien		1.20E-01	fraction	
Hydraulic conductivity of aquife Distance to compliance poin		1.00E+01 9.00E+01	m/d	
Distance (lateral) to compliance point perpendicular to flow direction		9.00E+01	m	
Distance (depth) to compliance point perpendicular to flow direction			m m	
Time since pollutant entered groundwate	•	7.30E+03	days	time variant options only
Parameters values determined from options		1.002100	uays	
Partition coefficien	t Kd	0.00E+00	l/kg	see options
Longitudinal dispersivit		9.00E+00	m	see options
Transverse dispersivit	-	9.00E-01	m	see options
Vertical dispersivit		9.00E-02	m	see options
Calculated Parameters	8 Variable			
Groundwater flow velocit	y v	1.20E+01	m/d	
Retardation facto		1.00E+00	fraction	
Decay rate used	d λ	6.93E-100	d ⁻¹	
Rate of contaminant flow due to retardation	n u	1.20E+01	m/d	
Contaminant concentration at distance x, assuming two-way vertical dispersion	n C _{ED}	1.73E+02	mg/l	
Attenuation factor (two way vertical dispersion, CO/CED	) AF	1.17E+00		
Remedial Targets				
Remedial Targe	t	7.63E-02	mg/l	For comparison with measured groundwate

 Domenico - Steady state
 90
 m

 Distance to compliance point
 90
 m

 Concentration of contaminant at compliance point
 Concentration of contaminant at compliance point
 Concentration
 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 pa	irtition coefficien	t

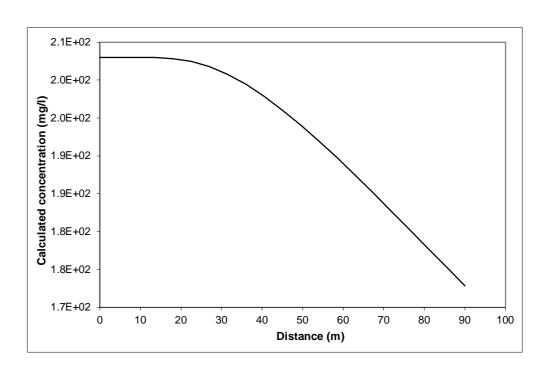
Entry if specify partition coefficient (opt	ion)		
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (	option)		
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (optio	n)		
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pН		
acid dissociation constant	рКа		
Fraction of organic carbon in aquifer	foc		fraction
7			
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



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

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



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

#### Note

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

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

The measured groundwater concentration should be compared

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

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

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

ter concentration.

## Calculated concentrations for distance-concentration graph

Domenico - Steady stateFrom calculation sheetDistanceConcentration

	mg/l
0	-
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



#### **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. All rights reserved. You will not modify, reverse compile or otherwise dis-assemble the worksheet.

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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 e	ach assessment			Fortifield
Site Name: Site Address:	Fassaroe - Site 3c Fassaroe Co. Wickle	ow		Consent of COV
Completed by:	Adrian Green			Cor
Date:	04-May-18		Version:	1
Contaminant	Ammonia			
Target Concentration (C _T )	0.065 r	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 comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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

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

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

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

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

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

17/05/2018, 16:21 EA_Remedial_Targets_Worksheet Site 3C_UPDATE 2018Introduction

Level 2 - Soil

Contaminant Target concentration	Cτ	Ammonia 0.065	mg/l	from Level 1This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore waterfrom Level 1(mg/l).
Input Parameters	Variable	Value	Unit	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 contamiantion' (Environment Agency 2006) Source of parameter value
Standard entry 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	$\sigma_{i}$
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	and the second sec
Define mixing zone depth by specifying or calculating depth (using pull down list)		Calculate		Roser and Andrewski and Andr
Enter mixing zone thickness	Mz		m	AN P FOR
Calculated mixing zone thickness	Mz	1.21E+01	m	- Carlos - C
Calculated Parameters			m fo	and the second sec
Dilution Factor	DF	8.29E+01	0	
Level 2 Remedial Target		5.39E+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 Concentrati For comparison with measured soil concentration. This assumes Level 1
				Remedial Target calculated from soil-water
Additional option Calculation of impact on receptor				Site being assessed: Fassaroe - Site 3c
Concentration of contaminant in contaminated discharge (entering receptor)	Сс	0.00E+00	mg/l	Site being assessed.     Passarbe - Site Sc       Completed by:     Adrian Green       Date:     04-May-18
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0 Version: 1



Level 3 - Soil	See Note				
Input Parameters	Variable	Value	Unit	Source E	nter Cale
Contaminant		Ammonia		from Level 1	
Target Concentration	Cτ	0.065	mg/l	from Level 1	
Dilution Factor		8.29E+01		from Level 2	
	2.	01202101	1		ntry if
Select analytical solution (click on brown cell below, the	hen on p	ull-down menu	)		oil wat
	Dom	nenico - Steady	state	Equations in HRA publication	ntry fo
Select nature of decay rate (click on brown cell below,	thon on	pull-down mon			action
Approach for simulating degradation of pollutants:		•			rganic ntry fe
Approach for simulating degradation of polititants.		gradation rate to	uissoive		orption
	Variable	Value	Unit		orption
					l valu
Enter source concentration Enter soil leachate concentration		203	T		id dis
Half life for degradation of contaminant in water	t _{1/2}		mg/l days		action
-		1.00E+99	-		action
Calculated decay rate		6.93E-100	days ⁻¹	calculated	
Width of plume in aquifer at source		6.00E+01	m		oil wat
Plume thickness in aquifer at source	•	1.21E+01	m a (am ³	from Level 2	
Bulk density of aquifer materials	-	1.50E+00	g/cm ³		
Effective porosity of aquifer		1.00E-01	fraction		efine
Hydraulic gradient		1.21E-01	fraction	from Level 2 (adjusted)	
Hydraulic conductivity of saturated aquifer		1.00E+01	m/d	from Level 2	
Distance to compliance point		9.00E+01	m		
Distance (lateral) to compliance point perpendicular to flow direction			m		ongitu
Distance (depth) to compliance point perpendicular to flow direction	5		m		ansv
Time since pollutant entered groundwater	t	7.30E+03	days	time variant options only	ertica
Parameters values determined from options			,	No	ote va
Partition coefficient		0.00E+00	l/kg	see options	
Longitudinal dispersivity	ax	9.000	m	see options Xu	1 & E0
Transverse dispersivity		0.900	m	see options	
Vertical dispersivity Parameter values should be checked against Level 1 and 2	ay	0.090	m	see options	
Calculated Parameters	Variable			Th de	ote nis wo grada
Groundwater flow velocity	v	1.21E+01	m/d		grada
Retardation factor	Rf	1.00E+00	fraction		grada ernati
Decay rate used	λ	6.93E-100	d ⁻¹	all	emau
Hydraulic gradient used in aquifer flow down-gradient		1.21E-01	fraction		
Rate of contaminant flow due to retardation		1.21E+01	m/d		
Ratio of Compliance Point to Source Concentration		9.79E-01	fraction		
Attenuation factor (C ₀ /C _{ED} )		1.02E+00	fraction		
Soil leachate concentration Remedial Targets	Co	2.03E+02			
Level 3 Remedial Target		5.50E+00	mg/l	For comparison with measured pore water concer	ntratio
Domenico - Steady state		or	0.1	This assumes Level 1 Remedial Target is based of	
		0.00E+00	mg/kg	For comparison with measured soil concentration	
Distance to compliance point		90		assumes Level 1 Remedial Target calculated from	
Ratio of Compliance Point to Source Concentration		9.79E-01	fraction	partitioning equation. 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



#### method of defining partition co-efficient (using pull down list) Iculate for ionic organic chemicals (acids)

if specify partition coefficient (option)	)		
ater partition coefficient	Kd		l/kg
for non-polar organic chemicals (opti	on)		
on of organic carbon in aquifer	foc		fraction
ic carbon partition coefficient	Koc		l/kg
for ionic organic chemicals (option)		-	_
on coefficient for related species	K _{oc,n}	0.00E+00	l/kg
on coefficient for ionised species	K _{oc,i}	0.00E+00	l/kg
lue	pН	0.00E+00	
dissociation constant	pKa	0.00E+00	
on of organic carbon in aquifer	foc	0.00E+00	fraction
			_
ater partition coefficient	Kd	0.00E+00	l/kg

#### dispersivity (click brown cell and use pull down list) Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	_
itudinal dispersivity	ax	0.00E+00	9.00E+00	4.18E+00	m
sverse dispersivity	az	0.00E+00	9.00E-01	4.18E-01	m
cal dispersivity	ау	0.00E+00	9.00E-02	4.18E-02	m

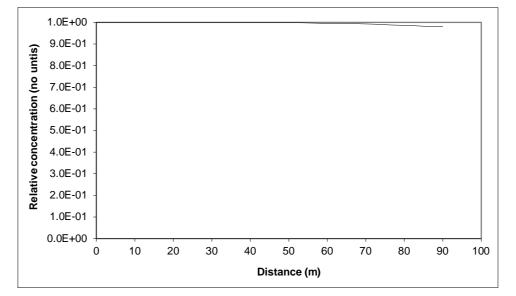
alues of dispersivity must be > 0

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

orksheet should be used if pollutant transport and dation is best described by a first order reaction. If dation is best desribed by an electron limited lation such as oxidation by  $O_2$ ,  $NO_3$ ,  $SO_4$  etc than and tive solution should be used

on. arget Concentration.

-water



Note: 'Relative concentration' is the ratio of calculated concentation 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.

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

### Calculated (relative) concentrations for distance-concentration graph

Domenico - Steady state				
From calcu	lation sheet			
	Relative			
Distance	concentration	Concentration		
	(No units)	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		

Level 3 - Groundwater	See Note			
Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Ammonia		from Level 1
Target Concentration	Cτ	6.50E-02	mg/l	from Level 1
Select analytical solution (click on brown cell below, the	en on pu	ll-down menu)		
	Don	nenico - Steady	state	Equations in HRA publication
Approach for simulating vertical dispersion:	Simulate vertical dispersion in 2 directions			persion in 2 directions
Select nature of decay rate (click on brown cell below, t				
Approach for simulating degradation of pollutants:	Apply de	egradation rate to	dissolved	•
	C	0.045.00		Source of parameter value
Initial contaminant concentration in groundwater at plume core		2.04E+02	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	1.00E+99	days	
Calculated decay rate		6.93E-100	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Plume thickness at source	Sz	6.00E+01 1.21E+01	m	
Saturated aquifer thickness		2.50E+01	m m	
Bulk density of aquifer materials		1.50E+01	g/cm ³	
Effective porosity of aquifer	•	1.00E-01	fraction	
Hydraulic gradient		1.20E-01	fraction	
Hydraulic conductivity of aquifer		1.00E+01	m/d	
Distance to compliance point		9.00E+01	m	
Distance (lateral) to compliance point perpendicular to flow direction	Z	01002101	m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater Parameters values determined from options	t	7.30E+03	days	time variant options only
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity		9.00E+00	m	see options
Transverse dispersivity		9.00E-01	m	see options
Vertical dispersivity		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	$C_{ED}$	1.74E+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 groundwate

Domenico - Steady state Distance to compliance point 90 m Concentration of contaminant at compliance point C_{ED}/C₀ 1.74E+02 mg/I 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

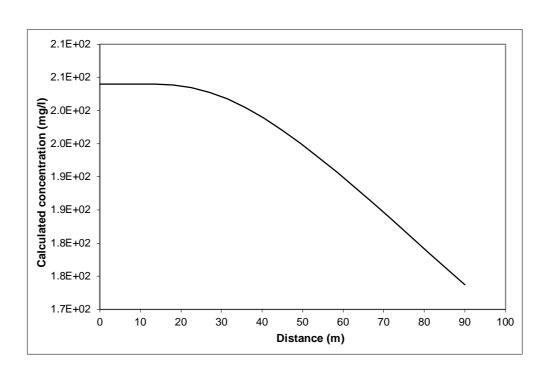
Entry if specify partition coefficient (op	tion)		
Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (	option)		
Fraction of organic carbon in aquifer	foc		fraction
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (optic	on)		-
Sorption coefficient for related species	K _{oc,n}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	рН		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
7	-		
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



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

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



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

#### Note

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

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

The measured groundwater concentration should be compared

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

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

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

ter concentration.

#### Calculated concentrations for distance-concentration graph

Domenico - Steady state From calculation sheet Distance Concentration

mg/l
2.0E+02
2.04E+02
2.04E+02
2.04E+02
2.04E+02
2.03E+02
2.03E+02
2.02E+02
2.00E+02
1.99E+02
1.97E+02
1.95E+02
1.93E+02
1.91E+02
1.88E+02
1.86E+02
1.84E+02
1.81E+02
1.79E+02
1.76E+02
1.74E+02