

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: 2-methylnaphthalene
 Target Concentration: 1.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E-03	mg/l
Half life for degradation of contaminant in water	t _{1/2}	2.58E+02	days
Calculated decay rate	λ	2.69E-03	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m
Plume thickness at source	Sy	1.00E+01	m
Saturated aquifer thickness	da	1.08E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	9.80E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	1.50E+03	m
Distance (latera) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	7.24E+00	l/kg
Longitudinal dispersivity	ax	13.510	m
Transverse dispersivity	az	1.351	m
Vertical dispersivity	ay	0.135	m

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	6.87E+01	fraction
Decay rate used	λ	2.69E-03	d ⁻¹
Rate of contaminant flow due to retardation	u	5.49E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	2.09E-106	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	1.08E-106	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	4.78E+102	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	8.27E+102	

Remedial Targets Remedial Target LTC3 4.78E+100 mg/l For comparison with measured groundwater concentration.

Ogata Banks Distance to compliance point 1600 m

Concentration of contaminant at compliance point C_{1D}/C₀ 2.09E-106 mg/l Ogata Banks
 after 9.9E+99 days

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd 7.24E+00 l/kg

Entry for non-polar organic chemicals (option) Soil water partition coefficient Kd 7.24E+00 l/kg

Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction

Organic carbon partition coefficient K_{oc} 7.24E+00 l/kg

Entry for ionic organic chemicals (option) Soil water partition coefficient K_d 7.24E+00 l/kg

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

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

acid dissociation constant pKa

Soil water partition coefficient Kd 7.24E+00 l/kg

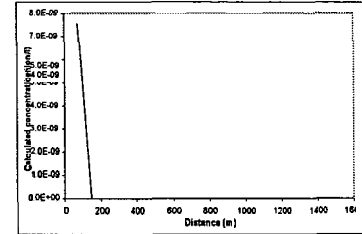
Dispersivity Calculate dependent on distance to compliance point (0) specifically dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity ax 1.35E+01 m

Transverse dispersivity az 1.35E+00 m

Vertical dispersivity ay 0.135E+01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x. Xu & Eckstein (1995) report ax = 0.83(log₁₀μ)^{0.44}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

75.0	7.6E-09
150.0	6.3E-14
225.0	3.7E-19
300.0	2.7E-24
375.0	1.9E-29
450.0	1.4E-34
600.0	7.4E-45
675.0	5.4E-50
750.0	4.0E-55
825.0	2.9E-60
900.0	1.8E-65
1050.0	1.2E-75
1125.0	8.9E-81
1200.0	6.7E-86

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bicos Area 7 Res
 Completed by: AJ
 Date: 24 11 2005
 Version: 11

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Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Anthracene
Target Concentration	C _T 1.00E+01 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)
 Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀ 1.00E+01	mg/l	
Half life for degradation of contaminant in water	t _{1/2} 9.20E+02	days	
Calculated decay rate	λ 7.53E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz 1.90E+02	m	
Plume thickness at source	Sy 1.00E+01	m	
Saturated aquifer thickness	da 1.08E+01	m	
Bulk density of aquifer materials	p 1.70E+00	g/cm ³	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 9.80E-03	fraction	
Hydraulic conductivity of aquifer	K 7.00E+00	m/d	
Distance to compliance point	x 1.50E+03	m	
Distance (lateral) to compliance point perpendicular to flow direction	z 0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y 0.00E+00	m	
Time since pollutant entered groundwater	t 9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd 5.13E+01	l/kg	see options
Longitudinal dispersivity	ax 13.510	m	see options
Transverse dispersivity	az 1.351	m	see options
Vertical dispersivity	ay 0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	4.80E+02	fraction
Decay rate used	λ	7.53E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	7.85E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	2.30E-163	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	1.15E-163	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	4.35E+151	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	8.43E+151	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target LTC3	4.35E+162	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	1500	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	2.30E-163	mg/l
after	9.9E+99	days	Ogata Banks

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

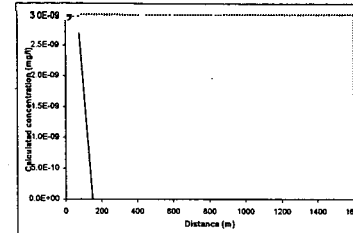
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	5.13E+01	l/kg
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	5.13E+01	l/kg
Sorption coefficient for related species	K _{ow}		l/kg
Sorption coefficient for ionised species	K _{ow}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	5.13E+01	l/kg

Calculate dependent on distance to compliance point (0)			
specific dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	13.510	m
Transverse dispersivity	az	1.351	m
Vertical dispersivity	ay	0.135	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
 Xu & Eckstein (1995) report ax = 0.83(log₁₀d)^{0.433}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
 From calculation sheet
 Distance Concentration

	mg/l
75.0	2.7E-09
150.0	4.8E-17
225.0	1.7E-24
100.0	4.3E-32
376.0	1.1E-39
450.0	2.8E-47
625.0	7.4E-55
600.0	1.9E-62
675.0	6.0E-70
IM.O	1.3E-77
825.0	3.6E-86
900.0	9.2E-93
015.0	2.4E-100
1050.0	6.4E-108
1125.0	1.7E-116
1200.0	4.6E-123
1216.0	1.2E-130
1350.0	3.2E-138
1425.0	8.6E-146
1500.0	2.3E-153

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed	Gless Area 1 Res
Completed by	AJ
Date	24/11/2005
Version	1.1

Tier 3 - Groundwater



Input Parameters (using pull-down menu) Variable Value Unit Source

Contaminant Aromatic C8-C10
Target Concentration C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core C_0 9.90E-09 mg/l
Half life for degradation of contaminant in water $t_{1/2}$ 1.83E+03 days
Calculated decay rate λ 3.80E-04 days⁻¹
Width of plume in aquifer at source (perpendicular to flow) Sz 1.90E+02 m
Plume thickness at source Sy 1.100E+01 m
Saturated aquifer thickness d_a 1.08E+01 m
Bulk density of aquifer materials ρ 1.70E+00 g/cm³
Effective porosity of aquifer n 1.82E-01 fraction
Hydraulic gradient i 9.80E-03 fraction
Hydraulic conductivity of aquifer K 7.00E+00 m/d
Distance to compliance point x 1.80E+03 m
Distance (lateral) to compliance point perpendicular to flow direction z 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction y 0.00E+00 m
Time since pollutant entered groundwater t 9.90E+09 days

Parameters values determined from options
Partition coefficient K_d 5.75E+00 l/kg see options
Longitudinal dispersivity α_x 13.510 m see options
Transverse dispersivity α_z 1.351 m see options
Vertical dispersivity α_y 0.135 m see options

Calculated Parameters Variable

Groundwater flow velocity v 3.77E-01 m/d
Retardation factor Rf 5.47E+01 fraction
Decay rate used λ 3.80E-04 d⁻¹
Rate of contaminant flow due to retardation u 6.88E-03 m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D} 3.30E-123 mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D} 1.70E-123 mg/l
Attenuation factor (one way vertical dispersion, C_{1D}/C_0) AF 3.00E+24
Attenuation factor (two way vertical dispersion, C_{2D}/C_0) AF 8.82E+24

Remedial Targets

Remedial Target C_{1D} 2.14E+24 mg/l For comparison with measured groundwater concentration.
Ogata Banks
Distance to compliance point 1500 m
Concentration of contaminant at compliance point C_{1D}/C_0 3.30E-123 mg/l Ogata Banks
after 9.9E+09 days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+09.

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d 5.75E+00 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction

Organic carbon partition coefficient K_{oc} 5.75E+00 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{ow} l/kg

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

pH value

acid dissociation constant pK_a

Soil water partition coefficient K_d 5.75E+00 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (D)

Specify dispersivity (1), or calc after Xu & Eckstein (2) ?

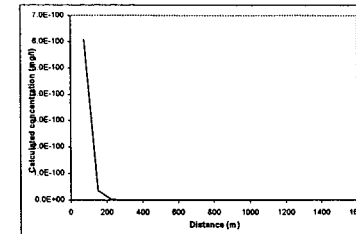
Longitudinal dispersivity α_x Enter value Calc value Xu & Eckstein 1.35E+01 m

Transverse dispersivity α_z 1.35E+00 m

Vertical dispersivity α_y 1.35E-01 m

For calculated value, assumes $\alpha_x = 0.1 * x$, $\alpha_z = 0.01 * x$, $\alpha_y = 0.001 * x$

Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10} t)^{0.114}$, $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

750.0	6.1E-100
1500.0	3.5E-101
2250.0	2.0E-102
3000.0	1.2E-103
3750.0	6.7E-105
4500.0	4.0E-106
5250.0	2.3E-107
6000.0	1.4E-108
6750.0	8.3E-110
7500.0	5.0E-111
8250.0	3.0E-112
9000.0	1.8E-113
9750.0	1.1E-114
10600.0	6.6E-116
11280.0	4.0E-117
12000.0	2.4E-118
12780.0	1.6E-119
14880.0	8.8E-122
15000.0	3.3E-123

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.

This sheet calculates the Tier3 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 Tier 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+09

Site being assessed: Bloss Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a
Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aromatic C10-C12
Target Concentration: 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	9.90E-09	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.83E+03	days
Calculated decay rate	λ	3.80E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m
Plume thickness at source	Sy	1.00E+01	m
Saturated aquifer thickness	da	1.08E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	9.80E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	1.80E+03	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
Parameters values determined from options			
Partition coefficient	Kd	9.12E+00	l/kg
Longitudinal dispersivity	ax	13.510	m
Transverse dispersivity	az	1.351	m
Vertical dispersivity	ay	0.135	m

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	8.62E+01	fraction
Decay rate used	λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	4.37E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	1.26E-132	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	8.48E-133	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	7.87E+33	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	1.53E+34	

Remedial Targets

Remedial Target	1.7C3	6.62E+30	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1500	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	1.26E-132	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

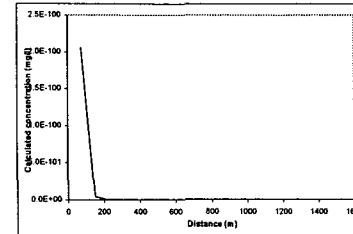
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	9.12E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K _{oc}		l/kg
Sorption coefficient for ionised species	K _{ow}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	9.12E+00	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	az		1.35E+01 m
Vertical dispersivity	ay		1.35E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀ x)^{0.75}; az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

76.0	2.1E-100
160.0	4.0E-102
225.0	7.7E-104
3M.0	1.6E-105
376.0	3.0E-107
460.0	6.9E-109
626.0	1.2E-110
606.0	4.6E-118
760.0	9.7E-116
906.0	
976.0	4.0E-119
	8.2E-121
1086.0	3.9E-128
1200.0	7.0E-126
1276.0	1.4E-127
1360.0	3.0E-129
1426.0	6.1E-131
16W.D	1.3E-132

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.

This sheet calculates the Tier3 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

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 Tier 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

Site being assessed: Bites Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

Simple hydrogeological calculations

(These are not specific to, or required in, the Remedial Targets Methodology)

Parameter	symbol	unit	justification
Hydraulic conductivity	K	8.10E-05 m/s	
Hydraulic gradient	i	9.80E-03 unitless	
Effective porosity of aquifer	n	1.82E-01 fraction	
Thickness of saturated aquifer	b	1.90E+02 m	
Width of aquifer perpendicular to flow	w	1.00E+01 m	
Distance to receptor	x	1.50E+03 m	
Density of stratum	ρ	1.70E+00 g/cm ³	
Soil-water partition co-efficient	Kd	3.16E+04 l/kg	
Retardation factor of pollutant	R	295378.5836	

Groundwater flow velocity	v(GW)	4.36E-06 m/s	3.77E-01 m/day	1.38E+02 m/year
Time for groundwater to reach receptor	t(GW)	3.44E+08 seconds	3.98E+03 days	1.09E+01 years
Rate of groundwater flow through aquifer	Q	1.51E-03 m ³ /s	1.30E+02 m ³ /day	4.76E+04 m ³ /year
Contaminant flow velocity	v(contam)	1.48E-11 m/s	1.28E-06 m/day	4.66E-04 m/year
Time for contaminant to reach receptor	t(contam)	1.02E+14 seconds	1.18E+09 days	3.22E+06 years

Tier 3 - Groundwater



Input Parameters (using pull-down menu) Variable Value Unit Source

Contaminant: Aromatic C12-C16
Target Concentration: 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	3.47E-02	mg/l	Soil water partition coefficient	Kd	1.82E+01	l/kg
Half life for degradation of contaminant in water	t _{1/2}	1.83E+03	days	Soil water partition coefficient	Kd	1.82E+01	l/kg
Calculated decay rate	λ	3.80E-04	days ⁻¹	Dispersivity	ax	1.35E+01	m
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m	Dispersivity	ay	1.35E+01	m
Plume thickness at source	Sy	1.00E+01	m	Dispersivity	az	1.35E+00	m
Saturated aquifer thickness	ds	1.08E+01	m	Dispersivity	ax	1.35E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	Dispersivity	ay	1.35E+01	m
Effective porosity of aquifer	n	1.82E-01	fraction	Dispersivity	az	1.35E+00	m
Hydraulic gradient	i	9.80E-03	fraction	Dispersivity	ax	1.35E+01	m
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	Dispersivity	ay	1.35E+01	m
Distance to compliance point	x	1.50E+03	m	Dispersivity	az	1.35E+00	m
Distance (lateral) to compliance point perpendicular to flow direction	y	0.00E+00	m	Dispersivity	ax	1.35E+01	m
Distance (depth) to compliance point perpendicular to flow direction	z	0.00E+00	m	Dispersivity	ay	1.35E+01	m
Time since pollutant entered groundwater	t	9.90E+99	days	Dispersivity	az	1.35E+00	m
Parameters values determined from options				Dispersivity	ax	1.35E+01	m
Partition coefficient	Kd	1.82E+01	l/kg	Dispersivity	ay	1.35E+01	m
Longitudinal dispersivity	ax	13.510	m	Dispersivity	az	1.35E+00	m
Transverse dispersivity	ay	1.351	m	Dispersivity	ax	1.35E+01	m
Vertical dispersivity	az	0.135	m	Dispersivity	ay	1.35E+01	m

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	1.71E+02	fraction
Decay rate used	λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	2.21E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	5.74E-56	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	2.96E-56	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	6.05E+53	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	1.17E+54	

Remedial Targets

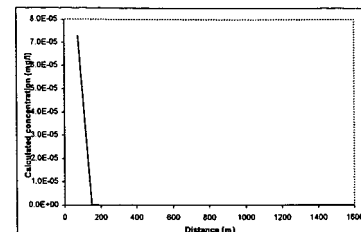
Remedial Target	LYC3	4.32E+00	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		1600	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	5.74E-56	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Soil water partition coefficient	Kd	1.82E+01	l/kg
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	1.82E+01	l/kg
Soil water partition coefficient	Kd	1.82E+01	l/kg
Dispersivity	ax	1.35E+01	m
Dispersivity	ay	1.35E+01	m
Dispersivity	az	1.35E+00	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x. Xu & Eckstein (1995) report ax = 0.83(log₁₀d)^{0.11}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
76.0	7.3E-05
160.0	1.4E-07
226.0	2.8E-10
300.0	5.6E-13
376.0	1.1E-16
460.0	2.2E-18
600.0	9.3E-24
976.0	1.9E-26
760.0	3.9E-29
626.0	6.0E-32
600.0	1.6E-34
176.0	3.4E-37
1060.0	7.1E-40
1126.0	1.6E-42
1200.0	3.0E-46
1276.0	6.3E-48
1360.0	1.3E-50
1426.0	2.7E-53
1600.0	5.7E-56

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.

This sheet calculates the Tier3 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.

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 Tier 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.

Site being assessed: Bless Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

Simple hydrogeological calculations

(These are not specific to, or required in, the Remedial Targets Methodology)

Parameter	symbol	unit	justification
Hydraulic conductivity	K	8.10E-05 m/s	
Hydraulic gradient	i	9.80E-03 unitless	
Effective porosity of aquifer	n	1.82E-01 fraction	
Thickness of saturated aquifer	b	1.90E+02 m	
Width of aquifer perpendicular to flow	w	1.00E+01 m	
Distance to receptor	x	1.50E+03 m	
Density of stratum	ρ	1.70E+00 g/cm ³	
Soil-water partition co-efficient	Kd	0.00E+00 l/kg	
Retardation factor of pollutant	R	1	

Groundwater flow velocity	v(GW)	4.36E-06 m/s	3.77E-01 m/day	1.38E+02 m/year
Time for groundwater to reach receptor	t(GW)	3.44E+08 seconds	3.98E+03 days	1.09E+01 years
Rate of groundwater flow through aquifer	Q	1.51E-03 m ³ /s	1.30E+02 m ³ /day	4.76E+04 m ³ /year
Contaminant flow velocity	v(contam)	4.36E-06 m/s	3.77E-01 m/day	1.38E+02 m/year
Time for contaminant to reach receptor	t(contam)	3.44E+08 seconds	3.98E+03 days	1.09E+01 years

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aromatic C18-C21
 Target Concentration: C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	3.47E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.65E+03	days	
Calculated decay rate λ	1.90E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) S_z	1.90E+02	m	
Plume thickness at source S_y	1.00E+01	m	
Saturated aquifer thickness d_a	1.00E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	9.80E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.50E+03	m	
Distance (latera) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient K_d	5.75E+01	V/kg	see options
Longitudinal dispersivity α_x	13510	m	see options
Transverse dispersivity α_z		m	see options
Vertical dispersivity α_y	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.77E-01	m/d
Retardation factor Rf	5.38E+02	fraction
Decay rate used λ	1.90E-04	d ⁻¹
Rate of contaminant flow due to retardation u	7.00E-04	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{ED}	5.77E-74	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{ED}	2.98E-74	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{ED}) AF	6.01E+71	
Attenuation factor (two way vertical dispersion, C_0/C_{ED}) AF	1.17E+72	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target	LTC3 4.29E+98	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	1600	m	
Concentration of contaminant at compliance point after	C_{ED}/C_0 5.77E-74	mg/l	Ogata Banks
	9.9E+99	days	

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

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

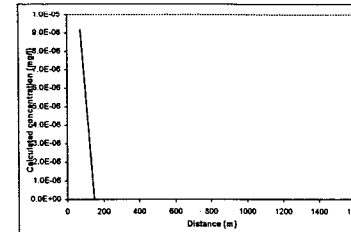
Calculate for non-polar organic chemicals

Soil water partition coefficient K_d		V/kg
Entry for non-polar organic chemicals (option) f_{oc}	1.00E+00	fraction
Fraction of organic carbon in aquifer f_{oc}	5.75E+01	V/kg
Organic carbon partition coefficient K_{oc}		V/kg
Entry for ionic organic chemicals (option) K_{ow}		V/kg
Sorption coefficient for ionised species K_{ow}		V/kg
pH value pH		
acid dissociation constant pK_a		
Soil water partition coefficient K_d	5.75E+01	V/kg

Dispersivity

Calculate dependent on distance to compliance point (0)	2		
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity α_x	Enter value	Calc value	Xu & Eckstein
Transverse dispersivity α_z		1.35E+01	m
Vertical dispersivity α_y		1.35E+00	m
		1.35E-01	m

For calculated value, assumes $\alpha_x = 0.1 \cdot x$, $\alpha_z = 0.01 \cdot x$, $\alpha_y = 0.001 \cdot x$. Xu & Eckstein (1995) report $\alpha_x = 0.63(\log_{10} x)^{1.15}$; $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
 From calculation sheet
 Distance Concentration

	mg/l
76.0	9.2E-08
160.0	2.3E-09
225.0	6.6E-13
300.0	1.4E-16
376.0	3.6E-20
460.0	9.0E-24
600.0	6.9E-31
676.0	1.6E-34
760.0	3.9E-38
828.0	1.0E-41
900.0	2.8E-45
976.0	6.8E-49
1060.0	1.8E-52
1126.0	4.6E-56
1200.0	1.2E-59
1176.0	3.2E-63
1360.0	8.4E-67
1426.0	2.2E-70
1600.0	6.8E-74

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Bress Area 1 Res
 Completed by: AJ
 Date: 24/11/2005
 Version: 11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aromatic C21-C35
Target Concentration: 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core: 3.47E-02 mg/l
Half life for degradation of contaminant in water: 3.65E+03 days
Calculated decay rate: 1.90E-04 days⁻¹
Width of plume in aquifer at source (perpendicular to flow): 1.90E+02 m
Plume thickness at source: 1.00E+01 m
Saturated aquifer thickness: 1.05E+01 m
Bulk density of aquifer materials: 1.70E+00 g/cm³
Effective porosity of aquifer: 1.82E-01 fraction
Hydraulic gradient: 9.80E-03 fraction
Hydraulic conductivity of aquifer: 7.00E+00 m/d
Distance to compliance point: 1.50E+03 m
Distance (lateral) to compliance point perpendicular to flow direction: 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction: 0.00E+00 m
Time since pollutant entered groundwater: 9.50E+09 days

Parameters values determined from options
Partition coefficient: 4.57E+02 W/g see options
Longitudinal dispersivity: 13.510 m see options
Transverse dispersivity: 1.351 m see options
Vertical dispersivity: 0.135 m see options

Calculated Parameters Variable

Groundwater flow velocity: 3.77E-01 m/d
Retardation factor: 4.27E+03 fraction
Decay rate used: 1.90E-04 d⁻¹
Rate of contaminant flow due to retardation: 8.83E-05 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion: 1.26E-239 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion: 8.49E-240 mg/l
Attenuation factor (one way vertical dispersion, C₀/C_x): 2.78E+237 AF
Attenuation factor (two way vertical dispersion, C₀/C_{2x}): 5.35E+237

Remedial Targets
Remedial Target: LYC3 1.97E+234 mg/l For comparison with measured groundwater concentration, Ogata Banks

Distance to compliance point: 1600 m

Concentration of contaminant at compliance point
before: 1.26E-239 mg/l Ogata Banks
after: 9.9E+99 days

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

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

Calculate for non-polar organic chemicals

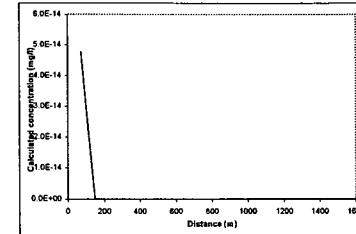
Entry if specify partition coefficient (option) Kd W/kg
Soil water partition coefficient Kd W/kg
Entry for non-polar organic chemicals (option) f_{oc} fraction
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} W/kg
Entry for ionic organic chemicals (option) K_{ow} W/kg
Sorption coefficient for related species K_{ow} W/kg
Sorption coefficient for ionised species K_{ow} W/kg
pH value pH
acid dissociation constant pKa W/kg

Soil water partition coefficient Kd 4.57E+02 W/kg

Dispersivity Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity: 13.510 m
Transverse dispersivity: 1.351 m
Vertical dispersivity: 0.135 m

For calculated value, assumes a_x = 0.1 * a_z, a_z = 0.01 * a_y, a_y = 0.001 * a_x
Xu & Eckstein (1995) report a_x = 0.83(log₁₀a_z)^{0.418}; a_z = a_x/10, a_y = a_x/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

Distance (m)	Concentration (mg/l)
76.0	4.8E-14
160.0	6.2E-26
226.0	7.9E-38
300.0	1.0E-49
376.0	1.4E-61
450.0	1.8E-73
626.0	2.4E-85
600.0	3.2E-97
673.0	4.3E-109
160.0	5.8E-121
826.0	7.8E-133
900.0	1.1E-144
976.0	1.4E-156
1050.0	1.9E-168
1126.0	2.6E-180
1200.0	3.6E-192
1216.0	4.9E-204
1360.0	6.7E-216
1426.0	9.2E-228
1600.0	1.3E-239

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Bress Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Benz(a)anthracene C_T 6.25E-08 mg/l

Target Concentration C_T 6.25E-08 mg/l

Equations in R&D Pub. 20

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

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core C₀ 1.20E-01 mg/l

Half life for degradation of contaminant in water t_{1/2} 1.35E-03 days

Calculated decay rate λ 5.10E-04 days⁻¹

Width of plume in aquifer at source (perpendicular to flow) S_Z 1.00E-02 m

Plume thickness at source S_Y 1.00E-01 m

Bulk density of aquifer materials ρ 1.70E+00 g/cm³

Effective porosity of aquifer n 1.82E-01 fraction

Hydraulic conductivity of aquifer K 7.00E+00 m/d

Distance to compliance point X 1.90E+03 m

Distance (depth) to compliance point perpendicular to flow direction Z 1.00E+00 m

Time point at which groundwater parameters values determined from options t 9.00E+99 days

Partition coefficient K_D 5.01E+03

Longitudinal dispersivity α_L 1.510 m

Transverse dispersivity α_T 1.351 m

Vertical dispersivity α_V 0.135 m

Variables

Groundwater flow velocity V 3.72E-01 m/d

Retardation factor R_T 4.68E+04

Decay rate used λ 5.10E-04 d⁻¹

Rate of contaminant flow due to retardation U 8.05E-06 m/d

Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l

Attenuation factor (for one-way vertical dispersion, C₀/C_X) AF #NUM!

Attenuation factor (two way vertical dispersion, C₀/C_X) AF #NUM!

Remedial Targets

Remedial Target LC3 #NUM! mg/l

For comparison with measured groundwater concentration.

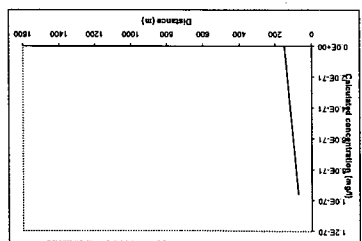
Distance to compliance point 1500 m

Concentration of contaminant at compliance point after C_X/C₀ #NUM! mg/l

Ogata Banks

The recommended value for time when calculating remedial targets using the time variant options as the may result in an overestimate of the remedial target is 9.0E+99.

Care should be used when calculating remedial targets using the time variant options as the may result in an overestimate of the remedial target.



Select Method for deriving Partition Coefficient (using pull down menu)

Calculates for non-polar organic chemicals

Enter if specify partition coefficient (option) K_D 5.01E+03

Entry for non-polar organic chemicals (option) K_D 1.00E+03 fraction

Fraction of organic carbon in aquifer f_{oc} 5.01E+03

Organic carbon partition coefficient (option) K_{oc} 5.01E+03

Empion coefficient for related species K_{oc} 5.01E+03

Sorption coefficient for related species K_{oc} 5.01E+03

pH Value pH 7

acid dissociation constant pK_a 7

Dispersivity

Calculate dispersivity on distance to compliance point (1) 2

Specify dispersivity (1), or each either Xu & Eckstein (2) 7

Enter value Calc value Xu & Eckstein

Longitudinal dispersivity α_L 1.35E+00 m

Transverse dispersivity α_T 1.35E+00 m

Vertical dispersivity α_V 1.35E-01 m

For calculated value, assumes α_L = 0.1 * α_T, α_T = 0.01 * α_V, α_V = 0.001 * α_L

Xu & Eckstein (1995) report α_L = 0.03(mg/L)^{0.5}, α_T = α_V * 10, α_V = α_L * 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.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the location or compliance location down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata. 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 Tier 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.



Site being assessed: West Area 1 Res

Compiled by: AJ

Date: 24 11 2005

Version: 11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Chrysene
Target Concentration C_T 8.25E-08 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core C_0 2.00E-01 mg/l
Half life for degradation of contaminant in water $t_{1/2}$ 2.00E+03 days
Calculated decay rate λ 3.47E-04 days⁻¹
Width of plume in aquifer at source (perpendicular to flow) Sz 1.50E+02 m
Plume thickness at source Sy 1.00E+01 m
Saturated aquifer thickness da 1.08E+01 m
Bulk density of aquifer materials ρ 1.70E+00 g/cm³
Effective porosity of aquifer n 1.82E-01 fraction
Hydraulic gradient i 9.80E-03
Hydraulic conductivity of aquifer K 7.00E+00 m/d
Distance to compliance point x 1.50E+03 m
Distance (lateral) to compliance point perpendicular to flow direction z 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction y 0.00E+00 m
Time since pollutant entered groundwater t 9.90E+99 days

Parameters values determined from options
Partition coefficient Kd 7.24E+02 V/kg
Longitudinal dispersivity ax 13.510 m
Transverse dispersivity az 1.351 m
Vertical dispersivity ay 0.135 m

Calculated Parameters Variable Value Unit
Groundwater flow velocity v 3.77E-01 m/d
Retardation factor Rf 6.77E+03 fraction
Decay rate used λ 3.47E-04 d⁻¹
Rate of contaminant flow due to retardation u 5.57E-05 m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{ep} #NUM! mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{ep} #NUM! mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{ep}) AF #NUM!
Attenuation factor (two way vertical dispersion, C_0/C_{ep}) AF #NUM!

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1500		m	
Concentration of contaminant at compliance point	C_{ep}/C_0	#NUM!	mg/l	Ogata Banks
after	9.9E+99		days	

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

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

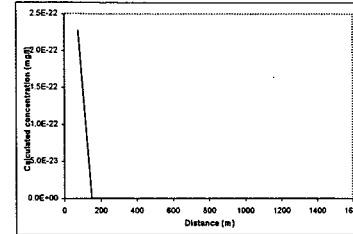
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd V/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer foc 1.00E+00 fraction
Organic carbon partition coefficient Koc 7.24E+02 V/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow} V/kg
Sorption coefficient for ionised species K_{ow} V/kg
pH value
acid dissociation constant pKa V/kg

Source of parameter value

Soil water partition coefficient Kd 7.24E+02 V/kg
Dispersivity
Calculate dispersivity on distance to compliance point (0)
specify dispersivity (1), or calc after Xu & Eckstein (2) ?
Longitudinal dispersivity ax Enter value Calc value Xu & Eckstein 1.35E+01 m
Transverse dispersivity az 1.35E+00 m
Vertical dispersivity ay 1.35E-01 m
For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * z$, $ay = 0.001 * y$
Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.4}$, $az = ax/10$, $ay = ax/100$ are assumed

time variant options only



Calculated concentration for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration mg/l

75.0	2.3E-22
150.0	2.4E-43
225.0	2.8E-64
300.0	2.8E-86
375.0	3.0E-108
450.0	3.2E-127
525.0	3.6E-148
600.0	3.9E-169
675.0	4.3E-190
750.0	4.8E-211
825.0	5.4E-232
900.0	6.0E-253
975.0	6.7E-274
1050.0	#NUM!
1125.0	#NUM!
1200.0	#NUM!
1275.0	#NUM!
1350.0	#NUM!
1425.0	#NUM!
1500.0	#NUM!

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.

This sheet calculates the Tier3 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.

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 Tier 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.

Site being assessed: Bess Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu)

Contaminant: Fluoride
 Target Concentration: 1.00E+00 mg/l
 C_T: 1.00E+00 mg/l

Equations in R&D Pub. 20

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

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '2' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core: 2.20E+00 mg/l
 Half life for degradation of contaminant in water: 9.90E+99 days
 Calculated decay rate: 7.00E-101 days⁻¹
 Width of plume in aquifer (perpendicular to flow): 1.90E+02 m
 Plume thickness at source: 1.00E+01 m
 Standard aquifer thickness: 1.00E+01 m
 Bulk density of aquifer materials: 1.20E+00 g/cm³
 Effective porosity of aquifer: 1.82E-01 fraction
 Hydraulic gradient: 1.80E-03 fraction
 Hydraulic conductivity of aquifer: 7.00E+00 m/d
 Distance to compliance point: 1.50E+03 m
 Distance (later) to compliance point perpendicular to flow direction: 2.00E+00 m
 Distance (depth) to compliance point perpendicular to flow direction: 0.00E+00 m
 Time since plume entered groundwater: 9.90E+99 days

Calculated Parameters

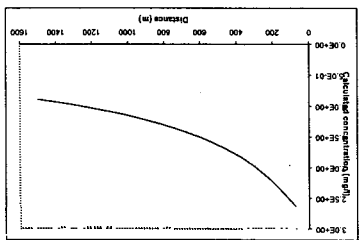
Variable: Vertical dispersivity: 0.135 m
 Transverse dispersivity: 1.351 m
 Longitudinal dispersivity: 13.510 m
 Partition coefficient: 0.00E+00
 Retardation factor (two way vertical dispersion, C_p/C_g): 5.80E+00
 Retardation factor (one way vertical dispersion, C_p/C_g): 4.58E-01
 Rate of contaminant flow due to retardation: 3.77E-01 m/d
 Decay rate used: 7.00E-101 d⁻¹
 Retardation factor: 1.00E+00
 Groundwater flow velocity: 3.77E-01 m/d

Remedial Targets

Remedial Target: LTC3 2.04E+00 mg/l
 For comparison with measured groundwater concentration.

Distance to compliance point: 1800 m
 Concentration of contaminant at compliance point after Ogata Banks: 8.68E-01 mg/l
 C_p/C₀: 8.68E-01 mg/l
 Ogata Banks days: 9.9E+99

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.



Calculate for non-polar organic chemicals

Select Method for deriving Partition Coefficient (using pull down menu)

Enter *H* specify partition coefficient (option)
 Entry for non-polar organic chemicals (option)
 Entry for ionic organic chemicals (option)
 Organic carbon partition coefficient: 0.00E+00
 Fraction of organic carbon in aquifer: 1.00E+00
 Sorption coefficient for labeled species: K_{oc}
 Sorption coefficient for unlabeled species: K_{ow}
 pH value: 7
 acid dissociation constant: pKa

Dispersivity

Calculate dispersivity on distance to compliance point (1)
 Specify dispersivity (1), or calc enter Xu & Eckstein (2) 7
 Enter value Calc value Xu & Eckstein

ax: 1.35E+01
 ay: 1.35E+00

For calculated values, assume $\alpha_x = 0.1$, $\alpha_z = 0.01$, $\alpha_y = 0.001$, $\alpha_x = 0.001$, $\alpha_z = 0.01$, $\alpha_y = 0.001$, $\alpha_x = 0.001$, $\alpha_z = 0.01$, $\alpha_y = 0.001$ are assumed.

Partition coefficient

Parameters values determined from options

Time since plume entered groundwater: 9.90E+99 days
 Distance (depth) to compliance point perpendicular to flow direction: 0.00E+00 m
 Distance (later) to compliance point perpendicular to flow direction: 2.00E+00 m
 Hydraulic conductivity of aquifer: 7.00E+00 m/d
 Hydraulic gradient: 1.80E-03 fraction
 Effective porosity of aquifer: 1.82E-01 fraction

Distance to compliance point

This sheet calculates the Tier 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 Tier 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: BGS Area 1 Risk
 Completed by: JG
 Date: 24 11 2005
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Fluoranthene
Target Concentration C_T 1.00E-03 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water.

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core C₀ 5.00E-01 mg/l

Half life for degradation of contaminant in water t_{1/2} 8.88E+02 days

Calculated decay rate λ 7.88E-04 days⁻¹

Width of plume in aquifer at source (perpendicular to flow) Sz 1.90E+02 m

Plume thickness at source Sy 1.00E+01 m

Saturated aquifer thickness da 1.08E+01 m

Bulk density of aquifer materials ρ 1.70E+00 g/cm³

Effective porosity of aquifer n 1.82E-01 fraction

Hydraulic gradient i 9.80E-03 fraction

Hydraulic conductivity of aquifer K 7.00E+00 m/d

Distance to compliance point x 1.50E+03 m

Distance (lateral) to compliance point perpendicular to flow direction z 0.00E+00 m

Distance (depth) to compliance point perpendicular to flow direction y 0.00E+00 m

Time since pollutant entered groundwater t 9.90E+99 days

Parameters values determined from options

Partition coefficient Kd 1.38E+02 l/kg

Longitudinal dispersivity αx 13.510 m

Transverse dispersivity αz 1.351 m

Vertical dispersivity αy 0.135 m

Calculated Parameters Variable

Groundwater flow velocity v 3.77E-01 m/d

Retardation factor Rf 1.29E+03 fraction

Decay rate used λ 7.88E-04 d⁻¹

Rate of contaminant flow due to retardation u 2.92E-04 m/d

Contaminant concentration at distance x, assuming one-way vertical dispersion C_{1D} #NUM! mg/l

Contaminant concentration at distance x, assuming two-way vertical dispersion C_{2D} #NUM! mg/l

Attenuation factor (one way vertical dispersion, C_{1D}/C₀) AF #NUM!

Attenuation factor (two way vertical dispersion, C_{2D}/C₀) AF #NUM!

Remedial Targets Remedial Target LTC3 #NUM! mg/l

Ogata Banks

Distance to compliance point 1600 m

Concentration of contaminant at compliance point C_{1D}/C₀ #NUM! mg/l

after 9.9E+99 days Ogata Banks

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 1.38E+02 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction

Organic carbon partition coefficient K_{oc} 1.38E+02 l/kg

Entry for ionic organic chemicals (option)

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

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

pH value pH

acid dissociation constant pKa

Soil water partition coefficient Kd 1.38E+02 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (D)

specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

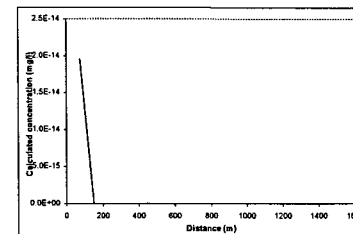
Longitudinal dispersivity αx 1.35E+01 m

Transverse dispersivity αz 1.35E+00 m

Vertical dispersivity αy 1.35E-01 m

For calculated value, assumes αx = 0.1 * z, αz = 0.01 * x, αy = 0.001 * z

Xu & Eckstein (1995) report αz = 0.83(log₁₀p)^{0.414}; αz = αz/10, αy = αy/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

mg/l

76.0 2.0E-14

1600.0 7.2E-14

225.0 2.5E-11

300.0 9.6E-11

376.0 3.6E-11

460.0 1.3E-11

626.0 5.1E-11

6W.0 1.9E-108

676.0 7.3E-122

760.0 2.8E-136

825.0 1.1E-148

900.0 4.1E-162

876.0 1.6E-176

1060.0 6.1E-189

1128.0 2.4E-202

1200.0 9.1E-216

1275.0 3.6E-229

1360.0 1.4E-242

1426.0 6.3E-256

16W.0 #NUM!

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.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor of compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata.

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 Tier 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

Site being assessed: Bress Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

Tier 3 -Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Fluorene
Target Concentration	C _T 6.25E-08 mg/l

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

Ogata Banks	Equations in R&D Pub. 20
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Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	3.00E-01	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.20E+02	days
Calculated decay rate	λ	5.78E-03	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m
Plume thickness at source	Sy	1.00E+01	m
Saturated aquifer thickness	da	1.05E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	9.80E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	1.50E+03	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
Parameters values determined from options			
Partition coefficient	Kd	2.63E+01	V/kg
Longitudinal dispersivity	ax	13.510	m
Transverse dispersivity	az	1.351	m
Vertical dispersivity	ay	0.135	m

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	2.47E+02	fraction
Decay rate used	λ	5.78E-03	d ⁻¹
Rate of contaminant flow due to retardation	u	1.53E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	#NUM!	

Remedial Targets

Remedial Target	LYCS	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1600	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	#NUM!	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

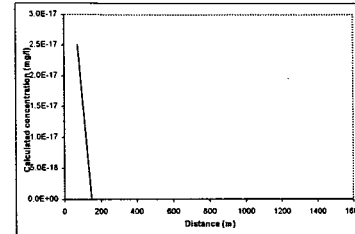
Soil water partition coefficient	Kd		V/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	2.63E+01	V/kg
Entry for ionic organic chemicals (option)	K _{ow}		V/kg
Sorption coefficient for ionised species	K _{ow}		V/kg
pH value	pH		
acid dissociation constant	pKa		

Source of parameter value

Soil water partition coefficient	Kd	2.63E+01	V/kg
Dispersivity			
Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	13.510	m
Transverse dispersivity	az	1.351	m
Vertical dispersivity	ay	0.135	m
For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(0g ₁₀) ^{0.413} , az = ax/10, ay = ax/100 are assumed			

time variant options only

Partition coefficient	Kd	see options
Longitudinal dispersivity	ax	see options
Transverse dispersivity	az	see options
Vertical dispersivity	ay	see options



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
76.0	2.6E-17
150.0	2.0E-33
225.0	1.6E-49
300.0	9.9E-65
450.0	7.7E-98
625.0	6.2E-114
800.0	6.0E-130
975.0	4.1E-146
1150.0	3.3E-162
1325.0	2.7E-178
1500.0	2.2E-194
1600.0	1.8E-210
1888.0	1.6E-268
1200.0	1.0E-258

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed	Bliss Area 1 Res
Compiled by	AJ
Date	24 11 2005
Version	11

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RBD Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Phenanthrene
Target Concentration C_T 8.25E-06 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C_0	1.30E+00	mg/l	see options
Half life for degradation of contaminant in water	$t_{1/2}$	4.00E+02	days	see options
Calculated decay rate	λ	1.73E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m	see options
Plume thickness at source	Sy	1.90E+01	m	see options
Saturated aquifer thickness	da	1.08E+01	m	see options
Bulk density of aquifer materials	ρ	2.17E+00	g/cm ³	see options
Effective porosity of aquifer	n	1.82E-01	fraction	see options
Hydraulic gradient	i	9.80E-03	fraction	see options
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	see options
Distance to compliance point	x	1.50E+03	m	see options
Distance (latera) to compliance point perpendicular to flow direction	z	0.00E+00	m	see options
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	see options
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	5.13E+01	l/kg	see options
Longitudinal dispersivity	ax	13.510	m	see options
Transverse dispersivity	az	1.351	m	see options
Vertical dispersivity	ay	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	4.80E+02	fraction
Decay rate used	λ	1.73E-03	d ⁻¹
Rate of contaminant flow due to retardation	u	7.85E-04	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion	C_{1D}	2.31E-241	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion	C_{2D}	1.19E-241	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D})	AF	5.83E+240	
Attenuation factor (two way vertical dispersion, C_0/C_{2D})	AF	1.09E+241	

Remedial Targets

Remedial Target	LTC3	3.52E+23E	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1600	m	
Concentration of contaminant at compliance point	C_{2D}/C_0	2.31E-241	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer

Organic carbon partition coefficient

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

Sorption coefficient for ionised species

pH value

acid dissociation constant

Soil water partition coefficient

Dispersivity

Calculate dependent on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

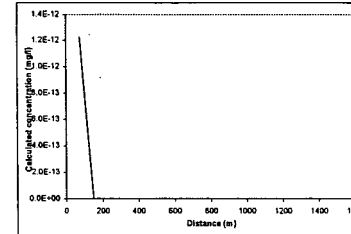
Transverse dispersivity

Vertical dispersivity

For calculated values, assumes $ax = 0.1 \cdot x$, $az = 0.01 \cdot x$, $ay = 0.001 \cdot x$

Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.11}$; $az = az/10$, $ay = ay/100$ are assumed

Kd		l/kg
foc	1.00E+00	fraction
Koc	5.13E+01	l/kg
K_{ow}		l/kg
K_{ow}		l/kg
pH		
pKa		
Kd	5.13E+01	l/kg
ax	Enter value	Calc value Xu & Eckstein
az		1.35E+01 m
ay		1.35E+00 m
		1.35E-01 m



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
75.0	1.00E-12
160.0	1.1E-24
226.0	9.6E-37
300.0	8.4E-49
375.0	7.6E-61
450.0	6.8E-73
525.0	6.2E-85
600.0	5.7E-97
675.0	5.2E-109
750.0	4.8E-121
825.0	4.4E-133
900.0	4.1E-145
975.0	3.8E-157
1060.0	3.6E-169
1125.0	3.2E-181
1200.0	3.0E-193
1275.0	2.8E-205
1360.0	2.6E-217
1425.0	2.5E-229
1500.0	2.3E-241

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.

This sheet calculates the Tier3 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 Tier 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

Site being assessed: Bicts Area 1 Res
Completed by: RJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a
Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Phenol
Target Concentration C_t 5.00E-04 mg/l

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

Equations in R&D Pub. 20
Ogata Status

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter 'Y' if backgradation rate is for the substance in water, 'N' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core C₀ 5.00E-013 mg/l

Half life for degradation of contaminant in water λ 1.00E+013 days

Calculated decay rate λ_c 6.93E-02 days

Width of plume in aquifer at source (m) W 1.00E+013 m

Plume thickness at source S₀ 1.00E+013 m

Saturated aquifer thickness da 1.00E+013 m

Bulk density of aquifer materials ρ 1.70E+000 g/cm³

Effective porosity of aquifer n 0.900E+001 fraction

Hydraulic gradient i 1.00E+001 m

Hydraulic conductivity of aquifer K 7.00E+000 m/d

Distance to compliance point perpendicular to flow direction X 1.00E+000 m

Distance (depth) to compliance point Z 0.00E+000 m

Time since pollutant entered groundwater t 9.90E+999 days

Parameters values determined from options

Partition coefficient Kd 1.00E+011 l/kg

Longitudinal dispersivity α_L 10.00 m

Transverse dispersivity α_T 1.00 m

Vertical dispersivity α_V 0.10 m

Calculated Parameters Variable

Groundwater flow velocity Y 3.77E-01 m/d

Retardation factor Rf 1.80E+000 fraction

Decay rate used λ_d 6.93E-02 d⁻¹

Rate of contaminant flow due to retardation u 1.91E-01 m/d

Rate of contaminant flow due to decay λ_d 6.93E-02 d⁻¹

Contaminant concentration at distance X, assuming two-way vertical dispersion C₀ 2.88E-27 mg/l

Attenuation factor (one way vertical dispersion, C₀/C_X) AF 8.92E+85

Attenuation factor (two way vertical dispersion, C₀/C_X) AF 1.73E+88

Remedial Targets
Ogata Status Remedial Target TCS 3.40E+02 mg/l

Distance to compliance point	1600	m
Concentration of contaminant at compliance point after	5.81E-07	mg/l
	9.9E+99	days
Distance to compliance point	1600	m
Concentration of contaminant at compliance point after	5.81E-07	mg/l
	9.9E+99	days

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

Select Method for deriving Partition Coefficient (using pull down menu)
Calculate for non-polar organic chemicals

Enter if specific partition coefficient (option) Kd 1.00E+011 l/kg

Soil water partition coefficient K_{ow} 1.00E+011 l/kg

Entry for non-polar organic chemical (option) K_{oc} 1.00E+011 l/kg

Fraction of organic carbon in aquifer f_{oc} 1.00E-011

Organic carbon partition coefficient K_{oc} 1.00E+011 l/kg

Soil water partition coefficient K_{ow} 1.00E+011 l/kg

Sorption coefficient for neutral species K_{ow} 1.00E+011 l/kg

pH value pH 7.00

acid dissociation constant pKa 4.00

Soil water partition coefficient Kd 1.00E+011 l/kg

Dispersivity

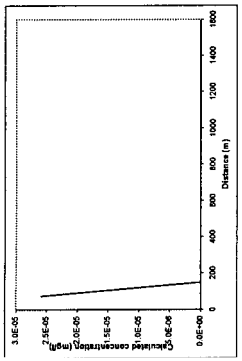
Specify dispersivity (1), or each after Xu & Eckstein (2) 2.00

Longitudinal dispersivity α_L 1.35E+01 m

Transverse dispersivity α_T 1.35E+00 m

Vertical dispersivity α_V 1.35E-01 m

For calculated value, assumes α = 0.1 * x, α_T = 0.01 * x, α_V = 0.001 * x
Xu & Eckstein (1999) report α = 0.02(d₀/d)^{0.5}, α_T = α_L/10, α_V = α_L/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An additional graph is available for two-way vertical dispersion. The depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier 3 remedial target for groundwater, based on the distance to the receptor or compliance location down hydraulic gradient of the aquifer. The remedial target is calculated based on the measured groundwater concentration. By setting a long travel time and the steady state solution, which should be used to calculate remedial targets. The measured groundwater concentration should be compared with the Tier 3 remedial target to determine the need for further action.

Site being assessed: BISS Area 1 RIS
Prepared by: [Redacted]
Date: 24.11.2005
Version: 1.1

Tier 3 -Groundwater



Input Parameters(using pull down menu) Variable Value Unit Sours.

Contaminant Target Concentration C_T Phosphorus 2.20E+00 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	1.03E+00	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate λ	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.90E+023	m	
Plume thickness at source Sy	1.00E+011	m	
Saturated aquifer thickness da	1.0E+011	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	9.80E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.50E+03	m	
Distance (lateral) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity ax	13.510	m	see options
Transverse dispersivity az	1.351	m	see options
Vertical dispersivity ay	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.77E-01	m/d
Retardation factor Rf	1.00E+00	fraction
Decay rate used λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation u	3.77E-01	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{E0}	3.39E-01	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{E2}	1.75E-01	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{E0}) AF	3.04E+00	
Attenuation factor (two way vertical dispersion, C_0/C_{E2}) AF	5.90E+00	

Remedial Targets

Remedial Target	LYC3	6.89E+00	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		1600	m	
Concentration of contaminant at compliance point	C_{E0}/C_0	3.39E-01	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer

Organic carbon partition coefficient

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

Sorption coefficient for ionised species

pH value

acid dissociation constant

Soil water partition coefficient

Dispersivity

Calculate dependent on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

Transverse dispersivity

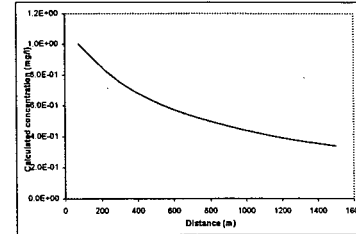
Vertical dispersivity

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

Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{1.15}$; $az = az/10$, $ay = ay/100$ are assumed

Kd		l/kg
foc	1.00E+00	fraction
Koc	0.00E+00	l/kg
K_{ow}		l/kg
K_{ow}		l/kg
pH		
pKa		
Kd	0.00E+00	l/kg

Enter value	Calc value Xu & Eckstein	Unit
	1.35E+01	m
	1.35E+00	m
	1.35E-01	m



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

76.0	1.0E+00
160.0	9.1E-01
225.0	8.2E-01
300.0	7.6E-01
376.0	7.0E-01
460.0	6.6E-01
626.0	6.1E-01
600.0	6.7E-01
676.0	6.4E-01
760.0	6.1E-01
826.0	4.9E-01
900.0	4.7E-01
976.0	4.6E-01
1060.0	4.3E-01
1126.0	4.1E-01
1200.0	3.9E-01
1276.0	3.8E-01
1360.0	3.6E-01
1426.0	3.6E-01
1500.0	3.4E-01

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

This sheet calculates the Tier3 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

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 Tier 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.

Site being assessed: Bress Area 1 Res
 Completed by: AJ
 Date: 24.11.2005
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a



Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Pyrene
Target Concentration C_T 6.25E-06 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	5.00E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.90E+03	days	
Calculated decay rate λ	1.82E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.90E+02	m	
Plume thickness at source Sy	1.00E+01	m	
Saturated aquifer thickness da	1.08E+01	m	
Bulk density of aquifer materials ρ	2.170E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	9.80E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.50E+03	m	
Distance (latera) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	1.38E+02	l/kg	see options
Longitudinal dispersivity ax	13.510	m	see options
Transverse dispersivity az	1.351	m	see options
Vertical dispersivity ay	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.77E-01	m/d
Retardation factor Rf	1.29E+03	fraction
Decay rate used λ	1.82E-04	d ⁻¹
Rate of contaminant flow due to retardation u	2.92E-04	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	2.00E-119	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	1.03E-119	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	3.00E+118	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	5.82E+118	

Remedial Targets

Remedial Target	LYCS	1.99E+13	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1600	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	2.00E-119	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd 1.38E+02 l/kg
 Soil water partition coefficient
 Entry for non-polar organic chemicals (option) foc 1.00E+00 fraction
 Fraction of organic carbon in aquifer
 Organic carbon partition coefficient Koc 1.38E+02 l/kg
 Entry for ionic organic chemicals (option) Kow l/kg
 Sorption coefficient for related species
 Sorption coefficient for ionized species Kow_i l/kg
 pH value
 acid dissociation constant pKa

Soil water partition coefficient Kd 1.38E+02 l/kg

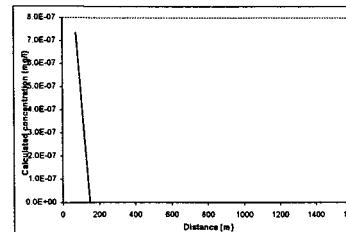
Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity ax	1.35E+01 m
Transverse dispersivity az	1.35E+00 m
Vertical dispersivity ay	1.35E-01 m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * z$, $ay = 0.001 * y$
 Xu & Eckstein (1995) report $ax = 0.83(\log_{10} K_{ow})^{0.5}$; $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

From calculation sheet
 Distance Concentration

Distance	Concentration
0	76.0
100	7.4E-07
200	150.0
300	6.4E-13
400	225.0
500	3.0E-19
600	300.0
700	1.1E-24
800	376.0
900	1.3E-30
1000	450.0
1100	1.5E-36
1200	626.0
1300	1.8E-42
1400	1000.0
1500	2.1E-48
1600	875.0
1700	2.6E-54
1800	760.0
1900	3.0E-60
2000	825.0
2100	3.8E-66
2200	900.0
2300	4.3E-72
2400	976.0
2500	5.2E-78
2600	1060.0
2700	6.3E-84
2800	1126.0
2900	7.6E-90
3000	1200.0
3100	9.2E-96
3200	1276.0
3300	1.1E-101
3400	1360.0
3500	1.4E-107
3600	1426.0
3700	1.6E-113
3800	1600.0
3900	2.0E-119

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Boss Aica 1 Ros
 Completed by: AJ
 Date: 24/11/2005
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 -Groundwater



Input Parameters(using cull down menu) Variable Value Unit Source

Contaminant	Selenium		
Target Concentration	C _T	1.00E-02	mg/l

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

Ogata Banks	Equations in R&D Pub. 20
-------------	--------------------------

Enter 1 to simulate vertical dispersion in one direction, 2 for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	2.00E-03	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m	
Plume thickness at source	Sy	1.10E+01	m	
Saturated aquifer thickness	da	1.08E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	9.80E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.50E+03	m	
Distance (latera) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	9.55E+00	l/kg	see options
Longitudinal dispersivity	ax	13.510	m	see options
Transverse dispersivity	az	1.351	m	see options
Vertical dispersivity	ay	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	9.02E+01	fraction
Decay rate used	λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation	U	4.18E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	6.58E-04	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	3.39E-04	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	3.04E+00	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	6.90E+00	

Remedial Targets

Remedial Target	LYC3	3.04E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1500	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	6.68E-04	mg/l	Ogata Banks
	after	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

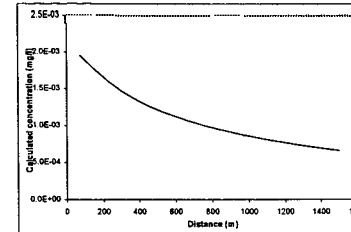
Entry if specify partition coefficient (option)	Kd	9.55E+00	l/kg
Soil water partition coefficient			
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer			
Organic carbon partition coefficient	Koc	9.55E+00	l/kg
Entry for ionic organic chemicals (option)	K _{ow}		
Sorption coefficient for related species	K _{ow}		
Sorption coefficient for ionised species	K _{ow}		
pH value	pH		
acid dissociation constant	pKa		

Soil water partition coefficient Kd 9.55E+00 l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	az		1.35E+00 m
Vertical dispersivity	ay		1.35E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report az = 0.83(log₁₀ax)^{0.5}; az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
76.0	1.9E-03
160.0	1.8E-03
226.0	1.6E-03
3W.0	1.6E-03
376.0	1.4E-03
460.0	1.3E-03
826.0	1.2E-03
900.0	1.1E-03
176.0	1.1E-03
760.0	1.0E-03
826.0	9.5E-04
900.0	9.1E-04
976.0	8.7E-04
1060.0	8.3E-04
1126.0	7.9E-04
1200.0	7.6E-04
1276.0	7.3E-04
1360.0	7.1E-04
1600.0	6.6E-04

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Bless Area 1 Res
Completed by: AJ
Date: 24 11 2005
Version: 11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Strontium
Target Concentration	C _T 1.00E+00 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core	C ₀	4.90E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m	
Plume thickness at source	Sy	1.00E+01	m	
Saturated aquifer thickness	da	1.08E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	9.80E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.50E+03	m	
Distance (laterally) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	13.51	m	see options
Transverse dispersivity	az	1.351	m	see options
Vertical dispersivity	ay	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation	u	3.77E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	1.61E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	8.31E-02	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	3.04E+00	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	5.90E+00	

Remedial Targets

Remedial Target LTCS 3.04E+00 mg/l For comparison with measured groundwater concentration.

Distance to compliance point	1500	m
Concentration of contaminant at compliance point	C _{1D} /C ₀	1.61E-01 mg/l
after	9.9E+99	days

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

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

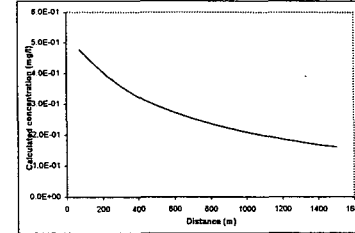
Calculate for non-polar organic chemicals

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

Dispersivity Calculate dependent on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity	ax	1.35E+01 m
Transverse dispersivity	az	1.35E+00 m
Vertical dispersivity	ay	1.35E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * z, ay = 0.001 * y
Xu & Eckstein (1995) report ax = 0.83(log₁₀d)^{0.41}, az = az/10, ay = ay/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
	mg/l
75.0	4.8E-01
150.0	3.9E-01
225.0	3.6E-01
300.0	3.3E-01
375.0	3.1E-01
450.0	2.9E-01
525.0	2.8E-01
600.0	2.7E-01
675.0	2.6E-01
750.0	2.5E-01
825.0	2.4E-01
900.0	2.3E-01
975.0	2.2E-01
1050.0	2.1E-01
1125.0	2.0E-01
1200.0	1.9E-01
1275.0	1.8E-01
1350.0	1.7E-01
1425.0	1.7E-01
1500.0	1.6E-01

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

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bess Area 1 Res
Completed by: AJ
Date: 24 11 2005
Version: 11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value unit Source

Contaminant Sulphate
Target Concentration C_T 2.00E+02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C_0	4.20E+01	mg/l	Source of parameter value
Half life for degradation of contaminant in water		9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	SZ	1.90E+02	m	
Plume thickness at source	Sy	1.00E+01	m	
Saturated aquifer thickness	da	1.00E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	i	1.82E-01	fraction	
Hydraulic gradient	i	9.85E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.50E+03	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	13.510	m	see options
Transverse dispersivity	az	1.351	m	see options
Vertical dispersivity	ay	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation	u	3.77E-01	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion	C_{1D}	1.38E+01	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion	C_{2D}	7.12E+00	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D})	AF	3.04E+00	
Attenuation factor (two way vertical dispersion, C_0/C_{2D})	AF	5.89E+00	

Remedial Targets

Remedial Target	LTC3	0.09E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1600	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	1.38E+01	mg/l	Ogata Banks
after		9.9E+99	days	

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

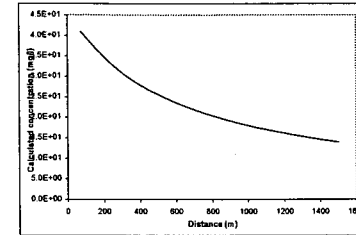
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)	f_{oc}	1.00E+00	fraction
Fraction of organic carbon in aquifer	K_{oc}	0.00E+00	l/kg
Organic carbon partition coefficient	K_{ow}		l/kg
Entry for ionic organic chemicals (option)	K_{ow}		l/kg
Sorption coefficient for related species	pH		
Sorption coefficient for ionised species	pKa		
pH value			
acid dissociation constant			
Soil water partition coefficient	Kd	0.00E+00	l/kg

Dispersivity			
Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	1.35E+01	m
Transverse dispersivity	az	1.35E+00	m
Vertical dispersivity	ay	1.35E-01	m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$
Xu & Eckstein (1995) report $ax = 0.83(\log_{10} t)^{0.44}$; $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks			
From calculation sheet			
Distance	Concentration		mg/l
		75.0	4.1E+01
		150.0	3.7E+01
		225.0	3.4E+01
		300.0	3.1E+01
		375.0	2.8E+01
		450.0	2.7E+01
		600.0	2.6E+01
		975.0	2.3E+01
		1275.0	2.1E+01
		1350.0	2.0E+01
		1425.0	1.9E+01
		1500.0	1.8E+01
		1600.0	1.7E+01
		1600.0	1.6E+01
		1600.0	1.5E+01
		1600.0	1.4E+01

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

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor of 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 Tier 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.

Site being assessed: Bess Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a
Tier 3 -Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: tert Butylbenzene
Target Concentration: C_T 1.00E-03 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core C₀ 9.90E-99 mg/l
Half life for degradation of contaminant in water t_{1/2} 9.99E+99 days
Calculated decay rate λ 6.94E-101 days⁻¹
Width of plume in aquifer at source (perpendicular to flow) Sz 1.90E+02 m
Plume thickness at source Sy 3.10E+01 m
Saturated aquifer thickness da 1.00E+01 m
Bulk density of aquifer materials ρ 1.70E+00 g/cm³
Effective porosity of aquifer n 1.82E-01 fraction
Hydraulic gradient i 9.80E-03 fraction
Hydraulic conductivity of aquifer K 7.00E+00 m/d
Distance to compliance point x 1.50E+03 m
Distance (lateral) to compliance point perpendicular to flow direction z 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction y 0.00E+00 m
Time since pollutant entered groundwater t 9.80E+99 days

Parameters values determined from options
Partition coefficient Kd 2.14E-01 W/g see options
Longitudinal dispersivity ax 13510 m see options
Transverse dispersivity az m see options
Vertical dispersivity ay 0.135 m see options

Calculated Parameters Variable

Groundwater flow velocity v 3.77E-01 m/d
Retardation factor Rf 3.00E+00 fraction
Decay rate used λ 6.94E-101 d⁻¹
Rate of contaminant flow due to retardation u 1.26E-01 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C_{EO} 3.26E-99 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C_{ED} 1.66E-99 mg/l
Attenuation factor (one way vertical dispersion, C₀/C_{ED}) AF 3.04E+00
Attenuation factor (two way vertical dispersion, C₀/C_{ED}) AF 6.90E+00

Remedial Targets	Remedial Target	LTC3	3.04E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks					
Distance to compliance point		1600		m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	3.26E-99		mg/l	Ogata Banks
	after	9.9E+99		days	

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

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

Calculate for non-polar organic chemicals

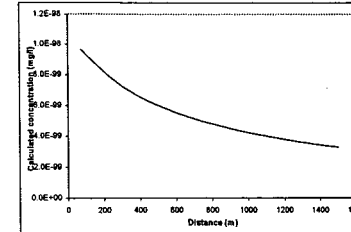
Entry if specify partition coefficient (option) Kd
Soil water partition coefficient Kd 2.14E-01 W/g
Entry for non-polar organic chemicals (option) f_{oc} 1.00E+00 fraction
Fraction of organic carbon in aquifer f_{oc} 2.14E-01 W/g
Organic carbon partition coefficient K_{oc} 2.14E-01 W/g
Entry for ionic organic chemicals (option) K_{ow}
Sorption coefficient for related species K_{ow}
Sorption coefficient for ionised species K_{ow}
pH value pH
acid dissociation constant pKa

Soil water partition coefficient Kd 2.14E-01 W/g

Dispersivity Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax 1.35E+01 m
Transverse dispersivity az 1.35E+00 m
Vertical dispersivity ay 1.35E-01 m

For calculated value, assume ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀ t)^{0.433}; az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

76.0 9.8E-99
170.0 8.7E-99
226.0 7.9E-99
300.0 7.3E-99
376.0 6.7E-99
460.0 6.3E-99
626.0 5.9E-99

506.0 5.5E-99
760.0 4.9E-99
826.0 4.7E-99
900.0 4.5E-99
976.0 4.3E-99
1060.0 4.1E-99
1126.0 3.9E-99
1200.0 3.8E-99
1276.0 3.6E-99
1360.0 3.5E-99
1426.0 3.4E-99
1600.0 3.3E-99

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

This sheet calculates the Tier3 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

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 Tier 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.

Site being assessed: Bliss Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Aliphatic C8-C10
Target Concentration C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	9.90E-09	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.83E+03	days	
Calculated decay rate λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) S_z	1.90E+02	m	
Plume thickness at source S_y	1.00E+01	m	
Saturated aquifer thickness d_a	1.08E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	9.80E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.50E+03	m	
Distance (laterally) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient K_d	1.15E+02	V/kg	see options
Longitudinal dispersivity α_x	13.510	m	see options
Transverse dispersivity α_z	1.351	m	see options
Vertical dispersivity α_y	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.77E-01	m/d
Retardation factor R_f	1.07E+03	fraction
Decay rate used λ	3.80E-04	days ⁻¹
Rate of contaminant flow due to retardation u	3.51E-04	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{e0}	5.47E-261	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{e2}	2.82E-261	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{e0}) AF	1.81E+162	
Attenuation factor (two way vertical dispersion, C_0/C_{e2}) AF	3.51E+162	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	1.29E+163	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	1500	m	
Concentration of contaminant at compliance point	5.47E-261	mg/l	Ogata Banks
after	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

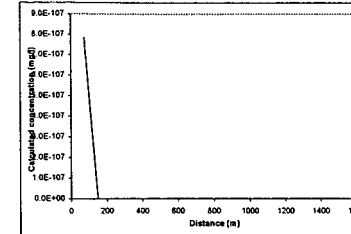
Entry if specify partition coefficient (option)
Soil water partition coefficient K_d 1.15E+02 V/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 1.15E+02 V/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow} V/kg
Sorption coefficient for ionised species K_{ow} V/kg
pH value
acid dissociation constant pK_a V/kg

Soil water partition coefficient K_d 1.15E+02 V/kg

Dispersivity
Calculate dependent on distance to compliance point (0)
specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity α_x Enter value Calc value Xu & Eckstein 1.35E+01 m
Transverse dispersivity α_z 1.35E+00 m
Vertical dispersivity α_y 1.35E-01 m

For calculated value, assumes $\alpha_x = 0.1 * x$, $\alpha_z = 0.01 * x$, $\alpha_y = 0.001 * x$
Xu & Eckstein (1995) report $\alpha_z = 0.83(\log_{10} C)^{0.5}$; $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks Distance Concentration

Distance (m)	Concentration (mg/l)
76.0	7.9E-107
160.0	6.8E-116
226.0	4.3E-123
300.0	3.2E-131
376.0	2.4E-139
450.0	1.8E-147
626.0	1.4E-155
600.0	1.1E-163
676.0	8.3E-172
760.0	6.4E-180
826.0	6.0E-188
900.0	3.9E-196
176.0	3.0E-204
1060.0	2.3E-212
1126.0	1.8E-220
1200.0	1.4E-228
1276.0	1.1E-236
1160.0	8.8E-244
1426.0	7.0E-253
1500.0	6.6E-261

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bloss Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull-down menu) Variable Value Unit Source

Contaminant: Aliphatic C10-C12
Target Concentration: 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull-down menu): 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull-down menu): 0

Initial contaminant concentration in groundwater at plume core	C ₀	9.90E-09	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	1.83E+03	days	
Calculated decay rate	λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	3.190E+02	m	
Plume thickness at source	Sy	1.00E+01	m	
Saturated aquifer thickness	da	1.08E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	9.80E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.50E+03	m	
Distance (laterally) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+09	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	9.12E+02	l/kg	see options
Longitudinal dispersivity	ax	13.510	m	see options
Transverse dispersivity	az	1.351	m	see options
Vertical dispersivity	ay	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	8.52E+03	fraction
Decay rate used	λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	4.43E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	#NUM!	

Remedial Targets

Remedial Target	LTCS	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1600	m		
Concentration of contaminant at compliance point	C _{1D} /C ₀	#NUM!	mg/l	Ogata Banks
after	9.9E+09	days		

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+09.

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

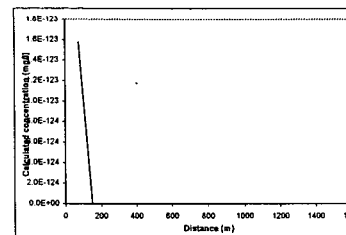
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	9.12E+02	l/kg
Organic carbon partition coefficient	K _{ow}		l/kg
Entry for ionic organic chemicals (option)	K _{ow}		l/kg
Sorption coefficient for related species	pH		
Sorption coefficient for ionised species	pKa		
pH value	Kd	9.12E+02	l/kg
acid dissociation constant			
Soil water partition coefficient	Kd	9.12E+02	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2		
Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	az		1.35E+01 m
Vertical dispersivity	ay		1.35E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀d^{0.15}); az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

75.0	1.6E-123
160.0	2.4E-148
225.0	3.5E-173
300.0	5.2E-198
176.0	7.9E-223
450.0	1.2E-247
625.0	1.9E-272
600.0	2.9E-297
676.0	0.0E+00
760.0	0.0E+00
825.0	0.0E+00
900.0	#NUM!
975.0	#NUM!
1050.0	#NUM!
1126.0	#NUM!
1200.0	#NUM!
1276.0	#NUM!
1350.0	#NUM!
1126.0	#NUM!
1500.0	#NUM!

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.

This sheet calculates the Tier3 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 Tier 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+09.

Site being assessed: Boss Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source
 Contaminant Methylc C12-C16 mg/l C_T 7.14E-04 mg/l
 Target Concentration C_T 7.14E-04 mg/l
 Select analytical solution (click on brown cell below, then on pull-down menu) Equations in R&D Pub. 20
 Enter 1 to simulate vertical dispersion in one direction, "Z" for two directions (pull down menu) 1
 Enter 1 if degradation rate is for the substance in water.
 If 0 rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0
 Source of parameter value

Initial contaminant concentration in groundwater at plume core C₀ 3.47E-02 mg/l
 Half life for degradation of contaminant in water t_{1/2} 1.83E+03 days
 Calculated decay rate λ 3.80E-04 days⁻¹
 Width of plume in aquifer at source (perpendicular to flow) S_Y 1.90E+02 m
 Plume thickness at source S_Y 1.00E+01 m
 Saturated aquifer thickness d_a 1.00E+01 m
 Bulk density of aquifer materials ρ 1.82E+03 g/cm³
 Effective porosity of aquifer n 0.35
 Hydraulic gradient i 1.82E-01 fraction
 Hydraulic conductivity of aquifer K 7.00E+00 m/d
 Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Z 0.00E+00 m
 Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Distance (depth) to compliance point perpendicular to flow direction Z 0.00E+00 m
 Distance to compliance point perpendicular to flow direction Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Distance (depth) to compliance point perpendicular to flow direction Z 0.00E+00 m
 Distance to compliance point perpendicular to flow direction Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

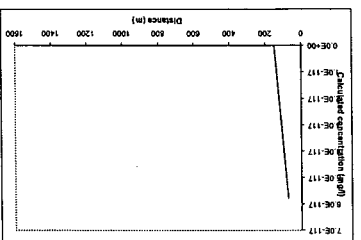
Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Distance (depth) to compliance point perpendicular to flow direction Z 0.00E+00 m
 Distance to compliance point perpendicular to flow direction Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Distance (depth) to compliance point perpendicular to flow direction Z 0.00E+00 m
 Distance to compliance point perpendicular to flow direction Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Distance (depth) to compliance point perpendicular to flow direction Z 0.00E+00 m
 Distance to compliance point perpendicular to flow direction Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Distance (depth) to compliance point perpendicular to flow direction Z 0.00E+00 m
 Distance to compliance point perpendicular to flow direction Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Distance to compliance point perpendicular to flow direction X 1.50E+03 m
 Distance (depth) to compliance point perpendicular to flow direction Z 0.00E+00 m
 Distance to compliance point perpendicular to flow direction Y 0.00E+00 m
 Terms above pollutant entered from options
 Parameters values determined from options
 Partition coefficient K_D 1.82E+04 kg
 Longitudinal dispersivity α_X 13.510 m
 Transverse dispersivity α_Y 0.135 m
 Vertical dispersivity α_Z 0.135 m
 Calculated Parameters Variable
 Groundwater flow velocity V 3.77E-01 m/d
 Retardation factor R_f 1.70E+05 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation U 2.22E-06 m/d
 Contaminant concentration at distance X, assuming one-way vertical dispersion C₀ #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C₀/C_x) A_F #NUM!
 Attenuation factor (two way vertical dispersion, C₀/C₀) A_F #NUM!
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.



Calculated concentrations for distance-concentration graph
 Ogate Banks
 From calculation sheet
 Distance Concentration
 7.0E-17 mg/l
 6.5E-17 mg/l
 6.0E-17 mg/l
 5.5E-17 mg/l
 5.0E-17 mg/l
 4.5E-17 mg/l
 4.0E-17 mg/l
 3.5E-17 mg/l
 3.0E-17 mg/l
 2.5E-17 mg/l
 2.0E-17 mg/l
 1.5E-17 mg/l
 1.0E-17 mg/l
 5.0E-17 mg/l
 0.0E+00 mg/l

Select Method for deriving Partition Coefficient (using pull down menu) Calculate for non-polar organic chemicals
 Enter 1 if apathy partition coefficient (option) K_D 1.00E+00 fraction
 Enter 2 for polar organic chemicals (option) K_D 1.82E+04 fraction
 Enter for non-polar organic chemicals (option) K_D 1.82E+04 fraction
 Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
 Organic carbon partition coefficient K_{oc} 1.82E+04 kg/kg
 Dispersion coefficient for retarded species K_{ac} #NUM!
 pH value pH #NUM!
 acid dissociation constant pK_a #NUM!
 Soil water partition coefficient K_D 1.82E+04 kg/kg
 Dispersivity α 2
 Calculate dependent on distance to compliance point (D) 2
 Enter value Calc value Xu & Eckstein (2) 7
 Longitudinal dispersivity α_X 13.5E+01 m
 Vertical dispersivity α_Y 1.35E-01 m
 Vertical dispersivity α_Z 1.35E-01 m
 For calculated value, assumes α_X = 0.1, α_Z = 0.01, α_Y = 0.001, X_u & Eckstein (1995) report α_X = 0.53(log₁₀α_X)^{0.7}, α_Z = α_Y/10, α_Y = α_X/100 are assumed
 This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance location hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata. 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 Tier 2 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.

Remedial Targets
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.
 Distance to compliance point 1600 m
 Concentration of contaminant at compliance point after C_{pl}CD #NUM! mg/l Ogata Banks
 C_{pl}CD 9.9E+99 days
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.
 Distance to compliance point 1600 m
 Concentration of contaminant at compliance point after C_{pl}CD #NUM! mg/l Ogata Banks
 C_{pl}CD 9.9E+99 days
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Remedial Targets
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.
 Distance to compliance point 1600 m
 Concentration of contaminant at compliance point after C_{pl}CD #NUM! mg/l Ogata Banks
 C_{pl}CD 9.9E+99 days
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Remedial Targets
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.
 Distance to compliance point 1600 m
 Concentration of contaminant at compliance point after C_{pl}CD #NUM! mg/l Ogata Banks
 C_{pl}CD 9.9E+99 days
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.

Remedial Targets
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.
 Distance to compliance point 1600 m
 Concentration of contaminant at compliance point after C_{pl}CD #NUM! mg/l Ogata Banks
 C_{pl}CD 9.9E+99 days
 Remedial Target TIC3 #NUM! mg/l
 Remedial Target TIC3 #NUM! mg/l
 For comparison with measured groundwater concentration.



R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aliphatic C16-C21
Target Concentration: 7.14E-04 mg/l

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

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu): 1
Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu): 0

Initial contaminant concentration in groundwater at plume core: 3.47E-02 mg/l
Half life for degradation of contaminant in water: 3.65E+03 days
Calculated decay rate: 1.90E-04 days⁻¹
Width of plume in aquifer at source (perpendicular to flow): 1.90E+02 m
Plume thickness at source: 1.00E+01 m
Saturated aquifer thickness: 1.28E+01 m
Bulk density of aquifer materials: 1.70E+00 g/cm³
Effective porosity of aquifer: 1.82E-01 fraction
Hydraulic gradient: 9.80E-03 fraction
Hydraulic conductivity of aquifer: 7.00E+00 m/d
Distance to compliance point: 1.50E+03 m
Distance (lateral) to compliance point perpendicular to flow direction: 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction: 0.00E+00 m
Time since pollutant entered groundwater: 9.90E+99 days

Parameters values determined from options:
Partition coefficient: 2.29E+06 V/kg
Longitudinal dispersivity: 13.510 m
Transverse dispersivity: 1.351 m
Vertical dispersivity: 0.135 m

Calculated Parameters

Groundwater flow velocity: 3.77E-01 m/d
Retardation factor: 2.14E+07 fraction
Decay rate used: 1.90E-04 d⁻¹
Rate of contaminant flow due to retardation: 1.76E-08 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion: #NUM!
Contaminant concentration at distance x, assuming two-way vertical dispersion: #NUM!
Attenuation factor (one way vertical dispersion, C₀/C_x): #NUM!
Attenuation factor (two way vertical dispersion, C₀/C_x): #NUM!

Remedial Targets

Remedial Target	LTCS	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1600	m		
Concentration of contaminant at compliance point	C ₀ /C ₀	#NUM!	mg/l	Ogata Banks
after		9.9E+99	days	

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

Select Method for deriving Partition Co-efficient (using pull down menu): Calculate for non-polar organic chemicals

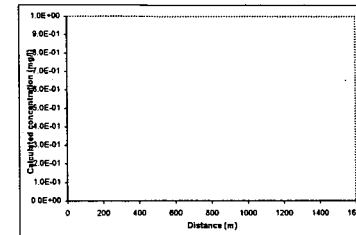
Soil water partition coefficient: K_d 2.29E+06 V/kg
Entry for non-polar organic chemicals (option): f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient: K_{oc} 2.29E+06 V/kg
Entry for ionic organic chemicals (option): K_{ow} #NUM!
Sorption coefficient for related species: K_{ow} #NUM!
Sorption coefficient for ionised species: K_{ow} #NUM!
pH value: pH #NUM!
acid dissociation constant: pKa #NUM!

Soil water partition coefficient: K_d 2.29E+06 V/kg

Dispersivity: Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2): 2

Longitudinal dispersivity: ax 1.35E+01 m
Transverse dispersivity: az 1.35E+00 m
Vertical dispersivity: ay 1.35E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀ x)^{0.433}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

mg/l
75.0 #NUM!
160.0 #NUM!
225.0 #NUM!
300.0 #NUM!
375.0 #NUM!
450.0 #NUM!
625.0 #NUM!
600.0 #NUM!
875.0 #NUM!
750.0 #NUM!
825.0 #NUM!
900.0 #NUM!
975.0 #NUM!
1050.0 #NUM!
1125.0 #NUM!
1200.0 #NUM!
1275.0 #NUM!
1350.0 #NUM!
1425.0 #NUM!
1500.0 #NUM!

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.

This sheet calculates the Tier3 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

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 Tier 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.

Site being assessed: Bliss Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Aliphatic C21-C35
Target Concentration C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	3.47E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	3.65E+03	days	
Calculated decay rate	λ	1.90E-04	d ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m	
Plume thickness at source	Sy	1.00E+01	m	
Saturated aquifer thickness	da	1.08E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	9.80E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.50E+03	m	
Distance (latera) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	2.29E+06	l/kg	see options
Longitudinal dispersivity	ax	13.510	m	see options
Transverse dispersivity	ay	1.351	m	see options
Vertical dispersivity	az	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	1.76E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{2D}	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{3D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C _{2D} /C ₀)	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C _{3D} /C ₀)	AF	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1500	m	
Concentration of contaminant at compliance point	C _{2D} /C ₀	#NUM!	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

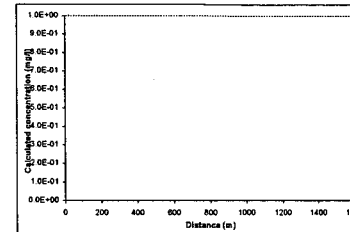
Entry if apicity partition coefficient (option) Kd
Soil water partition coefficient Kd 2.29E+06 l/kg
Entry for non-polar organic chemicals (option) f_{oc} 1.00E+00 fraction
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 2.29E+06 l/kg
Entry for ionic organic chemicals (option) K_{ow}
Sorption coefficient for related species K_{ow}
Sorption coefficient for ionised species K_{ow}
pH value pH
acid dissociation constant pKa

Soil water partition coefficient Kd 2.29E+06 l/kg

Dispersivity Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein	1.35E+01	m
Transverse dispersivity	ay			1.35E+00	m
Vertical dispersivity	az			1.35E-01	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x, ax100, ay = ax100 are assumed
Xu & Eckstein (1995) report ax = 0.83(log₁₀t)^{0.5}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

	mg/l
75.0	#NUM!
150.0	#NUM!
225.0	#NUM!
300.0	#NUM!
375.0	#NUM!
450.0	#NUM!
525.0	#NUM!
600.0	#NUM!
675.0	#NUM!
750.0	#NUM!
825.0	#NUM!
900.0	#NUM!
975.0	#NUM!
1050.0	#NUM!
1125.0	#NUM!
1200.0	#NUM!
1275.0	#NUM!
1350.0	#NUM!
1425.0	#NUM!
1500.0	#NUM!

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Eriss Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Ammoniacal Nitrogen as Nitrate
Target Concentration: 1.20E+01 mg/l

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

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	6.40E+00	mg/l	
Half life for degradation of contaminant in water	2.19E+03	days	
Calculated decay rate	3.17E-04	day ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	1.00E+02	m	
Plume thickness at source	1.00E+01	m	
Saturated aquifer thickness	1.08E+01	m	
Bulk density of aquifer materials	1.70E+01	g/cm ³	
Effective porosity of aquifer	1.82E-01	fraction	
Hydraulic gradient	8.80E-03	fraction	
Hydraulic conductivity of aquifer	7.00E+00	m/d	
Distance (lateral) to compliance point	1.50E+03	m	
Distance (lateral) to compliance point perpendicular to flow direction	1.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	1.00E+00	m	
Time since pollutant entered groundwater	9.90E+99	days	time variant options only
Partition coefficient	5.00E-01	l/kg	see options
Longitudinal dispersivity	13.510	m	see options
Transverse dispersivity	1.351	m	see options
Vertical dispersivity	0.135	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.77E-01	m/d
Retardation factor	Rf	5.67E+00	fraction
Decay rate used	λ	3.17E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	6.65E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	2.51E-03	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	1.29E-03	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	2.55E+03	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	4.86E+03	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target	LTC3	3.07E+02	mg/l
Distance to compliance point	1600	m	Ogata Banks
Concentration of contaminant at compliance point	2.61E-03	mg/l	Ogata Banks
Time after	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd 5.00E-01 l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer foc 1.00E+00 fraction
Organic carbon partition coefficient Koc 5.00E-01 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow} 1 l/kg
Sorption coefficient for ionised species K_{oc} 1 l/kg
pH value
acid dissociation constant pKa 1 l/kg

Soil water partition coefficient Kd 5.00E-01 l/kg

Dispersivity

Calculates dependent on distance to compliance point (D), specify dispersivity (1), or calc after Xu & Eckstein (2)?

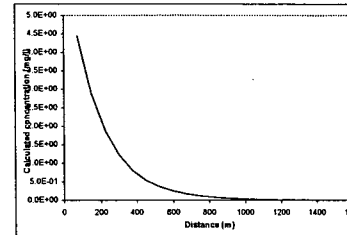
Longitudinal dispersivity ax 1.35E+01 m

Transverse dispersivity az 1.35E+00 m

Vertical dispersivity ay 1.35E-01 m

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

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.75}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Output/Calculation sheet

Distance Concentration

Distance	Concentration	mg/l
75.0	4.6E+00	
160.0	2.9E+00	
225.0	1.9E+00	
300.0	1.2E+00	
375.0	8.1E-01	
450.0	6.4E-01	
525.0	1.5E-01	
600.0	2.4E-01	
675.0	1.6E-01	
750.0	1.1E-01	
825.0	7.6E-02	
900.0	5.1E-02	
975.0	3.5E-02	
1050.0	2.4E-02	
1125.0	1.6E-02	
1200.0	1.1E-02	
1275.0	7.7E-03	
1350.0	5.3E-03	
1425.0	3.5E-03	
1500.0	2.5E-03	

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bless Area 1 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

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RBD Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T Aliphatic C16-C21 7.14E-04 mg/l

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

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water,

'2' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 2

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	9.90E+99	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.63E+03	days	
Calculated decay rate λ	1.90E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) S_z	8.00E+01	m	
Plume thickness at source S_y	2.10E+01	m	
Saturated aquifer thickness d_a	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance (latera) to compliance point x	1.70E+03	m	
Distance (depth) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient K_d	2.29E+06	l/kg	see options
Longitudinal dispersivity α_x	14.075	m	see options
Transverse dispersivity α_z	1.407	m	see options
Vertical dispersivity α_y	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor R_f	2.14E+07	fraction
Decay rate used λ	1.90E-04	d ⁻¹
Rate of contaminant flow due to retardation u	1.83E-08	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	#NUM!	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	#NUM!	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	#NUM!	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	1.70E+03	m	
Distance to compliance point	1700	m	
Concentration of contaminant at compliance point after C_{1D}/C_0	#NUM!	mg/l	Ogata Banks
	9.9E+99	days	

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

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

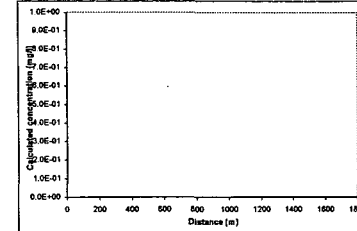
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Soil water partition coefficient K_d 2.29E+06 l/kg
 Entry for non-polar organic chemicals (option) Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
 Organic carbon partition coefficient K_{oc} 2.29E+06 l/kg
 Entry for ionic organic chemicals (option) Sorption coefficient for related species K_{ow} l/kg
 Sorption coefficient for ionised species K_{ow} l/kg
 pH value pH
 acid dissociation constant pKa

Dispersivity Calculate dependent on distance to compliance point (0), specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity α_x 1.41E+01 m
 Transverse dispersivity α_z 1.41E+00 m
 Vertical dispersivity α_y 1.41E-01 m

For calculated value, assumes $\alpha_x = 0.1 \cdot x$, $\alpha_z = 0.01 \cdot x$, $\alpha_y = 0.001 \cdot x$
 Xu & Eckstein (1995) report $\alpha_x = 0.63(\log_{10} x)^{0.4}$, $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
 From calculation sheet
 Distance Concentration

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.

This sheet calculates the Tier3 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

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 Tier 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.

Site being assessed: Bless Area 4 Res
 Completed by: AJ
 Date: 24 11 2005
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Alliphatic C21-C35
Target Concentration C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core	C ₀	9.90E-99	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	3.85E+03	days	
Calculated decay rate	λ	1.90E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	2.10E+01	m	
Saturated aquifer thickness	da	2.17E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.02E-02	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.70E+03	m	
Distance (laterally) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
<i>Parameters values determined from options</i>				
Partition coefficient	Kd	2.29E+06	l/kg	see options
Longitudinal dispersivity	ax	14.075	m	see options
Transverse dispersivity	az	1.407	m	see options
Vertical dispersivity	ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.92E-01	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	1.83E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C _T)	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C _{2D} /C _T)	AF	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point after	C _{1D} /C ₀	#NUM!	mg/l	Ogata Banks
	after	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd 2.29E+06 l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer foc 1.00E+00 fraction
Organic carbon partition coefficient Koc 2.29E+06 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{oc, i}
Sorption coefficient for ionised species K_{oc, i} l/kg
pH value
acid dissociation constant pKa

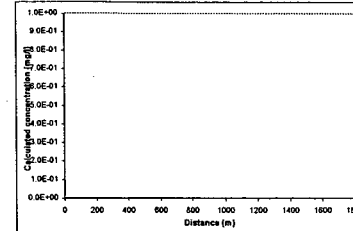
Soil water partition coefficient Kd 2.29E+06 l/kg

Dispersivity

Calculate dependant on distance to compliance point (0), specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity ax 1.41E+01 m
Transverse dispersivity az 1.41E+00 m
Vertical dispersivity ay 1.41E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀y)^{0.433}; az = ax/10, ay = ay/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
85.0	#NUM!
170.0	#NUM!
266.0	#NUM!
340.0	#NUM!
426.0	#NUM!
510.0	#NUM!
595.0	#NUM!
680.0	#NUM!
766.0	#NUM!
850.0	#NUM!

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bkts Area 4 Res
Completed by: AJ
Date: 24 11 2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Ammoniacal Nitrogen as
Target Concentration: C_T 1.20E-01 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	5.50E+01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	2.19E+03	days	
Calculated decay rate λ	3.17E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E+01	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness da	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (lateral) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	5.00E-01	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	5.67E+00	fraction
Decay rate used λ	3.17E-04	d ⁻¹
Rate of contaminant flow due to retardation u	6.92E-02	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	1.04E-02	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	5.80E-03	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	5.28E+03	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	9.49E+03	

Remedial Targets

Remedial Target	LTC3	6.33E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	1.04E-02	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd 5.00E-01 l/kg
Soil water partition coefficient
Entry for non-polar organic chemicals (option) foc 1.00E+00 fraction
Fraction of organic carbon in aquifer
Organic carbon partition coefficient Koc 5.00E-01 l/kg
Entry for ionic organic chemicals (option) K_{ow} l/kg
Sorption coefficient for related species
Sorption coefficient for ionised species K_{ow} l/kg
pH value
acid dissociation constant pKa

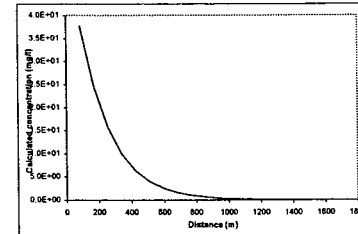
Soil water partition coefficient Kd 5.00E-01 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (D) specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax 1.41E+01 m
Transverse dispersivity az 1.41E+00 m
Vertical dispersivity ay 1.41E-01 m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$
Xu & Eckstein (1995) report $ax = 0.83(\log_{10} t)^{0.43}$, $az = az/10$, $ay = ay/100$ are assumed



Calculated concentrations for distance-concentration graph

Output calculation sheet

Distance Concentration

mg/l	
85.0	3.8E+01
290.0	2.9E+01
340.0	9.9E+00
426.0	6.3E+00
610.0	4.0E+00
695.0	2.6E+00
690.0	1.8E+00

355.0 9.9E+00

335.0 4.4E-01

1020.0 2.9E-01

1105.0 1.9E-01

1290.0 8.2E-02

1160.0 5.4E-02

1440.0 3.9E-02

1530.0 2.4E-02

1616.0 1.6E-02

1700.0 1.0E-02

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

This sheet calculates the Tier3 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.

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 Tier 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

Site being assessed: Bless Area 4 Ries
Completed by: AJ
Date: 24 11 2005
Version: 11

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Tier 3 Groundwater
Site Name:

		Distance to compliance point (m)	1700								
		Groundwater velocity (m/d)	0.51153846								
		Groundwater travel time (d)	3323.30827								
		Maximum groundwater concentration at source (mg/l) ²	Acceptable concentration (screening) water (mg/l)	Retardation factor	Contaminant velocity (m/d)	Contaminant travel time (d)	Contaminant travel time (yr)	Half life (d)	Attenuation Factor (AF)	Tier 3 Groundwater RTV (mg/l)	Tier 3 Groundwater Hazard Index
Total Cyanide			0.01	7.4195E+10	6.89447E-12	2.46575E+14	675,546,576,317.69	29.1666667	#NUM!	#NUM!	#NUM!
Flouride			1	1	0.511538462	3323.308271	9.10	9.9E+99	3.452683033	3.45E+00	0.00E+00
Sulphide			0.00025	1	0.511538462	3323.308271	9.10	9.9E+99	3.452683033	8.63E-04	0.00E+00
Ammoniacal Nitrogen as N			0.12	5.67032967	0.090213178	18844.25349	51.63	2190	1027.70665	1.23E+02	0.00E+00
Arsenic			0.01	1098.43178	0.000465699	3650427.426	10,001.17	9.9E+99	3.452683033	3.45E-02	0.00E+00
Nickel			0.02	1	0.511538462	3323.308271	9.10	9.9E+99	3.452683033	6.91E-02	0.00E+00
Strontium			1	1	0.511538462	3323.308271	9.10	9.9E+99	3.452683033	3.45E+00	0.00E+00
Aliphatic C8-C10			0.000714	1073.22063	0.000476639	3566642.991	9,771.62	1825	8.5485E+151	6.10E+148	0.00E+00
Aliphatic C10-C12			0.0007141	8517.951191	6.00542E-05	28307777.641	77,555.56	1825	#NUM!	#NUM!	#NUM!
Aliphatic C12-C16			0.0007141	169936.5181	3.01017E-06	564751434.11	1,547,264.20	1825	#NUM!	#NUM!	#NUM!
Aliphatic C16-C21			0.0007141	21393615.11	2.39108E-08	710975781221	194,787,885.27	3650	#NUM!	#NUM!	#NUM!
Aliphatic C21-C35			0.000714	21393615.11	2.39108E-08	71097578122	194,787,885.27	3650	#NUM!	#NUM!	#NUM!
Aromatic C8-C10			0.000714	54.7383291	0.00934516	181912.3417	498.39	1825	7.41809E+21	5.30E+18	0.00E+00
Aromatic C10-C12			0.000714	86.1695119	0.005936421	286367.8516	784.57	1825	3.7638E+30	2.69E+27	0.00E+00
Aromatic C12-C16			0.000714	170.935518	0.002992581	568071.4191	1,556.36	1825	1.46421E+49	1.05E+46	0.00E+00
Aromatic C16-C21			0.000714	538.383291	0.000950138	1789213.643	4,901.96	3650	1.3141E+66	9.38E+62	0.00E+00
Aromatic C21-C35			0.000714	4269.58721	0.00011981	14189154.48	38,874.40	3650	2.8902E+223	2.06E+220	0.00E+00
									3.26278E+79	1.63E+76	0.00E+00

R&D Publication20 Remedial Targets Worksheet, Release2.2a

Tier 3 -Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T Aromatic C8-C10 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	9.90E-09	mg/l	
Half life for degradation of contaminant in water t _{1/2}	1.83E+03	days	
Calculated decay rate λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E+01	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness da	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (laterals) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	5.75E+00	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	5.47E+01	fraction
Decay rate used λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation u	7.17E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C _{1D}	2.17E+125	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C _{2D}	1.21E+125	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀) AF	4.56E+28	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀) AF	8.19E+28	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks LTC3	3.25E+03	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	1700	m	
Concentration of contaminant at compliance point after C _{1D} /C ₀	2.17E+125	mg/l	Ogata Banks
	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd [redacted] l/kg
 Soil water partition coefficient Kd [redacted] l/kg
 Entry for non-polar organic chemicals (option) Fraction of organic carbon in aquifer foc 1.00E+00 fraction
 Organic carbon partition coefficient Koc 5.75E+00 l/kg
 Entry for ionic organic chemicals (option) Sorption coefficient for related species K_{ow} [redacted] l/kg
 Sorption coefficient for ionised species K_{ow} [redacted] l/kg
 pH value pH [redacted]
 acid dissociation constant pKa [redacted]

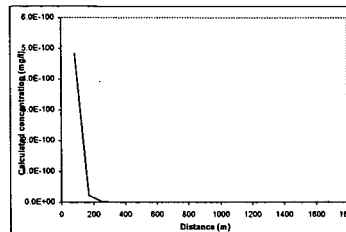
Soil water partition coefficient Kd 5.75E+00 l/kg

Dispersivity

Calculate dispersivity on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity ax	[redacted]	1.41E+01	m
Transverse dispersivity az	[redacted]	1.41E+00	m
Vertical dispersivity ay	[redacted]	1.41E-01	m

For calculated value, assumes ax = 0.1 * z, az = 0.01 * x, ay = 0.001 * x
 Xu & Eckstein (1995) report ax = 0.83(ρg_s)^{0.414}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

Distance	Concentration (mg/l)
85.0	4.8E-100
170.0	2.3E-101
255.0	1.0E-102
340.0	4.8E-104
426.0	2.1E-105
610.0	9.4E-107
696.0	4.3E-108
680.0	2.0E-109
766.0	9.0E-111
850.0	4.2E-112
936.0	1.9E-113
1026.0	9.0E-116
1106.0	4.2E-118
1190.0	2.0E-117
1276.0	9.2E-119
1380.0	4.3E-120
1446.0	2.0E-121
1530.0	9.7E-123
1616.0	4.6E-124
1700.0	2.2E-126

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Bessy Area 4 Res
 Completed by: AJ
 Date: 24/11/2005
 Version: 11

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R8D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aromatic C10-C12
Target Concentration: C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	9.90E-99	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.83E-03	days	
Calculated decay rate λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	3.00E-01	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness da	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (latera) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	9.12E+00	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	8.62E+01	fraction
Decay rate used λ	3.80E-04	days ⁻¹
Rate of contaminant flow due to retardation u	4.55E-03	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	1.21E-135	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	9.79E-136	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	8.15E+36	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	1.47E+37	

Remedial Targets

Remedial Target	LTCS	Value	Unit	Source
Ogata Banks		6.92E+33	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	1.21E-135	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd 9.12E+00 l/kg
Soil water partition coefficient
Entry for non-polar organic chemicals (option) foc 1.00E+00 fraction
Fraction of organic carbon in aquifer
Organic carbon partition coefficient Koc 9.12E+00 l/kg
Entry for ionic organic chemicals (option) K_{ow}
Sorption coefficient for related species
Sorption coefficient for ionised species K_{oc} l/kg
pH value
acid dissociation constant pKa

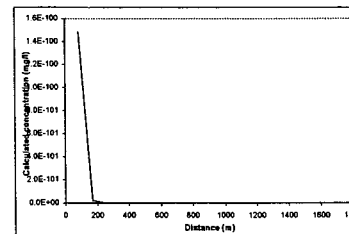
Soil water partition coefficient Kd 9.12E+00 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)
specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Dispersivity	ax	ay	az	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity					1.41E+01 m
Transverse dispersivity					1.41E+00 m
Vertical dispersivity					1.41E-01 m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$
Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.75}$, $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
Distance to Compliance point

86.0	1.0E+00
170.0	2.1E-102
266.0	3.0E-104
340.0	4.1E-106
426.0	6.7E-108
510.0	7.9E-110
696.0	1.1E-111
830.0	1.9E-113
766.0	2.2E-116
850.0	3.1E-117
935.0	4.4E-119
1020.0	6.3E-121
1106.0	9.1E-123
1396.0	1.9E-125
1380.0	2.7E-128
1445.0	4.0E-130
1530.0	6.7E-132
1816.0	8.3E-134
1700.0	1.2E-135

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Sites Area 4 Res
Completed by: AJ
Date: 24 11 2005
Version: 11

R&D Publication20 Remedial Targets Worksheet, Release2.2a

Tier 3 -Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Total Cyanide
Target Concentration C_T 1.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C ₀	9.90E-09	mg/l	
Half life for degradation of contaminant in water t _{1/2}	2.92E+01	days	
Calculated decay rate λ	7.38E-02	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E+01	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness da	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (laterally) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	7.94E+09	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	7.42E+10	fraction
Decay rate used λ	2.38E-02	d ⁻¹
Rate of contaminant flow due to retardation u	5.29E-12	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C ₀	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C ₀₂	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C ₀₂) AF	#NUM!	
Attenuation factor (two way vertical dispersion, C ₀ /C ₀₂) AF	#NUM!	

Remedial Targets

Remedial Target	LYCS	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1700		m	
Concentration of oontaminant at oompliance point after	C ₀₂ /C ₀	#NUM!	mg/l	Ogata Banks
		9.9E+99	days	

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

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

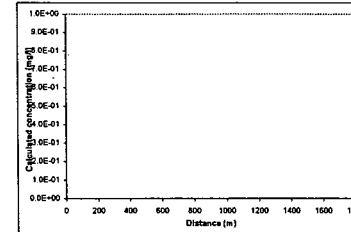
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient Kd		l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer f _{oc}	1.00E+00	fraction
Organic carbon partition coefficient K _{oc}	7.94E+09	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species K _{ow}		l/kg
Sorption coefficient for ionised species K _{ow}		l/kg
pH value pH		
acid dissociation constant pKa		
Soil water partition coefficient Kd	7.94E+09	l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)		
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2	
Longitudinal dispersivity ax	14.075	m
Transverse dispersivity az	1.407	m
Vertical dispersivity ay	0.141	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * z, ay = 0.001 * y. Xu & Eckstein (1995) report ax = 0.83(log₁₀pH)^{-1.1}; 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.

This sheet calculates the Tier3 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. 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 Tier 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.

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

Distance	Concentration
	mg/l
85.0	#NUM!
170.0	#NUM!
255.0	#NUM!
340.0	#NUM!
425.0	#NUM!
510.0	#NUM!
595.0	#NUM!
680.0	#NUM!
765.0	#NUM!
850.0	#NUM!
935.0	#NUM!
1020.0	#NUM!
1105.0	#NUM!
1190.0	#NUM!
1275.0	#NUM!
1360.0	#NUM!
1445.0	#NUM!
1530.0	#NUM!
1615.0	#NUM!
1700.0	#NUM!

Site being assessed: Bicos Area 4 Res
Completed by: AJ
Date: 24.11.2005
Version: 11

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Aromatic C12-C16		
Target Concentration	C _T	7.14E-04	mg/l

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

Ogata Banks	Equations in R&D Pub. 20
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Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C ₀	0.90E+99	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.83E+03	days
Calculated decay rate	λ	3.80E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	2.10E+01	m
Saturated aquifer thickness	da	2.17E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.02E-02	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	1.70E+03	m
Distance (laterally) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	1.82E+01	V/kg
Longitudinal dispersivity	ax	14.075	m
Transverse dispersivity	az	1.407	m
Vertical dispersivity	ay	0.141	m

Calculated Parameters Variable

Groundwater flow velocity	v	3.92E-01	m/d
Retardation factor	Rf	1.71E+02	fraction
Decay rate used	λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	2.30E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{0x}	2.78E+157	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{0p}	1.53E+157	mg/l
Attenuation factor (one way vertical dispersion, C _{0x} /C _T)	AF	3.59E+58	
Attenuation factor (two way vertical dispersion, C _{0p} /C _T)	AF	6.48E+58	

Remedial Targets

Remedial Target	LTC5	2.56E+65	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				

Distance to compliance point 1700 m

Concentration of contaminant at compliance point
 before 2.78E+157 mg/l
 after 9.9E+99 mg/l

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

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

Calculate for non-polar organic chemicals

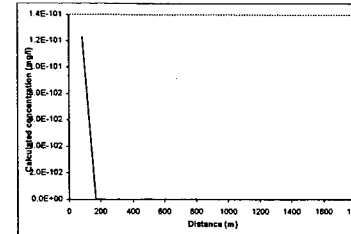
Soil water partition coefficient	Kd	1.82E+01	V/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	1.82E+01	V/kg
Organic carbon partition coefficient	K _{ow}		V/kg
Entry for ionic organic chemicals (option)	K _{ow}		V/kg
Sorption coefficient for related species	K _{ow}		V/kg
pH value	pH		
acid dissociation constant	pKa		

Soil water partition coefficient Kd 1.82E+01 V/kg

Dispersivity

Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	14.075	m
Transverse dispersivity	az	1.41E+00	m
Vertical dispersivity	ay	0.141E-01	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * z, ay = 0.001 * y
 Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.75}, az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
 From calculation sheet
 Distance Concentration

	mg/l
85.0	1.2E-101
170.0	1.6E-104
255.0	1.7E-107
340.0	1.9E-110
426.0	2.2E-113
510.0	2.6E-116
595.0	2.9E-119
680.0	3.4E-122
716.0	4.0E-126

850.0 5.6E-131
 1020.0 6.6E-134

1190.0 9.2E-140
 1276.0 1.1E-142
 1380.0 1.3E-145
 1445.0 1.6E-148
 1530.0 1.9E-151
 1690.0 2.8E-153

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bites Arca 4 Res
 Compiled by: RJ
 Date: 24 11 2009
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Aromatic C16-C21
Target Concentration C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water.

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core C ₀	9.90E-99	mg/l	
Half life for degradation of contaminant in water t _{1/2}	3.85E+03	days	
Calculated decay rate λ	1.90E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E+01	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness da	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (latera) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	5.75E+01	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	5.38E+02	fraction
Decay rate used λ	1.90E-04	d ⁻¹
Rate of contaminant flow due to retardation u	7.29E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C _{1D}	7.11E-177	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C _{2D}	3.98E-177	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D}) AF	1.38E+78	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D}) AF	2.60E+78	

Remedial Targets

Remedial Target	Value	Unit	Source
LTC3	9.94E+74	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	1700	m	
Concentration of contaminant at compliance point C _{1D} /C ₀	7.11E-177	mg/l	Ogata Banks
after	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd [redacted] l/kg
Soil water partition coefficient Kd [redacted] l/kg
Entry for non-polar organic chemicals (option) f_{oc} 1.00E+00 fraction
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 5.75E+01 l/kg
Entry for ionic organic chemicals (option) K_{ow} [redacted] l/kg
Sorption coefficient for related species K_{ow} [redacted] l/kg
Sorption coefficient for ionised species K_{ow} [redacted] l/kg
pH value pH [redacted]
acid dissociation constant pKa [redacted]

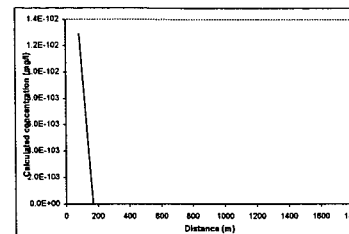
Soil water partition coefficient Kd 5.75E+01 l/kg

Dispersivity Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Dispersivity	ax	Enter value	Calc value Xu & Eckstein	m
Longitudinal dispersivity	ax		1.41E+01	m
Transverse dispersivity	az		1.41E+00	m
Vertical dispersivity	ay		1.41E-01	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.414}, az = az/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

Distance	Concentration	mg/l
85.0	1.3E-102	
170.0	1.6E-106	
256.0	1.9E-110	
340.0	2.3E-114	
426.0	2.8E-118	
510.0	3.4E-122	
596.0	4.1E-126	
680.0	5.0E-130	
766.0	6.1E-134	

956.0	5.5E-138	
1020.0	1.2E-145	
1106.0	1.4E-149	
1190.0	1.8E-153	
1276.0	2.2E-157	

1446.0	2.6E-165	
1530.0	4.5E-169	
1616.0	6.6E-173	
1700.0	7.1E-177	

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Sites Area 4 Rec
Completed by: AJ
Date: 26/11/2005
Version: 11

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Sour.

Contaminant Target Concentration C_T Aromatic C21-C35 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter 1 to simulate vertical dispersion in one direction, 2 for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water.

'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Parameter	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	9.90E-09	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.65E+03	days	
Calculated decay rate λ	1.90E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	0.00E+00	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness ds	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (latera) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient Kd	4.57E+02	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

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

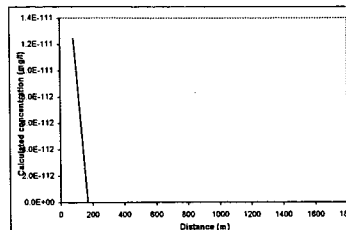
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient Kd		l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer foc	1.00E+00	fraction
Organic carbon partition coefficient Koc	4.57E+02	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species $K_{oc,s}$		l/kg
Sorption coefficient for ionised species $K_{oc,i}$		l/kg
pH value pH		
acid dissociation constant pKa		
Soil water partition coefficient Kd	4.57E+02	l/kg

Dispersivity Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Dispersivity	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity ax		1.41E+01 m
Transverse dispersivity az		1.41E+00 m
Vertical dispersivity ay		1.41E-01 m

For calculated value, assumes $ax = 0.1 \cdot x$, $az = 0.01 \cdot x$, $ay = 0.001 \cdot x$. Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.4}$, $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
85.0	1.2E-111
170.0	1.6E-124
255.0	1.7E-137
340.0	2.0E-150
425.0	2.3E-163
510.0	2.7E-176
595.0	3.2E-189
680.0	3.8E-202
765.0	4.6E-215
850.0	6.3E-228
935.0	8.4E-241
1020.0	7.6E-254
1105.0	9.1E-267
1190.0	1.1E-279
1275.0	1.3E-292
1360.0	1.6E-305
1445.0	0.0E+00
1530.0	0.0E+00
1615.0	0.0E+00
1700.0	#NUM!

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.

This sheet calculates the Tier3 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. 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 Tier 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: Blets Area 4 Res
 Completed by: AJ
 Date: 24 11 2005
 Version: 11

Remedial Targets Remedial Target LTCS #NUM! mg/l For comparison with measured groundwater concentration.

Distance to compliance point	1700	m
Concentration of contaminant at compliance point after C_{cp}/C_0	#NUM!	mg/l
	9.9E+99	days

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

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T 1.00E-02 mg/l Aesthetic

Enter '1' to activate vertical dispersion in one direction (i.e. field data from aquifer) (pull down menu) 0

Enter '1' if biodegradation rate is for the substance in water.

If rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core C_0 9.90E-99 mg/l

Half life for degradation of contaminant in plume core $t_{1/2}$ 9.90E+99 days

Calculated decay rate λ 7.00E-101 days⁻¹

Width of plume in aquifer at source (perpendicular to flow) SZ 6.60E-010 m

Purine aquifer thickness dy 2.10E-010 m

Bulk density of aquifer materials ρ 1.70E+001 g/cm³

Effective porosity of aquifer θ 1.82E-01 fraction

Hydraulic conductivity of aquifer K 1.70E+000 m/d

Distance to compliance point L 1.70E+003 m

Distance (later) to compliance point perpendicular to flow direction L_{\perp} 1.70E+000 m

Distance (depth) to compliance point perpendicular to flow direction L_{\parallel} 1.70E+000 m

Time since pollutant entered groundwater t 9.90E+99 days

Partition coefficient K_d 1.73E+02 kg/m³ see options

Longitudinal dispersivity α_x 1.407 m see options

Transverse dispersivity α_z 1.407 m see options

Vertical dispersivity α_y 0.141 m see options

Calculated Parameters Variable Value

Groundwater flow velocity v 3.82E-01 m/d

Retardation factor Rf 1.10E+03

Decay rate used λ 7.00E-101 d⁻¹

Rate of contaminant flow due to retardation u 3.87E-04 m/d

Contaminant concentration at distance x , assuming one-way vertical dispersion C_0 2.87E-99 mg/l

Contaminant concentration at distance x , assuming two-way vertical dispersion C_0 3.45E-00 mg/l

Attenuation factor (two way vertical dispersion, C_0/C_x) AF 8.21E+00

Remedial Targets

Remedial Target C_{RTO} 3.45E-02 mg/l For comparison with measured groundwater concentration.

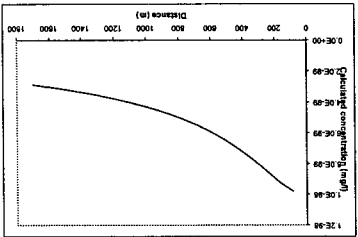
Ogata Banks

Distance to compliance point 1700 m

Concentration of contaminant at compliance point after C_{PCO} 2.87E-99 mg/l Ogata Banks

after 9.9E+99 days

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.



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.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance location 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 Tier 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration
0	85.0
25.0	9.8E-99
170.0	9.2E-99
250.0	8.4E-99
340.0	7.7E-99
425.0	7.0E-99
610.0	6.6E-99
680.0	6.6E-99
880.0	6.6E-99
950.0	6.6E-99
1020.0	4.8E-99
1100.0	4.0E-99
1190.0	3.8E-99
1270.0	3.8E-99
1350.0	3.4E-99
1440.0	3.4E-99
1520.0	3.1E-99
1610.0	3.0E-99
1700.0	2.9E-99

See being assessed: Bloss Ares & Roe
 Completed by: AU
 Date: 24 11 2005
 Version: 11

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ENVIRONMENT AGENCY

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

This worksheet has been produced in combination with the document 'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources' - Environment Agency R&D Publication 20, (1999).

Users of this worksheet should always refer to the User Manual, to R&D Publication 20 and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

© Environment Agency, 2002. (Produced by the Agency's National Groundwater and Contaminated Land Centre and Envirospine)

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

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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 ft

Details to be completed for each assessment			
Site Name:	Bless Area 4 Res		
Site Address:			
Completed by:	AJ		
Date:	24/112005	Version:	11
Contaminant	Fluoride		
Target Concentration (C _T)	1 mg/l	Origin of C _T :	EPA 2003

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

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

Worksheet options are identified by brown background and employ a pull-down menu or require a "0", "1" or "2" to be entered. Data entry are identified as blue background.

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

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

The worksheet also calculates a number of frequently used hydrogeological equations.

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Nickel
Target Concentration: C_T 2.00E-02 mg/l

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

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu): 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu): 0

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	6.00E-03	mg/l	see options
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	see options
Calculated decay rate λ	7.00E-101	days ⁻¹	see options
Width of plume in aquifer at source (perpendicular to flow) Sz	3.00E+01	m	see options
Plume thickness at source Sy	2.10E+01	m	see options
Saturated aquifer thickness da	2.17E+01	m	see options
Bulk density of aquifer materials ρ	1.70E+01	g/cm ³	see options
Effective porosity of aquifer \dots	1.82E-01	fraction	see options
Hydraulic gradient i	1.02E-02	fraction	see options
Hydraulic conductivity of aquifer K	7.00E+00	m/d	see options
Distance to compliance point x	1.70E+03	m	see options
Distance (lateral) to compliance point perpendicular to flow direction z	0.00E+00	m	see options
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	see options
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	1.00E+00	fraction
Decay rate used λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation u	3.92E-01	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	1.74E-03	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	9.97E-04	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	3.45E+00	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	6.21E+00	

Remedial Targets

Remedial Target	LTC3	6.91E-02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	1.74E-03	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

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

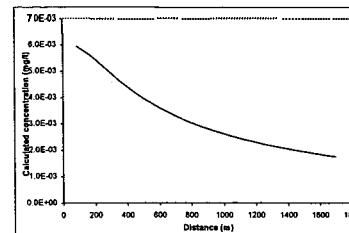
Soil water partition coefficient Kd 0.00E+00 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity ax		1.41E+01	m
Transverse dispersivity az		1.41E+00	m
Vertical dispersivity ay		1.41E-01	m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$. Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.4}$, $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
85.0	5.9E-03
170.0	5.6E-03
255.0	6.1E-03
340.0	4.7E-03
426.0	4.3E-03
610.0	3.9E-03
696.0	3.6E-03
680.0	3.3E-03

868.0 2.9E-03
935.0 2.7E-03
1098.0 2.6E-03

1190.0 2.3E-03
1276.0 2.2E-03
1300.0 2.1E-03
1445.0 2.0E-03
1530.0 1.9E-03
1616.0 1.8E-03
1700.0 1.7E-03

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bites Area 4 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

Tier 3 - Groundwater

Input Parameters (using pull-down menu) Variable Value Unit Sours.

Contaminant Phenol
Target Concentration C_T 5.00E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	9.90E-09	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.00E+01	days	
Calculated decay rate λ	6.93E-02	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) S_z	8.00E+01	m	
Plume thickness at source S_y	2.10E+01	m	
Saturated aquifer thickness d_a	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (latera) to compliance point perpendicular to flow direction y	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction z	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient K_d	1.05E-01	l/kg	see options
Longitudinal dispersivity α_x	14.075	m	see options
Transverse dispersivity α_z	1.407	m	see options
Vertical dispersivity α_y	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor R_f	1.98E+00	fraction
Decay rate used λ	6.93E-02	d ⁻¹
Rate of contaminant flow due to retardation u	1.98E-01	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	2.68E-192	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	1.49E-192	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	3.70E+93	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	6.65E+93	

Remedial Targets

Remedial Target	Value	Unit	Notes
Remedial Target	1.95E+99	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	1700	m	
Concentration of contaminant at compliance point after	2.68E-192	mg/l	Ogata Banks
	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) K_d 1.05E-01 l/kg
 Soil water partition coefficient K_d 1.05E-01 l/kg
 Entry for non-polar organic chemicals (option) f_{oc} 1.00E+00 fraction
 Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
 Organic carbon partition coefficient K_{oc} 1.05E-01 l/kg
 Entry for ionic organic chemicals (option) K_{ow} 1.05E-01 l/kg
 Sorption coefficient for related species K_{ow} 1.05E-01 l/kg
 Sorption coefficient for ionised species K_{ow} 1.05E-01 l/kg
 pH value pH
 acid dissociation constant pK_a

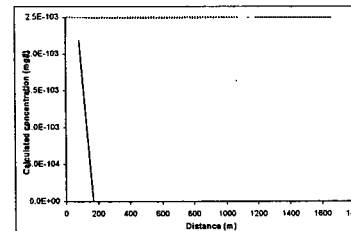
Soil water partition coefficient K_d 1.05E-01 l/kg

Dispersivity

Calculate dependent on distance to compliance point (D) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Parameter	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity α_x		1.41E+01	m
Transverse dispersivity α_z		1.41E+00	m
Vertical dispersivity α_y		1.41E-01	m

For calculated value, assumes $\alpha_x = 0.1 \cdot x$, $\alpha_z = 0.01 \cdot x$, $\alpha_y = 0.001 \cdot x$
 Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10} x)^{1.41}$, $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

85.0	2.70E+03
170.0	4.6E-108
266.0	9.4E-113
340.0	1.9E-117
426.0	3.9E-122
610.0	8.0E-127
696.0	1.6E-131
630.0	3.4E-136
706.0	7.0E-141
850.0	1.6E-146
935.0	3.1E-150
1020.0	6.4E-156
1106.0	1.4E-161
1190.0	2.9E-164
1271.0	6.1E-169
1360.0	1.3E-173
1446.0	2.7E-178
1530.0	6.9E-183
1011.0	1.3E-187
1700.0	2.7E-192

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Blisls Area 4 Res
 Completed by: AJ
 Date: 24/11/2005
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Strontium
Target Concentration C_T 1.00E+00 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter 1 to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	5.70E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate λ	7.00E-101	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E+01	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness da	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (latera) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	1.00E+00	fraction
Decay rate used λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation u	3.92E-01	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	1.65E-01	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	9.19E-02	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	3.45E+00	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	8.21E+00	

Remedial Targets

Remedial Target	LTC3	3.45E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	1.65E-01	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

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

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer foc 1.00E+00 fraction

Organic carbon partition coefficient Koc 0.00E+00 l/kg

Entry for ionic organic chemicals (option)

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

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

pH value pH

acid dissociation constant pKa

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

Dispersivity

Calculate dependant on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

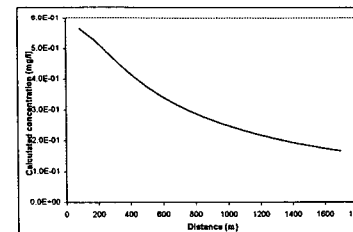
Longitudinal dispersivity ax 1.41E+01 m

Transverse dispersivity az 1.41E+00 m

Vertical dispersivity ay 1.41E-01 m

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

Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.41}$, $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

	mg/l
85.0	5.6E-01
278.0	8.9E-01
340.0	4.4E-01
426.0	4.1E-01
610.0	3.7E-01
835.0	3.4E-01
950.0	3.2E-01
706.0	3.0E-01
850.0	2.8E-01
1020.0	2.6E-01

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

1105.0 2.3E-01
1296.0 2.2E-01

1360.0 2.0E-01
1446.0 1.9E-01
1530.0 1.8E-01
1616.0 1.7E-01
1700.0 1.7E-01

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Sites Area 4 Res
Completed by: RJ
Date: 24/11/2005
Version: 11

Simple hydrogeological calculations

(These are not specific to, α required in, the Remedial Targets Methodology)

Parameter	symbol	unit	justification
Hydraulic conductivity	K	8.10E-05 m/s	
Hydraulic gradient	i	9.80E-03 unitless	
Effective porosity of aquifer	n	1.82E-01 fraction	
Thickness of saturated aquifer	b	2.10E+01 m	
Width of aquifer perpendicular to flow	w	8.00E+01 m	
Distance to receptor	x	1.70E+03 m	
Density of stratum	p	1.70E+00 g/cm ³	
Soil-water partition co-efficient	Kd	0.00E+00 l/kg	
Retardation factor of pollutant	R	1	

Groundwater flow velocity	v(GW)	4.36E-06 m/s	3.77E-01 m/day	1.38E+02 m/year
Time for groundwater to reach receptor	t(GW)	3.90E+08 seconds	4.51E+03 days	1.24E+01 years
Rate of groundwater flow through aquifer	Q	1.33E-03 m ³ /s	1.15E+02 m ³ /day	4.21E+04 m ³ /year
Contaminant flow velocity	v(contam)	4.36E-06 m/s	3.77E-01 m/day	1.38E+02 m/year
Time for contaminant to reach receptor	t(contam)	3.90E+08 seconds	4.51E+03 days	1.24E+01 years

R&D Publication20 Remedial Targets Worksheet, Release 2.2a



Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T Aliphatic C8-C10
7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	9.90E-09	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.83E+03	days	
Calculated decay rate λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E-01	m	
Plume thickness at source Sy	2.10E+01	m	
Saturated aquifer thickness da	2.17E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.02E-02	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	1.70E+03	m	
Distance (latera) to compliance point perpendicular to flow direction y	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction z	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+09	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	1.15E+02	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	1.07E+03	fraction
Decay rate used λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation u	3.66E-04	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{E0}	2.38E-275	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{E0}	1.32E-275	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{E0}) AF	4.10E+170	
Attenuation factor (two way vertical dispersion, C_0/C_{E0}) AF	7.48E+176	

Remedial Targets Remedial Target LTCS 2.97E+173 mg/l For comparison with measured groundwater concentration. Ogata Banks

Distance to compliance point 1700 m
Concentration of contaminant at compliance point C_{E0}/C_0 2.38E-275 mg/l Ogata Banks
after 9.9E+198 days

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd 1.15E+02 l/kg
Soil water partition coefficient
Entry for non-polar organic chemicals (option) foc 1.00E+00 fraction
Fraction of organic carbon in aquifer
Organic carbon partition coefficient Koc 1.15E+02 l/kg
Entry for ionic organic chemicals (option) K_{oc} l/kg
Sorption coefficient for related species
Sorption coefficient for ionised species $K_{oc,i}$ l/kg
pH value
acid dissociation constant pKa

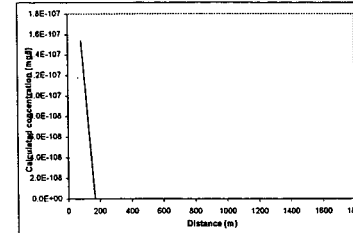
Soil water partition coefficient Kd 1.15E+02 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity ax 1.41E+01 m
Transverse dispersivity az 1.41E+00 m
Vertical dispersivity ay 1.41E-01 m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$, $ax = av/10$, $ay = az/100$ are assumed
Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.4}$, $az = ax/10$, $ay = az/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
Dieta Calc Concentration

mg/l	
64.0	1.6E-107
260.0	3.3E-126
348.0	6.7E-143
510.0	9.7E-152
836.0	1.4E-160
630.0	2.0E-159
765.0	3.0E-178
	6.4E-196
935.0	1.6E-207
1020.0	9.6E-205
1198.0	2.1E-222
1276.0	3.1E-231
1360.0	4.7E-240
1445.0	7.0E-249
1530.0	1.0E-257
1016.0	1.6E-266
1700.0	2.4E-275

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.

This sheet calculates the Tier3 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. 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 Tier 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

Site being assessed: Siles Area 4 Res
Completed by: AJ
Date: 24/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Aliphatic C10-C12
Target Concentration C_T 7.14E-04 mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)
Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core C_0	9.90E-99	mg/l	see options
Half life for degradation of contaminant in water $t_{1/2}$	1.83E+03	days	see options
Calculated decay rate λ	3.80E-04	days ⁻¹	see options
Width of plume in aquifer at source (perpendicular to flow) SZ	3.00E+01	m	see options
Plume thickness at source Sy	2.10E+01	m	see options
Saturated aquifer thickness da	2.17E+01	m	see options
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	see options
Effective porosity of aquifer n	1.82E-01	fraction	see options
Hydraulic gradient i	1.02E-02	fraction	see options
Hydraulic conductivity of aquifer K	7.00E+00	m/d	see options
Distance to compliance point x	1.70E+03	m	see options
Distance (lateral) to compliance point perpendicular to flow direction z	0.00E+00	m	see options
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	see options
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	9.12E+02	l/kg	see options
Longitudinal dispersivity ax	14.075	m	see options
Transverse dispersivity az	1.407	m	see options
Vertical dispersivity ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	3.92E-01	m/d
Retardation factor Rf	8.52E+03	fraction
Decay rate used λ	3.80E-04	days ⁻¹
Rate of contaminant flow due to retardation u	4.61E-05	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	#NUM!	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	#NUM!	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point after	C_{1D}/C_0	#NUM!	mg/l	Ogata Banks
		9.9E+99	days	

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

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

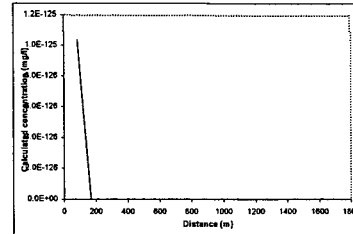
Calculate for non-polar organic chemicals

Soil water partition coefficient Kd	9.12E+02	l/kg
Fraction of organic carbon in aquifer foc	1.00E+00	fraction
Organic carbon partition coefficient Koc	9.12E+02	l/kg
Sorption coefficient for related species K_{ow}		l/kg
Sorption coefficient for ionised species K_{ow}		l/kg
pH value		
acid dissociation constant pKa		
Soil water partition coefficient Kd	9.12E+02	l/kg

Dispersivity

Calculate dependant on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2	
Longitudinal dispersivity ax	1.41E+01	m
Transverse dispersivity az	1.41E+00	m
Vertical dispersivity ay	1.41E-01	m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * z$, $ay = 0.001 * y$. Xu & Eckstein (1995) report $ax = 0.83(\log_{10} K_{ow})^{1.5}$; $az = az/10$, $ay = ay/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
85.0	1.0E-125
170.0	1.0E-182
255.0	1.0E-179
340.0	9.6E-207
426.0	9.3E-234
610.0	WE-161
696.0	8.7E-288
680.0	0.0E+00
765.0	0.0E+00
860.0	0.0E+00
938.0	RNUM!
1020.0	RNUM!
1105.0	RNUM!
1190.0	RNUM!
1276.0	RNUM!
1360.0	RNUM!
1445.0	RNUM!
1630.0	RNUM!
1616.0	RNUM!
1700.0	RNUM!

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.

This sheet calculates the Tier3 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.

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 Tier 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.

Site being assessed	Sites Area 4 Res
Completed by	AJ
Date	24/11/2005
Version	11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a



Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aliphatic C12-C16
Target Concentration: C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C_0	9.90E-99	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days	
Calculated decay rate	λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	3.80E+01	m	
Plume thickness at source	Sy	2.10E+01	m	
Saturated aquifer thickness	da	2.17E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.02E-02	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.70E+03	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	1.82E+04	l/kg	see options
Longitudinal dispersivity	ax	14.075	m	see options
Transverse dispersivity	az	1.407	m	see options
Vertical dispersivity	ay	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	3.92E-01	m/d
Retardation factor	Rf	1.70E+05	fraction
Decay rate used	λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	2.31E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{E0}	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{E2}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{E0})	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C_0/C_{E2})	AF	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	C_{E0}/C_0	#NUM!	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

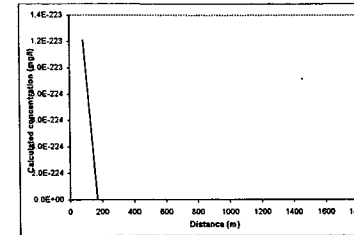
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd		l/kg
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	foc	1.82E+04	l/kg
Organic carbon partition coefficient	Koc		l/kg
Entry for ionic organic chemicals (option)	K_{ow}		l/kg
Sorption coefficient for related species	K_{ow}		l/kg
Sorption coefficient for ionised species	K_{ow}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	1.82E+04	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)		2	
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	1.41E+01	m
Transverse dispersivity	az	1.41E+00	m
Vertical dispersivity	ay	1.41E-01	m

For calculated value, assume ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀ax)^{0.75}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
85.0	1.2E+23
170.0	0.0E+00
266.0	#NUM!
340.0	#NUM!
426.0	#NUM!
510.0	#NUM!
595.0	#NUM!
680.0	#NUM!
716.0	#NUM!
860.0	#NUM!
936.0	#NUM!
1020.0	#NUM!
1106.0	#NUM!
1190.0	#NUM!
1276.0	#NUM!
1360.0	#NUM!
1445.0	#NUM!
1530.0	#NUM!
1615.0	#NUM!
1700.0	#NUM!

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bites Area 4 Res
Completed by: AJ
Date: 24 11 2005
Version: 11

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Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T Aliphatic C10-C12 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core C_0 2.12E-02 mg/l
 Half life for degradation of contaminant in water $t_{1/2}$ 1.83E+03 days
 Calculated decay rate λ 3.80E-04 days⁻¹
 Width of plume in aquifer at source (perpendicular to flow) Sz 8.00E+01 m
 Plume thickness at source Sy 5.00E+01 m
 Saturated aquifer thickness da 5.71E+01 m
 Bulk density of aquifer materials ρ 1.70E+00 g/cm³
 Effective porosity of aquifer n 1.82E-01 fraction
 Hydraulic gradient I 7.00E-03 fraction
 Hydraulic conductivity of aquifer K 7.00E+00 m/d
 Distance to compliance point x 8.50E+02 m
 Distance (lateral) to compliance point perpendicular to flow direction y 0.00E+00 m
 Distance (depth) to compliance point perpendicular to flow direction z 0.00E+00 m
 Time since pollutant entered groundwater t 9.90E+99 days

Parameters values determined from options
 Partition coefficient Kd 9.12E+02 l/kg see options
 Longitudinal dispersivity ax 11.114 m see options
 Transverse dispersivity ay 1.111 m see options
 Vertical dispersivity az 0.111 m see options

Calculated Parameters Variable

Groundwater flow velocity v 2.69E-01 m/d
 Retardation factor Rf 8.52E+03 fraction
 Decay rate used λ 3.80E-04 d⁻¹
 Rate of contaminant flow due to retardation u 3.16E-05 m/d
 Contaminant concentration at distance x , assuming one-way vertical dispersion C_{E1} #NUM! mg/l
 Contaminant concentration at distance x , assuming two-way vertical dispersion C_{E2} #NUM! mg/l
 Attenuation factor (one way vertical dispersion, C_0/C_{E1}) AF #NUM!
 Attenuation factor (two way vertical dispersion, C_0/C_{E2}) AF #NUM!

Remedial Target	Remedial Target	LYC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks					
Distance to compliance point		850	m		
Concentration of contaminant at compliance point	C_{10}/C_0	#NUM!	mg/l	Ogata Banks	
after		8.9E+99	days		

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

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

Calculate for non-polar organic chemicals

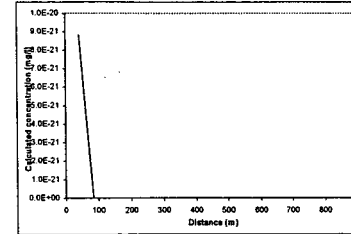
Entry if specify partition coefficient (option) Kd 9.12E+02 l/kg
 Soil water partition coefficient
 Entry for non-polar organic chemicals (option) foc 1.00E+00 fraction
 Fraction of organic carbon in aquifer
 Organic carbon partition coefficient Koc 9.12E+02 l/kg
 Entry for ionic organic chemicals (option) Kow #NUM! l/kg
 Sorption coefficient for related species
 Sorption coefficient for ionised species Kow #NUM! l/kg
 pH value
 acid dissociation constant pKa #NUM!

Soil water partition coefficient Kd 9.12E+02 l/kg

Dispersivity
 Calculate dependent on distance to compliance point (0) ax 11.114 m
 specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax 11.11E+01 m
 Transverse dispersivity ay 1.11E+00 m
 Vertical dispersivity az 0.111E+01 m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * z$, $ay = 0.001 * y$ are assumed
 Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.43}$; $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
 From calculation sheet
 Distance Concentration

Distance	Concentration
42.6	8.8E-21
85.0	3.7E-39
127.5	1.6E-57
170.0	6.2E-76
268.0	2.0E-94
297.5	4.1E-131
340.0	1.7E-149
382.6	6.7E-168
426.0	2.7E-186
467.5	1.1E-204
510.0	4.6E-223
662.6	1.8E-241
696.0	7.4E-260
722.5	3.0E-278
745.0	#NUM!
807.5	#NUM!
850.0	#NUM!

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Blossington area 6
 Compiled by: Anna Jeffcoat
 Date: 23 11 2005
 Version: 11

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T **Aliphatic C12-C16**
7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) **1**

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) **0**

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	2.12E+02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.33E+03	days	
Calculated decay rate λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) S_z	8.02E-01	m	
Plume thickness at source S_y	5.60E+01	m	
Saturated aquifer thickness d_a	5.71E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	7.00E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient K_d	1.82E+04	l/kg	see options
Longitudinal dispersivity α_x	11.114	m	see options
Transverse dispersivity α_z	1.111	m	see options
Vertical dispersivity α_y	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	2.69E-01	m/d
Retardation factor Rf	1.70E+05	fraction
Decay rate used λ	3.80E-04	days ⁻¹
Rate of contaminant flow due to retardation u	1.58E-06	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	#NUM!	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C_{1D}/C_0) AF	#NUM!	
Attenuation factor (two way vertical dispersion, C_{2D}/C_0) AF	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	850		m	
Concentration of contaminant at compliance point after	C_{1D}/C_0	#NUM!	mg/l	Ogata Banks
	after	9.9E+99	days	

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

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

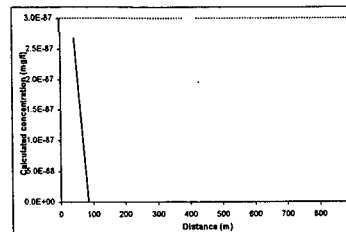
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) K_d		l/kg
Soil water partition coefficient K_d		l/kg
Entry for non-polar organic chemicals (option) f_{oc}	1.00E+00	fraction
Fraction of organic carbon in aquifer f_{oc}	1.82E+04	l/kg
Organic carbon partition coefficient K_{oc}		l/kg
Entry for ionic organic chemicals (option) K_{ow}		l/kg
Sorption coefficient for related species K_{ow}		l/kg
Sorption coefficient for ionised species K_{ow}		l/kg
pH value pH		
acid dissociation constant pKa		
Soil water partition coefficient K_d	1.82E+04	l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)	2			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?				
Longitudinal dispersivity α_x	Enter value	Calc value Xu & Eckstein	1.11E+01	m
Transverse dispersivity α_z			1.11E+00	m
Vertical dispersivity α_y			1.11E-01	m

For calculated value, assumes $\alpha_x = 0.1 \times x$, $\alpha_z = 0.01 \times z$, $\alpha_y = 0.001 \times y$. Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10} K_{ow})^{0.41}$; $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration	mg/l
Ogata Banks		
From calculation sheet		
42.5	2.7E-87	
66.0	3.4E-172	
127.6	4.2E-267	
270.0	#NUM!	
255.0	#NUM!	
297.5	#NUM!	
340.0	#NUM!	
382.5	#NUM!	
488.0	#NUM!	
610.0	#NUM!	
652.5	#NUM!	
695.0	#NUM!	
637.5	#NUM!	
680.0	#NUM!	
722.5	#NUM!	
765.0	#NUM!	
807.6	#NUM!	
850.0	#NUM!	

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Blessington area 6
Completed by: Anna Jeffcoat
Date: 23 11 2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aliphatic C16-C21
Target Concentration: 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core	C ₀	2.12E-02	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	3.85E+03	days	
Calculated decay rate	λ	1.90E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.60E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	p	1.20E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	I	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	2.29E+06	l/kg	see options
Longitudinal dispersivity	ax	11.114	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	av	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.89E-01	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	1.28E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	#NUM!	

Remedial Targets

Remedial Target	LYC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point after	C _{1D} /C ₀	#NUM!	mg/l	Ogata Banks
		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd
Soil water partition coefficient Kd 2.29E+06 l/kg
Entry for non-polar organic chemicals (option) f_{oc} 1.00E+00 fraction
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 2.29E+06 l/kg
Entry for lepic organic chemicals (option) K_{ow}
Sorption coefficient for related species K_{ow}
Sorption coefficient for ionised species pH
pH value pH
acid dissociation constant pKa

Source of parameter value

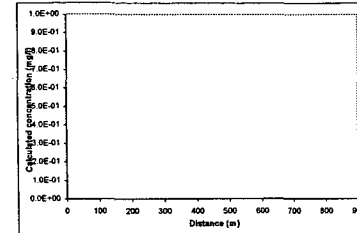
Soil water partition coefficient Kd 2.29E+06 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity ax
Transverse dispersivity az
Vertical dispersivity av

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, av = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.414}, az = ax/10, av = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

42.5	#NUM!
55.0	#NUM!
127.5	#NUM!
170.0	#NUM!
212.5	#NUM!
266.0	#NUM!
297.5	#NUM!
340.0	#NUM!
362.6	#NUM!
426.0	#NUM!
467.5	#NUM!
610.0	#NUM!
662.5	#NUM!
696.0	#NUM!
637.5	#NUM!
680.0	#NUM!
722.5	#NUM!
716.0	#NUM!
107.6	#NUM!
850.0	#NUM!

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.

This sheet calculates the Tier3 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

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 Tier 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.

Site being assessed: Bixington area 6
Completed by: Anna Jeffcoat
Date: 23/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aliphatics C6-C8
Target Concentration: C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	2.12E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	7.30E+02	days	
Calculated decay rate	λ	9.50E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.00E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Partition coefficient	Kd	1.45E+01	l/kg	see options
Longitudinal dispersivity	ax	11.111	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	1.36E+02	fraction
Decay rate used	λ	9.50E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	1.88E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	1.91E-04	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	1.83E-04	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	1.11E+02	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	1.18E+02	

Remedial Targets

Remedial Target	LTC3	7.94E-04	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		850	m	
Concentration of contaminant at compliance point after	C _{1D} /C ₀	1.91E-04	mg/l	Ogata Banks
		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer

Organic carbon partition coefficient

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

pH value

acid dissociation constant

Soil water partition coefficient

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

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

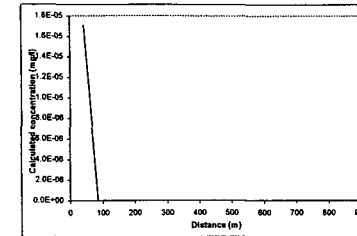
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.111}; az = ax/10, ay = ax/100 are assumed

Enter value Calc value Xu & Eckstein

ax 1.11E+01 m

az 1.11E+00 m

ay 1.11E-01 m



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

42.6	1.7E-08
88.0	1.4E-08
127.6	1.1E-11
170.0	8.7E-16
212.6	6.8E-18
266.0	6.3E-21
217.6	4.2E-24
340.0	3.3E-27
382.6	2.6E-30
426.0	2.0E-33
487.6	1.8E-36
610.0	1.3E-39
662.6	9.9E-43
888.0	6.1E-49
880.0	4.9E-52
722.6	3.8E-56
766.0	3.0E-58
807.6	2.4E-61
860.0	1.9E-64

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.

This sheet calculates the Tier3 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

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 Tier 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.

Site being assessed: Blessington area 6
Completed by: Anna Jeffcoat
Date: 23/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant **monoclaal Nitrogen as N**
 Target Concentration C_T 1.20E-01 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) **1**

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) **0**

Initial contaminant concentration in groundwater at plume core	C_0	4.00E-01	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	2.19E+02	days	
Calculated decay rate	λ	3.17E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	S_z	8.00E+01	m	
Plume thickness at source	S_y	5.60E+01	m	
Saturated aquifer thickness	d_a	5.71E+01	m	
Bulk density of aquifer materials	ρ	2.170E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	K_d	5.00E-01	l/kg	see options
Longitudinal dispersivity	α_x	11.114	m	see options
Transverse dispersivity	α_z	1.111	m	see options
Vertical dispersivity	α_y	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	R_f	5.67E+00	fraction
Decay rate used	λ	3.17E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	4.75E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{1D}	1.28E-03	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{2D}	1.23E-03	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D})	AF	3.12E+02	
Attenuation factor (two way vertical dispersion, C_0/C_{2D})	AF	3.25E+02	

Remedial Targets

Remedial Target	LTC3	3.74E+01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	1.28E-03	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
 Soil water partition coefficient K_d 5.00E-01 l/kg
 Entry for non-polar organic chemicals (option)
 Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
 Organic carbon partition coefficient K_{oc} 5.00E-01 l/kg
 Entry for ionic organic chemicals (option)
 Sorption coefficient for related species $K_{oc,1}$ l/kg
 Sorption coefficient for ionised species $K_{oc,2}$ l/kg
 pH value pH
 acid dissociation constant pK_a

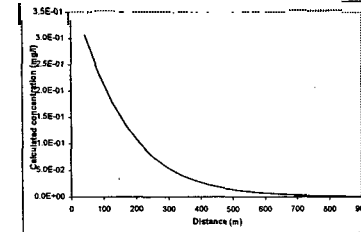
Soil water partition coefficient K_d 5.00E-01 l/kg

Dispersivity Calculate dependent on distance to compliance point (D) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity	α_x	11.11E+01	m
Transverse dispersivity	α_z	1.11E+00	m
Vertical dispersivity	α_y	1.11E-01	m

For calculated value, assumes $\alpha_x = 0.1 \lambda$, $\alpha_z = 0.01 \lambda$, $\alpha_y = 0.001 \lambda$
 Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10} D)^{1.1}$; $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
42.5	3.1E-01
86.0	2.3E-01
127.5	1.8E-01
170.0	1.3E-01
212.5	9.9E-02
255.0	7.4E-02
297.5	5.6E-02
340.0	4.1E-02
382.5	3.1E-02
425.0	2.3E-02
467.5	1.7E-02
510.0	1.3E-02
552.5	9.6E-03
595.0	7.1E-03
637.5	5.4E-03
680.0	4.0E-03
722.5	3.0E-03
765.0	2.3E-03
807.5	1.7E-03
850.0	1.3E-03

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Blislington area 6
 Completed by: Anna Jeffcoat
 Date: 23/11/2005
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Aromatic C7-C8
Target Concentration C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core C₀ 7.70E-02 mg/l
Half life for degradation of contaminant in water t_{1/2} 7.30E+02 days
Calculated decay rate λ 9.50E-04 days⁻¹
Width of plume in aquifer at source (perpendicular to flow) Sz 8.00E+01 m
Plume thickness at source Sy 5.00E+01 m
Saturated aquifer thickness da 5.71E+01 m
Bulk density of aquifer materials ρ 1.70E+02 g/cm³
Effective porosity of aquifer n 1.82E-01 fraction
Hydraulic gradient i 7.00E-03 fraction
Hydraulic conductivity of aquifer K 7.00E+01 m/d
Distance to compliance point x 8.50E+02 m
Distance (lateral) to compliance point perpendicular to flow direction y 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction z 0.00E+00 m
Time since pollutant entered groundwater t 9.90E+99 days *time variant options only*

Parameters values determined from options
Partition coefficient K_d 9.12E-01 l/kg see options
Longitudinal dispersivity α_x 11.114 m see options
Transverse dispersivity α_z 1.111 m see options
Vertical dispersivity α_y 0.111 m see options

Calculated Parameters Variable

Groundwater flow velocity v 2.69E-01 m/d
Retardation factor R_f 9.52E+00 fraction
Decay rate used λ 9.50E-04 d⁻¹
Rate of contaminant flow due to retardation u 2.83E-02 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C_{ED} 1.21E-11 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C_{ED} 1.16E-11 mg/l
Attenuation factor (one way vertical dispersion, C₀/C_{ED}) AF 8.34E+09
Attenuation factor (two way vertical dispersion, C₀/C_{ED}) AF 6.62E+08

Remedial Targets

Remedial Target LTCS 4.53E+08 mg/l For comparison with measured groundwater concentration.
Ogata Banks
Distance to compliance point 860 m
Concentration of contaminant at compliance point C_{ED}/C₀ 1.21E-11 mg/l Ogata Banks
after 9.9E+99 days

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) K_d 9.12E-01 l/kg
Entry for non-polar organic chemicals (option) Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 9.12E-01 l/kg
Entry for ionic organic chemicals (option) Sorption coefficient for related species K_{ow} 1 l/kg
Sorption coefficient for ionised species K_{ow} 1 l/kg
pH value pH 7
acid dissociation constant pKa 4

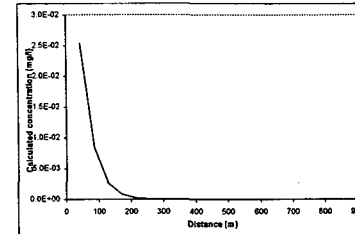
Soil water partition coefficient K_d 9.12E-01 l/kg

Dispersivity Calculate dependant on distance to compliance point (0) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity α_x 1.11E+01 m
Transverse dispersivity α_z 1.11E+00 m
Vertical dispersivity α_y 1.11E-01 m

For calculated value, assumes α_x = 0.1 * x, α_z = 0.01 * x, α_y = 0.001 * x
Xu & Eckstein (1995) report α_x = 0.83(log₁₀x)^{0.75}; α_z = α_x/10, α_y = α_x/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks	From calculation sheet	Distance	Concentration
			mg/l
42.5	2.5E-02		
92.5	8.3E-03		
212.5	8.0E-04		
288.0	8.9E-05		
340.0	9.4E-06		
382.5	3.0E-06		
426.0	9.7E-07		
487.5	3.1E-07		
610.0	1.0E-07		
688.0	3.3E-08		
807.6	3.7E-11		
850.0	1.2E-11		

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bressington
Completed by: AJ
Date: 23/11/2005
Version: 11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Aromatic C8-C10
Target Concentration: C_T 7.14E-04 mg/l

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

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C_0	2.12E-02	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days
Calculated decay rate	λ	3.80E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.60E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	8.50E+02	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
Parameters values determined from options			
Partition coefficient	Kd	5.75E+00	l/kg
Longitudinal dispersivity	α_x	1.111	m
Transverse dispersivity	α_z	1.111	m
Vertical dispersivity	α_y	0.111	m

Calculated Parameters

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	5.47E+01	fraction
Decay rate used	λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	4.92E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{1D}	5.96E-21	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{2D}	5.71E-21	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D})	AF	3.58E+18	
Attenuation factor (two way vertical dispersion, C_0/C_{2D})	AF	3.71E+18	

Remedial Targets

Remedial Target	LTC3	2.64E+18	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	5.96E-21	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

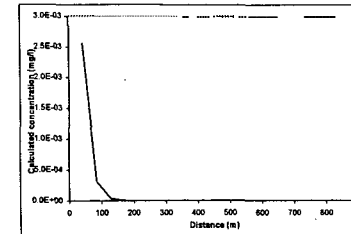
Soil water partition coefficient	Kd	5.75E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	5.75E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K_{ow}		l/kg
Sorption coefficient for ionised species	K_{ow}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	5.75E+00	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0), specify dispersivity (1), or calc after Xu & Eckstein (2)?

Longitudinal dispersivity	α_x	1.11E+01	m
Transverse dispersivity	α_z	1.11E+00	m
Vertical dispersivity	α_y	1.11E-01	m

For calculated value, assumes $\alpha_x = 0.1 \cdot x$, $\alpha_z = 0.01 \cdot x$, $\alpha_y = 0.001 \cdot x$ Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10}d)^{0.1114}$, $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration	mg/l
42.5	2.6E-03	
85.0	3.1E-04	
127.6	3.7E-05	
170.0	4.3E-06	
212.6	5.1E-07	
256.0	6.0E-08	
300.0	7.0E-09	
345.0	8.1E-10	

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.

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Blossington site 6
Completed by: Anna Jeffcoat
Date: 23 11 2005
Version: 11

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Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Aromatic C10-C12		
Target Concentration	C _T	7.14E-04	mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) **1**

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) **0**

Initial contaminant concentration in groundwater at plume core	C ₀	2.12E-02	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	1.83E+03	days	
Calculated decay rate	λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.60E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	17.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (latera) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	9.12E+00	l/kg	see options
Longitudinal dispersivity	αx	11.114	m	see options
Transverse dispersivity	αz	1.111	m	see options
Vertical dispersivity	αy	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	8.62E+01	fraction
Decay rate used	λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	3.12E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	5.18E-28	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	4.98E-28	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	4.10E+25	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	4.27E+25	

Remedial Targets

Remedial Target	LTC3	2.82E+22	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C _{2D} /C ₀	5.18E-28	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	9.12E+00 l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.00E+00 fraction
Organic carbon partition coefficient	Koc	9.12E+00 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,rel}	l/kg
Sorption coefficient for ionised species	K _{ow,rel}	l/kg
pH value	pH	
acid dissociation constant	pKa	

Source of parameter value

Soil water partition coefficient	Kd	9.12E+00	l/kg
Dispersivity			
Calculate dependant on distance to compliance point (D)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	αx	11.11E+01	m
Transverse dispersivity	αz	1.11E+00	m
Vertical dispersivity	αy	1.11E-01	m

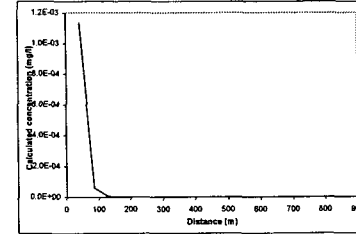
Soil water partition coefficient Kd 9.12E+00 l/kg

Calculate dependant on distance to compliance point (D) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity	αx	11.11E+01	m
Transverse dispersivity	αz	1.11E+00	m
Vertical dispersivity	αy	1.11E-01	m

For calculated value, assumes αx = 0.1 * x, αz = 0.01 * z, αy = 0.001 * y
Xu & Eckstein (1995) report αx = 0.83(log₁₀ t)^{0.433}; αz = αx/10, αy = αx/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
426.0	6.1E-08
127.6	3.2E-06
170.0	1.7E-07
232.6	8.7E-09
268.0	4.4E-10
237.6	2.4E-11
340.6	6.4E-18
426.0	3.3E-16
447.5	1.7E-16
610.0	9.1E-18
622.5	4.7E-19
696.0	2.8E-20
847.6	1.3E-21
880.0	6.3E-23
722.6	3.6E-24
785.0	1.9E-25
807.5	9.9E-27
850.0	5.2E-28

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed	Eslington area B
Completed by	Anna Jeffcoat
Date	23 11 2005
Version	11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a
Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value unit Source

Contaminant: Aromatic C12-C16
Target Concentration: C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	2.12E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.83E+03	days	
Calculated decay rate λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	7.80E+01	m	
Plume thickness at source Sy	5.50E+01	m	
Saturated aquifer thickness da	5.71E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	7.00E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient Kd	1.82E+01	l/kg	see options
Longitudinal dispersivity ax	11.114	m	see options
Transverse dispersivity az	1.111	m	see options
Vertical dispersivity ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	2.69E-01	m/d
Retardation factor Rf	1.71E+02	fraction
Decay rate used λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation u	1.58E-03	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	7.69E-43	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	7.37E-43	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	2.76E+40	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	2.87E+40	

Remedial Targets

Remedial Target	LYC3	1.97E+37	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		880	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	7.69E-43	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

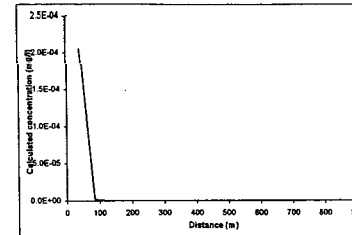
Calculate for non-polar organic chemicals

Entry if specific partition coefficient (option) Kd		l/kg
Soil water partition coefficient Kd	1.82E+01	l/kg
Entry for non-polar organic chemicals (option) foc	1.00E+00	fraction
Fraction of organic carbon in aquifer foc	1.82E+01	fraction
Organic carbon partition coefficient Koc		l/kg
Entry for ionic organic chemicals (option) Koc_{org}		l/kg
Sorption coefficient for related species Koc_{rel}		l/kg
Sorption coefficient for ionised species Koc_{ion}		l/kg
pH value pH		
acid dissociation constant pKa		
Soil water partition coefficient Kd	1.82E+01	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0) ax	2	Enter value	Calc value Xu & Eckstein	1.11E+01	m
specify dispersivity (1), or calc after Xu & Eckstein (2) ? ax				1.11E+00	m
Longitudinal dispersivity ax				1.11E-01	m
Transverse dispersivity az					
Vertical dispersivity ay					

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$
Xu & Eckstein (1995) report $ax = 0.63(\log_{10} C_0^{0.45})$; $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Distance Concentration

42.6	2.12E-04
96.0	2.0E-06
120.0	1.9E-08
268.0	1.8E-10
297.6	1.8E-12
340.0	1.8E-14

426.0	1.3E-22
467.6	1.2E-24
610.0	1.2E-26
662.6	1.1E-28
696.0	1.0E-30

698.0	9.3E-35
722.6	8.9E-37
765.0	8.6E-39
907.6	8.1E-41
850.0	7.7E-43

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Blossington area 6
Completed by: Anna Jeffcoat
Date: 23/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Aromatic C16-C21
Target Concentration C_T 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Variable	Value	Unit	Source of parameter value
C ₀	2.12E-02	mg/l	
t _{1/2}	3.85E+03	days	
λ	1.90E-04	days ⁻¹	
Sz	8.00E+01	m	
Sy	5.60E+01	m	
da	5.71E+01	m	
p	1.70E+00	g/cm ³	
n	1.82E-01	fraction	
i	7.00E-03	fraction	
K	7.00E+00	m/d	
x	8.50E+02	m	
z	0.00E+00	m	
y	0.00E+00	m	
t	9.90E+99	days	time variant options only
Kd	5.75E+01	1/kg	see options
ax	11.114	m	see options
az	1.111	m	see options
ay	0.111	m	see options

Calculated Parameters Variable

v	2.69E-01	m/d
Rf	5.38E+02	fraction
λ	1.90E-04	d ⁻¹
u	5.00E-04	m/d
C _{ED}	3.26E-56	mg/l
C _{ED}	3.12E-56	mg/l
AF	6.51E+53	
AF	6.79E+53	

Remedial Targets

Remedial Target	LTC3	Value	Unit	Source
Ogata Banks		4.85E+50	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		860	m	
Concentration of contaminant at compliance point	C _{ED} /C ₀	3.26E-56	mg/l	Ogata Banks
after		6.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient K_d 5.75E+01 1/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 5.75E+01 1/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow} 1/kg
Sorption coefficient for ionised species K_{oc1} 1/kg
pH value pH
acid dissociation constant pKa

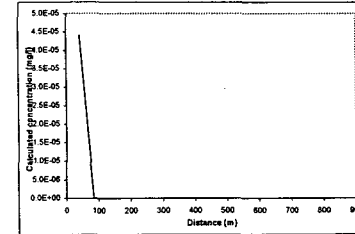
Soil water partition coefficient K_d 5.75E+01 1/kg

Dispersivity Calculate dependant on distance to compliance point (D) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax 1.11E+01 m
Transverse dispersivity az 1.11E+00 m
Vertical dispersivity ay 1.11E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀μ^{0.4}); az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
42.6	4.4E-05
132.0	3.9E-09
170.0	3.8E-13
258.0	1.8E-18
297.6	3.2E-21
340.0	6.4E-24
382.6	1.3E-26
488.0	8.6E-30
610.0	1.1E-34
682.6	2.2E-37
696.0	4.9E-40
637.5	9.2E-43
680.0	1.9E-46
722.6	3.8E-48
711.0	7.8E-51
807.6	1.6E-63
860.0	3.3E-66

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Blasington area 6
Completed by: Anna Jettical
Date: 23/11/2005
Version: 11

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Aromatic C21-C35
Target Concentration C_r 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core	C ₀	2.12E-02	mg/l
Half life for degradation of contaminant in water	t _{1/2}	3.65E+03	days
Calculated decay rate	λ	1.90E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.80E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	8.90E+02	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days

Parameters values determined from options

Partition coefficient	Kd	4.57E+02	l/kg	see options
Longitudinal dispersivity	ax	11.114	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.89E-01	m/d
Retardation factor	Rf	4.27E+03	fraction
Decay rate used	λ	1.90E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	8.31E-05	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	7.31E-179	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	7.01E-179	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	2.90E+178	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	3.02E+178	

Remedial Targets

Remedial Target	LTC3	2.07E+173	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	7.31E-179	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd [] l/kg
Soil water partition coefficient
Entry for non-polar organic chemicals (option) f_{oc} 1.00E+00 fraction
Fraction of organic carbon in aquifer
Organic carbon partition coefficient K_{oc} 4.57E+02 l/kg
Entry for ionic organic chemicals (option) K_{oc,ion} [] l/kg
Sorption coefficient for related species
Sorption coefficient for ionised species K_{oc,i} [] l/kg
pH value pH []
acid dissociation constant pKa []

Soil water partition coefficient Kd 4.57E+02 l/kg

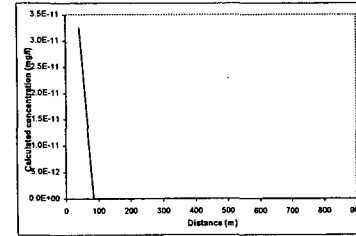
Dispersivity

Calculate dependent on distance to compliance point (D) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity	ax	1.11E+01 m
Transverse dispersivity	az	1.11E+00 m
Vertical dispersivity	ay	1.11E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * z, ay = 0.001 * y
Xu & Eckstein (1995) report ax = 0.83(log₁₀p)^{0.111}; az = ax/10, ay = ax/100 are assumed



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

Calculated concentrations for distance-concentration graph

Distance	Concentration
Ogata Banks	
From calculation sheet	
42.5	3.3E-11
88.0	6.0E-20
127.5	7.6E-29
170.0	1.1E-37
212.5	1.7E-46
255.0	2.5E-55
297.5	3.8E-64
340.0	5.6E-73
382.5	8.4E-82
425.0	1.3E-90
467.5	1.9E-99
510.0	2.8E-108
552.5	4.2E-117
595.0	6.3E-126
637.5	9.6E-135
680.0	1.4E-143
722.5	2.1E-152
765.0	3.2E-161
807.5	4.9E-170
850.0	7.3E-179

This sheet calculates the Tier3 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

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 Tier 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.

Site being assessed	Blessington
Completed by	AJ
Date	23 11 2005
Version	11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Arsenic		
Target Concentration	C _T	1.00E-02	mg/l

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

Ogata Banks	Equations in R&D Pub. 20
-------------	--------------------------

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	C ₀	1.40E-02	mg/l
Half life for degradation of contaminant in water	t _{1/2}	1.930E+99	days
Calculated decay rate	λ	7.00E-101	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.60E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance (latera) to compliance point	x	8.50E+02	m
Distance (depth) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	1.17E+02	l/kg
Longitudinal dispersivity	α _x	11.114	m
Transverse dispersivity	α _z	1.111	m
Vertical dispersivity	α _y	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	1.10E+03	fraction
Decay rate used	λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation	u	2.45E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	9.00E-03	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	8.02E-03	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	1.58E+00	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	1.62E+00	

Remedial Targets	Remedial Target	Value	Unit	Source
Ogata Banks	LTC3	1.56E-02	mg/l	For comparison with measured groundwater concentration.
	Distance to compliance point	850	m	
	Concentration of contaminant at compliance point	C _{1D} /C ₀	9.00E-03	mg/l Ogata Banks
	after	9.9E+99	days	

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

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

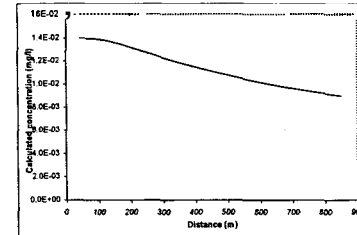
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	1.17E+02	l/kg
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	1.17E+02	l/kg
Sorption coefficient for related species	K _{ow}	1.17E+02	l/kg
Sorption coefficient for ionised species	K _{oc(i)}	1.17E+02	l/kg
pH value	pH		
acid dissociation constant	pKa		

Dispersivity

Calculate dependent on distance to compliance point (D)	2		
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	α _x	1.11E+01	m
Transverse dispersivity	α _z	1.11E+00	m
Vertical dispersivity	α _y	1.11E-01	m

For calculated value, assumes α_x = 0.1 * x, α_z = 0.01 * x, α_y = 0.001 * x
Xu & Eckstein (1995) report α_x = 0.83(log₁₀α_x)^{0.75}, α_z = α_x/10, α_y = α_x/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
Distance to Compliance Point

mg/l
42.6
86.0
129.6
212.6
288.8
340.0
382.6

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.

488.0
610.0
662.6
696.0
637.6
680.0
722.6
786.0
807.6
860.0

This sheet calculates the Tier 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. 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 Tier 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

Site being assessed	Birstington area 6
Completed by	Anna Jeffcoat
Date	23/11/2005
Version	11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Benzene
Target Concentration	C _T 1.00E-03 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	2.12E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	7.20E+02	days	
Calculated decay rate	λ	9.63E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.60E+01	m	
Saturated aquifer thickness	da	6.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (later) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	2.14E-01	l/kg	see options
Longitudinal dispersivity	ax	11.114	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.63E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	8.98E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	3.65E-05	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	3.50E-05	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	5.80E+03	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	6.05E+03	

Remedial Targets

Remedial Target	LTC3	6.90E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	3.65E-05	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient K_d 2.14E-01 l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 2.14E-01 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow} 1.00E+00 l/kg
Sorption coefficient for ionized species K_{ow} 1.00E+00 l/kg
pH value pH 7.00
acid dissociation constant pKa 4.00

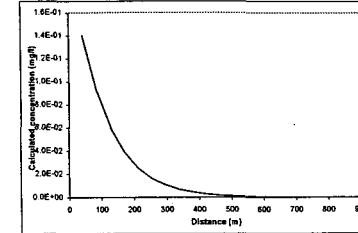
Soil water partition coefficient K_d 2.14E-01 l/kg

Dispersivity

Calculate dispersivity on distance to compliance point (D) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein	1.11E+01	m
Transverse dispersivity	az			1.11E+00	m
Vertical dispersivity	ay			1.11E-01	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀d)^{0.433}, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

Distance	Concentration
42.6	1.4E-01
86.0	9.3E-02
127.6	6.1E-02
170.0	3.9E-02
212.6	2.6E-02
266.0	1.8E-02

288.8	6.8E-03
328.6	4.8E-03

487.6	1.8E-03
610.0	1.2E-03
662.6	7.6E-04
696.0	4.9E-04
637.6	3.2E-04
680.0	2.1E-04

722.6	8.8E-05
107.6	5.6E-05
680.0	3.7E-05

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.

This sheet calculates the Tier3 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. 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 Tier 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

Site being assessed	Blessington
Completed by	AJ
Date:	23 11 2005
Version	11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 -Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Boron		
Target Concentration	C _T	1.00E+00	mg/l

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

Ogata Banks	Equations in R&D Pub. 20
-------------	--------------------------

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	2.70E+01	mg/l
Half life for degradation of contaminant in water	t _{1/2}	9.90E+99	days
Calculated decay rate	λ	7.00E-101	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.60E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	8.50E+02	m
Distance (laterally) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	0.00E+00	l/kg
Longitudinal dispersivity	ax	11.114	m
Transverse dispersivity	ay	1.111	m
Vertical dispersivity	ay	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d ⁻¹
Rate of contaminant flow due to retardation	u	2.69E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	1.73E+01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	1.66E+01	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	1.56E+00	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	1.62E+00	

Remedial Targets

Remedial Target	LYCS	1.66E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	1.73E+01	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

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

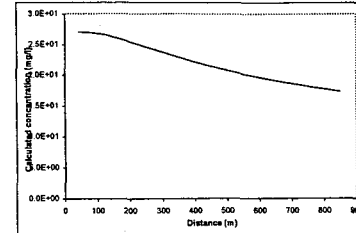
Soil water partition coefficient Kd 0.00E+00 l/kg

Dispersivity Calculate dependent on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity	ax	1.11E+01	m
Transverse dispersivity	az	1.11E+00	m
Vertical dispersivity	ay	1.11E-01	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀μ²)^{0.17}; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks		
From calculation sheet		
Distance	Concentration	mg/l
426	2.7E+01	340.0
1020.0	2.7E+01	382.5
170.0	2.6E+01	428.0
212.6	2.6E+01	467.5
269.0	2.4E+01	610.0
		552.5
		696.0
		637.5
		850.0
		765.0
		807.5
		850.0

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed	Blossington area 9
Completed by	Anno Jetticot
Date	23/11/2005
Version	11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Chlorobenzene		
Target Concentration	C _T	1.00E-03	mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core	C ₀	3.30E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	3.00E+02	days	
Calculated decay rate	λ	2.31E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.60E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	1.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	7.94E-01	l/kg	see options
Longitudinal dispersivity	ax	11.114	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	8.42E+00	fraction
Decay rate used	λ	2.31E-03	d ⁻¹
Rate of contaminant flow due to retardation	u	3.20E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	7.11E-20	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	8.81E-20	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	4.84E+17	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	4.85E+17	

Remedial Targets

Remedial Target	LTC3	4.94E+14	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	7.11E-20	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
 Soil water partition coefficient Kd l/kg
 Entry for non-polar organic chemicals (option)
 Fraction of organic carbon in aquifer foc 1.00E+00 fraction
 Organic carbon partition coefficient Koc 7.94E-01 l/kg
 Entry for ionic organic chemicals (option)
 Sorption coefficient for related species K_{oc,1} l/kg
 Sorption coefficient for ionised species K_{oc,2} l/kg
 pH value pH
 acid dissociation constant pKa

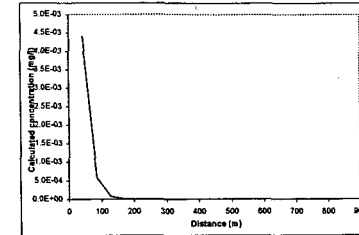
Soil water partition coefficient Kd 7.94E-01 l/kg

Dispersivity

Calculate dependant on distance to compliance point (0) 2
 specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity	ax	11.11E+01	m
Transverse dispersivity	az	1.11E+00	m
Vertical dispersivity	ay	1.11E-01	m

For calculated value, assumes ax = 0.1 m, az = 0.01 m, ay = 0.001 m
 Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.11}, az = az/10, ay = ay/100 are assumed



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

Calculated concentrations for distance-concentration graph

Ogata Banks
 From calculation sheet
 Distance Concentration

	mg/l
426	4.4E-03
850	5.9E-04
127.6	7.8E-06
170.0	1.0E-06
212.5	1.3E-06
255.0	1.7E-07
297.5	2.2E-08
340.0	2.9E-09
382.6	3.7E-10
426.0	4.9E-11
467.6	6.3E-12
610.0	8.3E-13
662.6	1.1E-13
695.0	1.4E-14
637.6	1.8E-16
680.0	2.4E-16
722.5	3.2E-17
765.0	4.1E-18
607.6	5.4E-19
860.0	7.1E-20

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed:	Blossington
Completed by:	AJ
Date:	23 11 2005
Version:	11



ENVIRONMENT AGENCY

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Date of Workbook Issue: April 2002

This worksheet has been produced in combination with the document 'Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources' - Environment Agency R&D Publication 20, (1999).

Users of this worksheet should always refer to the User Manual, to R&D Publication 20 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 fi

(Details to be completed for each assessment)

Site Name:	Blessington Appeal		
Site Address:	Area 6 Res		
Completed by:	Anna Jeffcoat	Version:	11
Date:	25-Nov-05		
Contaminant	Chloroethane		
Target Concentration (C _T)	0.001 mg/l	Origin of C _T :	from Benzene 98/83/EC

This worksheet can be used to determine remedial targets for soils (Worksheets Tier 1 Soil, Tier 2 Soil and Tier 3 Soil) or to determine remedial targets for groundwater (Tier 3 Groundwater). For Tier 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations). Site details entered on this page are automatically copied to Tier 1, 2 and 3 Worksheets. Worksheet options are identified by brown background and employ a pull-down menu or require a "0", "1" or "2" to be entered. Data entry are identified as blue background. Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports. It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The worksheet also calculates a number of frequently used hydrogeological equations.

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Ethylbenzene
Target Concentration C_T 1.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core C₀ 1.32E+00 mg/l
Half life for degradation of contaminant in water t_{1/2} 2.28E+02 days
Calculated decay rate λ 3.04E-03 days⁻¹
Width of plume in aquifer at source (perpendicular to flow) Sz 8.00E+01 m
Plume thickness at source Sy 5.60E+01 m
Saturated aquifer thickness da 5.71E+01 m
Bulk density of aquifer materials ρ 1.70E+00 g/cm³
Effective porosity of aquifer n 1.82E-01 fraction
Hydraulic gradient I 7.00E-03 fraction
Hydraulic conductivity of aquifer K 7.00E+00 m/d
Distance to compliance point z 1.850E+02 m
Distance (lateral) to compliance point perpendicular to flow direction x 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction y 0.00E+00 m
Time since pollutant entered groundwater t 9.90E+99 days

Parameters values determined from options
Partition coefficient Kd 1.32E+00 l/kg see options
Longitudinal dispersivity α_x 11.114 m see options
Transverse dispersivity α_z 1.111 m see options
Vertical dispersivity α_y 0.111 m see options

Calculated Parameters Variable
Groundwater flow velocity v 2.69E-01 m/d
Retardation factor Rf 1.33E+01 fraction
Decay rate used λ 3.04E-03 d⁻¹
Rate of contaminant flow due to retardation u 2.02E-02 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C_{0z} 3.20E-30 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C_{0y} 3.07E-30 mg/l
Attenuation factor (one way vertical dispersion, C₀/C_{1z}) AF 4.12E+29
Attenuation factor (two way vertical dispersion, C₀/C_{1y}) AF 4.30E+29

Remedial Targets Remedial Target LTC3 4.12E+27 mg/l For comparison with measured groundwater concentration.

Ogata Banks
Distance to compliance point 860 m
Concentration of contaminant at compliance point after C_{2p}/C₀ 3.20E-30 mg/l
Ogata Banks
after 9.9E+99 days

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

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

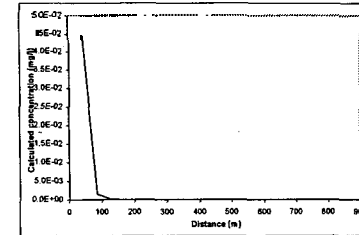
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd 1.32E+00 l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 1.32E+00 l/kg
Sorption coefficient for related species K_{ow} 1.32E+00 l/kg
Sorption coefficient for ionised species K_{ow,i} 1.32E+00 l/kg
pH value pH
acid dissociation constant pKa
Soil water partition coefficient Kd 1.32E+00 l/kg

Dispersivity
Calculate dependent on distance to compliance point (0) 2
specify dispersivity (1), or calc after Xu & Eckstein (2)?

Longitudinal dispersivity α_x 1.11E+01 m
Transverse dispersivity α_z 1.11E+00 m
Vertical dispersivity α_y 1.11E-01 m

For calculated value, assumes α_x = 0.1 * z, α_z = 0.01 * z, α_y = 0.001 * z
Xu & Eckstein (1995) report α_x = 0.83(log₁₀z)^{0.411}; α_z = α_x/10, α_y = α_x/100 are assumed



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

Calculated concentrations for distance-concentration graph

Distance	Concentration
42.6	4.6E-02
86.0	1.6E-03
127.6	6.0E-05
170.0	1.7E-06
212.6	6.4E-08
266.0	1.8E-09
297.6	6.8E-11
340.0	1.9E-12
382.6	6.3E-14
486.0	8.8E-18
610.0	2.2E-18
652.6	7.4E-20
696.0	2.4E-21
017.6	8.0E-23
680.0	1.1E-24
722.6	8.5E-26
766.0	2.9E-27
807.6	9.6E-29
860.0	3.2E-30

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Bishington
Compiled by: AJ
Date: 23/11/2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 -Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T Isopropylbenzene 1.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core	C ₀	8.80E-02	mg/l
Half life for degradation of contaminant in water	t _{1/2}	8.20E+02	days
Calculated decay rate	λ	9.63E-04	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Da	6.60E+01	m
Saturated aquifer thickness	sy	5.71E+01	m
Bulk density of aquifer materials	p	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.00E-03	fraction
Hydraulic conductivity of aquifer	K	1.00E+00	m/d
Distance to compliance point	x	8.50E+02	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days
Parameters values determined from options			
Partition coefficient	Kd	2.14E-01	V/kg
Longitudinal dispersivity	αx	11.114	m
Transverse dispersivity	αz	1.111	m
Vertical dispersivity	αy	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.63E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	8.80E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	1.52E-05	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	1.45E-05	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C _T)	AF	5.80E+03	
Attenuation factor (two way vertical dispersion, C _{2D} /C _T)	AF	6.05E+03	

Remedial Targets

Remedial Target	LTC3	5.90E+01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	1.52E-06	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Kd [] V/kg
 Soil water partition coefficient
 Entry for non-polar organic chemicals (option) f_{oc} 1.00E+00 fraction
 Fraction of organic carbon in aquifer
 Organic carbon partition coefficient K_{oc} 2.14E-01 V/kg
 Entry for ionic organic chemicals (option) K_{ow} [] V/kg
 Sorption coefficient for related species
 Sorption coefficient for ionised species K_{ow,i} [] V/kg
 pH value pH []
 acid dissociation constant pKa []

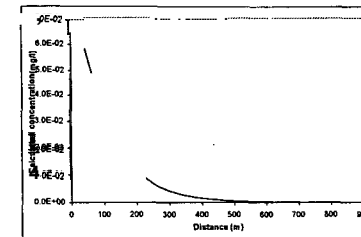
Soil water partition coefficient Kd 2.14E-01 V/kg

Dispersivity Calculate dependant on distance to compliance point (0) 2

specific dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity	αx	1.11E+01	m
Transverse dispersivity	αz	1.11E+00	m
Vertical dispersivity	αy	1.11E-01	m

For calculated value, assumes αx = 0.1 * x, αz = 0.01 * x, αy = 0.001 * x
 Xu & Eckstein (1995) report αx = 0.83(log₁₀x)^{0.111}; αz = αz/10, αy = αz/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks		
From calculation sheet	Distance	Concentration
		mg/l
	88.8	3.9E-02
	127.6	2.6E-02
	170.0	1.0E-02
	212.6	1.1E-02
	265.0	4.8E-03
	297.5	4.4E-03
	340.0	2.8E-03
	382.6	1.8E-03
	426.0	1.2E-03
	467.5	7.6E-04
	610.0	4.8E-04
	652.6	3.1E-04
	696.0	2.0E-04
	837.6	1.1E-04
	880.0	8.8E-05
	722.6	6.6E-05
	785.0	3.8E-05
	807.6	2.3E-05
	860.0	1.6E-05

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Blottington
 Completed by: AJ
 Date: 23/11/2005
 Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant n-butylbenzene
Target Concentration C_T 1.00E-03 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' if biodegradation rate is for the substance in water, '2' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core C₀ 1.27E-01 mg/l

Half life for degradation of contaminant in water t_{1/2} 9.99E+99 days

Calculated decay rate λ 8.94E-101 days⁻¹

Width of plume in aquifer at source (perpendicular to flow) Sz 8.00E+01 m

Plume thickness at source Sy 5.00E+01 m

Saturated aquifer thickness da 5.71E+01 m

Bulk density of aquifer materials ρ 1.70E+00 g/cm³

Effective porosity of aquifer n 1.82E-01 fraction

Hydraulic gradient I 7.00E-03 m/d

Hydraulic conductivity of aquifer K 7.00E+00 m/d

Distance to compliance point x 8.50E+02 m

Distance (lateral) to compliance point perpendicular to flow direction z 0.00E+00 m

Distance (depth) to compliance point perpendicular to flow direction y 0.00E+00 m

Time since pollutant entered groundwater t 9.90E+99 days

Parameters values determined from options

Partition coefficient Kd 8.91E+00 kg/see options

Longitudinal dispersivity αx 11.111 m/see options

Transverse dispersivity αz 1.111 m/see options

Vertical dispersivity αy 0.111 m/see options

Calculated Parameters Variable

Groundwater flow velocity v 2.69E-01 m/d

Retardation factor Rf 8.42E+01 fraction

Decay rate used λ 8.94E-101 d⁻¹

Rate of contaminant flow due to retardation u 3.20E-03 m/d

Contaminant concentration at distance x, assuming one-way vertical dispersion C_{1D} 8.16E-02 mg/l

Contaminant concentration at distance x, assuming two-way vertical dispersion C_{2D} 7.82E-02 mg/l

Attenuation factor (one way vertical dispersion, C_{1D}/C₀) AF 1.59E+00

Attenuation factor (two way vertical dispersion, C_{2D}/C₀) AF 1.82E+00

Remedial Targets

Remedial Target LYCS 1.50E-03 mg/l For comparison with measured groundwater concentration.

Ogata Banks

Distance to compliance point 850 m

Concentration of contaminant at compliance point C_{1D}/C₀ 8.16E-02 mg/l Ogata Banks

after 9.9E+99 days

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 8.91E+00 kg/see options

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction

Organic carbon partition coefficient K_{oc} 8.91E+00 kg/see options

Entry for ionic organic chemicals (option)

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

pH value pH

acid dissociation constant pK_a

Soil water partition coefficient Kd 8.91E+00 kg/see options

Dispersivity

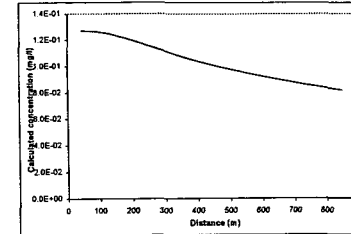
Calculate dispersivity dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2)? 2

Longitudinal dispersivity αx 1.11E+01 m/Enter value

Transverse dispersivity αz 1.11E+00 m/Calc value

Vertical dispersivity αy 1.11E-01 m/Xu & Eckstein

For calculated value, assumes αx = 0.1 * x, αz = 0.01 * x, αy = 0.001 * x. Xu & Eckstein (1995) report αx = 0.83(log₁₀t)^{0.433}; αz = αx/10, αy = αx/100 are assumed



Calculated concentrations for distance-concentration graph

From Remediation sheet

Distance Concentration

42.6 1.3E-01
86.0 1.3E-01
127.5 1.2E-01
170.0 1.2E-01

268.0 1.2E-01
297.5 5.7E-01
340.0 1.1E-01
382.5 1.1E-01

425.0 1.0E-01
467.5 1.0E-01
510.0 9.7E-02
552.5 9.5E-02

605.0 9.3E-02
680.0 8.8E-02
722.5 8.7E-02
765.0 8.6E-02
808.0 8.5E-02

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

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed Blessington
Completed by AJ
Date 23/11/2005
Version 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Naphthalene
Target Concentration: C_T 1.00E-03 mg/l

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

Ogata Banks

Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C_0	4.67E-01	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	2.58E+02	days	
Calculated decay rate	λ	2.69E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.00E+01	m	
Saturated aquifer thickness	da	3.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (latera) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	7.24E+00	l/kg	see options
Longitudinal dispersivity	ax	11.114	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	6.87E+01	fraction
Decay rate used	λ	2.69E-03	d ⁻¹
Rate of contaminant flow due to retardation	u	3.92E-03	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion	C_{1D}	8.73E-78	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion	C_{2D}	9.96E-78	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D})	AF	5.35E+76	
Attenuation factor (two way vertical dispersion, C_0/C_{2D})	AF	5.58E+76	

Remedial Targets

Remedial Target	LTC3	6.35E+03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	8.73E-78	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	7.24E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K_{oc}		l/kg
Sorption coefficient for ionised species	K_{oc}		l/kg
pH value	pH		
acid dissociation constant	pKa		

Soil water partition coefficient Kd 7.24E+00 l/kg

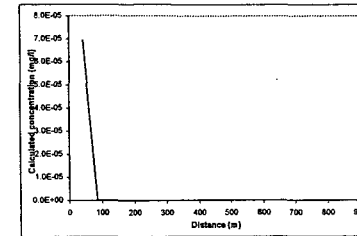
Dispersivity

Calculate dependent on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity	ax	Enter value	Calc value	Xu & Eckstein	m
Transverse dispersivity	az				1.11E+00 m
Vertical dispersivity	ay				1.11E-01 m

For calculated value, assumes $ax = 0.1 \cdot x$, $az = 0.01 \cdot x$, $ay = 0.001 \cdot x$
Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{0.41}$; $az = ax/10$, $ay = ax/100$ are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
42.6	7.0E-06
86.0	1.0E-08
127.6	1.5E-12
170.0	2.2E-16
212.6	3.2E-20
266.0	4.6E-24

399.0	6.7E-28
352.6	1.4E-33

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.

482.6	2.9E-33
610.0	4.3E-47

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Basingstoke
Completed by: AJ
Date: 23 11 2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull-down menu) Variable Value Unit Source

Contaminant	Propylbenzene		
Target Concentration	C _r	1.00E-03	mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	5.60E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t _{1/2}	7.20E+02	days	
Calculated decay rate	λ	9.63E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.80E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	2.14E-01	l/kg	see options
Longitudinal dispersivity	ax	11.114	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.63E-04	d ⁻¹
Rate of contaminant flow due to retardation	u	8.98E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	9.65E-06	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	9.25E-06	mg/l
Attenuation factor (one way vertical dispersion, C _{1D} /C ₀)	AF	5.80E+03	
Attenuation factor (two way vertical dispersion, C _{2D} /C ₀)	AF	8.05E+03	

Remedial Targets

Remedial Target	LYCS	6.90E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	9.65E-06	mg/l	Ogata Banks
after		9.9E+99	days	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+09

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

Calculate for non-polar organic chemicals

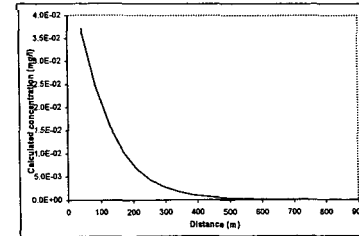
Entry if specify partition coefficient (option)
 Soil water partition coefficient K_d l/kg
 Entry for non-polar organic chemicals (option)
 Fraction of organic carbon in aquifer f_{oc} fraction
 Organic carbon partition coefficient K_{oc} l/kg
 Entry for ionic organic chemicals (option)
 Sorption coefficient for related species K_{oc,r} l/kg
 Sorption coefficient for ionised species K_{oc,i} l/kg
 pH value pH
 acid dissociation constant pKa

Soil water partition coefficient K_d 2.14E-01 l/kg

Dispersivity
 Calculate dependent on distance to compliance point (D)
 specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax m
 Transverse dispersivity az m
 Vertical dispersivity ay m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
 Xu & Eckstein (1999) report ax = 0.83(log₁₀x)^{0.114}; 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.

This sheet calculates the Tier3 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

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 Tier 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

Calculated concentrations for distance-concentration graph

Ogata Banks
 From calculation sheet
 Distance Concentration

	mg/l
42.6	3.7E-02
85.0	2.6E-02
127.6	1.6E-02
210.0	6.0E-03
255.0	4.3E-03
297.5	2.8E-03
340.0	1.8E-03
382.5	1.1E-03
426.0	7.4E-04
461.6	4.8E-04
610.0	3.1E-04
652.5	2.0E-04
636.0	1.3E-04
680.0	8.4E-05
722.5	5.6E-05
764.0	2.3E-05
807.5	1.5E-05
850.0	9.7E-06

Site being assessed	Blossington
Completed by	AJ
Date:	23/11/2005
Version:	11

Tier 3 - Groundwater

Input Parameters (using pull-down menu) Variable Value Unit Source

Contaminant: sec butylbenzene
Target Concentration: C_T 1.00E-03 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C_D	6.90E-02	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	7.20E+02	days	
Calculated decay rate	λ	9.63E-04	d^{-1}	
Width of plume in aquifer at source (perpendicular to flow)	S_z	8.00E+01	m	
Plume thickness at source	S_y	5.00E+01	m	
Saturated aquifer thickness	d_a	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm^3	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03		
Hydraulic conductivity of aquifer	K	7.00E+00	m/d	
Distance to compliance point	x	8.50E+02	m	
Distance (latera) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	K_d	2.14E-01	l/kg	see options
Longitudinal dispersivity	α_x	11.114	m	see options
Transverse dispersivity	α_z	1.111	m	see options
Vertical dispersivity	α_y	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	R_f	3.00E+00	fraction
Decay rate used	λ	9.63E-04	d^{-1}
Rate of contaminant flow due to retardation	u	8.99E-02	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion	C_{ED}	1.54E-05	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion	C_{ED}	1.47E-05	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{ED})	AF	5.90E+03	
Attenuation factor (two way vertical dispersion, C_0/C_{ED})	AF	6.05E+03	

Remedial Targets

Remedial Target	LYCS	6.90E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C_{ED}/C_0	1.64E-06	mg/l	Ogata Banks
after		9.9E+98	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient K_d [redacted] l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 2.14E-01 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{oc} [redacted] l/kg
Sorption coefficient for ionised species $K_{oc,i}$ [redacted] l/kg
pH value pH [redacted]
acid dissociation constant pK_a [redacted]

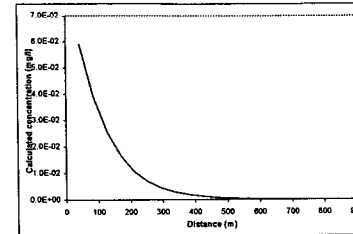
Soil water partition coefficient K_d 2.14E-01 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity	α_x	Enter value	Calc value Xu & Eckstein	m
Transverse dispersivity	α_z		1.11E+00	m
Vertical dispersivity	α_y		1.11E-01	m

For calculated value, assumes $\alpha_x = 0.1 \cdot x$, $\alpha_z = 0.01 \cdot x$, $\alpha_y = 0.001 \cdot x$. Xu & Eckstein (1995) report $\alpha_x = 0.63(\log_{10} x)^{0.414}$, $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed



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

Calculated concentrations for distance-concentration graph

Ogata Banks Distance to Compliance point

	mg/l
42.6	5.9E-02
85.0	3.9E-02
120.0	1.8E-02
268.8	6.9E-03
382.6	4.4E-03
425.0	1.8E-03
467.6	7.0E-04
510.0	4.9E-04
662.6	3.2E-04
896.0	2.1E-04
930.0	8.0E-05
122.5	6.8E-05
165.0	3.8E-05
307.5	2.4E-06
850.0	1.6E-06

This sheet calculates the Tier3 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 Tier 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.

Site being assessed: Blosington
Completed by: AJ
Date: 23 11 2005
Version: 11

Simple hydrogeological calculations

(These are not specific to, or required in, the Remedial Targets Methodology)

Parameter	symbol	unit	justification
Hydraulic conductivity	K	8.10E-05 m/s	
Hydraulic gradient	i	7.00E-03 unitless	
Effective porosity of aquifer	n	1.82E-01 fraction	
Thickness of saturated aquifer	b	5.60E+01 m	
Width of aquifer perpendicular to flow	w	8.00E+01 m	
Distance to receptor	x	8.50E+02 m	
Density of stratum	ρ	1.70E+00 g/cm ³	
Soil-water partition co-efficient	Kd	9.55E+00 l/kg	
Retardation factor of pollutant	R	90.20236264	

Groundwater flow velocity	v(GW)	3.12E-06 m/s	2.69E-01 m/day	9.82E+01 m/year
Time for groundwater to reach receptor	t(GW)	2.73E+08 seconds	3.16E+03 days	8.65E+00 years
Rate of groundwater flow through aquifer	Q	2.54E-03 m ³ /s	2.19E+02 m ³ /day	8.01E+04 m ³ /year
Contaminant flow velocity	v(contam)	3.45E-08 m/s	2.98E-03 m/day	1.09E+00 m/year
Time for contaminant to reach receptor	t(contam)	2.46E+10 seconds	2.85E+05 days	7.80E+02 years

Simple hydrogeological calculations

(These are not specific to, or required in, the Remedial Targets Methodology)

Parameter	symbol	unit	justification
Hydraulic conductivity	K	8.10E-05 m/s	
Hydraulic gradient	i	7.00E-03 unitless	
Effective porosity of aquifer	n	1.82E-01 fraction	
Thickness of saturated aquifer	b	5.60E+01 m	
Width of aquifer perpendicular to flow	w	8.00E+01 m	
Distance to receptor	x	8.50E+02 m	
Density of stratum	ρ	1.70E+00 g/cm ³	
Soil-water partition co-efficient	Kd	0.00E+00 l/kg	
Retardation factor of pollutant	R	1	

Groundwater flow velocity	v(GW)	3.12E-06 m/s	2.69E-01 m/day	9.82E+01 m/year
Time for groundwater to reach receptor	t(GW)	2.73E+08 seconds		
Rate of groundwater flow through aquifer	Q	2.54E-03 m ³ /s	2.19E+02 m ³ /day	8.01E+04 m ³ /year
Contaminant flow velocity	v(contam)	3.12E-06 m/s	2.69E-01 m/day	9.82E+01 m/year
Time for contaminant to reach receptor	t(contam)	2.73E+08 seconds	3.16E+03 days	8.65E+00 years

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant
Target Concentration C_r 5.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water,
'0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core C₀ 4.61E-01 mg/l
Half life for degradation of contaminant in water t_{1/2} 2.10E+02 days
Calculated decay rate λ 3.30E-03 days⁻¹
Width of plume in aquifer at source (perpendicular to flow) Sz 4.00E-01 m
Plume thickness at source da 5.60E+01 m
Saturated aquifer thickness da 5.71E+01 m
Bulk density of aquifer materials ρ 1.70E+00 g/cm³
Effective porosity of aquifer n 1.82E-01 fraction
Hydraulic gradient i 7.00E-03 fraction
Hydraulic conductivity of aquifer K 7.00E+00 m/d
Distance to compliance point x 8.50E+02 m
Distance (lateral) to compliance point perpendicular to flow direction z 0.00E+00 m
Distance (depth) to compliance point perpendicular to flow direction y 0.00E+00 m
Time since pollutant entered groundwater t 9.90E+99 days *time variant options only*

Parameters values determined from options
Partition coefficient Kd 4.84E+00 l/kg *see options*
Longitudinal dispersivity αx 11.114 m *see options*
Transverse dispersivity αz 1.111 m *see options*
Vertical dispersivity αy 0.111 m *see options*

Calculated Parameters Variable

Groundwater flow velocity v 2.69E-01 m/d
Retardation factor Rf 4.43E+01 fraction
Decay rate used λ 3.30E-03 d⁻¹
Rate of contaminant flow due to retardation u 6.07E-03 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C_{1D} 5.89E-88 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C_{2D} 5.84E-88 mg/l
Attenuation factor (one way vertical dispersion, C₀/C_{1D}) AF 7.83E+68
Attenuation factor (two way vertical dispersion, C₀/C_{2D}) AF 8.17E+68

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	5.00E-02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	850	m	
Concentration of contaminant at compliance point after	5.89E-88	mg/l	Ogata Banks
	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd [] l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 4.84E+00 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow, a} [] l/kg
Sorption coefficient for ionised species K_{oc, i} [] l/kg
pH value pH []
acid dissociation constant pKa []

Soil water partition coefficient Kd 4.84E+00 l/kg

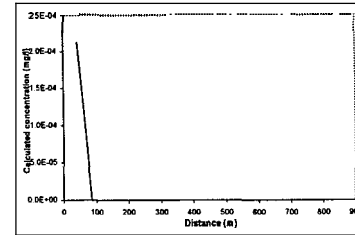
Dispersivity

Calculate dependent on distance to compliance point (0) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity αx 1.11E+01 m
Transverse dispersivity αz 1.11E+00 m
Vertical dispersivity αy 1.11E-01 m

For calculated value, assumes αx = 0.1 * z, αz = 0.01 * x, αy = 0.001 * x
Xu & Eckstein (1999) report αx = 0.83(log₁₀α^{-1.15}), αz = αz/10, αy = αy/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.

This sheet calculates the Tier3 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. 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 Tier 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.

Calculated concentrations for distance-concentration graph

Distance	Concentration
42.5	2.7mg/l4
85.0	9.8E-08
127.5	8.8E-14
212.6	8.1E-18
255.0	4.1E-21
297.6	1.8E-24
340.0	8.2E-28
382.6	3.7E-31
425.0	1.7E-34
487.6	7.5E-38
610.0	3.4E-41
662.6	1.5E-44
696.0	8.8E-48
917.6	3.1E-51
880.0	1.4E-54
722.5	6.3E-58
766.0	2.9E-61
807.6	1.3E-64
850.0	5.9E-68

Site being assessed: Blessington
Completed by: A/J
Date: 23 11 2005
Version: 11

Simple hydrogeological calculations

(These are not specific to, or required in, the Remedial Targets Methodology)

Parameter	symbol	unit	justification
Hydraulic conductivity	K	8.10E-05 m/s	
Hydraulic gradient	i	7.00E-03 unitless	
Effective porosity of aquifer	n	1.82E-01 fraction	
Thickness of saturated aquifer	b	5.60E+01 m	
Width of aquifer perpendicular to flow	w	8.00E+01 m	
Distance to receptor	x	8.50E+02 m	
Density of stratum	p	1.70E+00 g/cm ³	
Soil-water partition co-efficient	Kd	0.00E+00 l/kg	
Retardation factor of pollutant	R	1	

Groundwater flow velocity	v(GW)	3.12E-06 m/s	2.69E-01 m/day	9.82E+01 m/year
Time for groundwater to reach receptor	t(GW)	2.73E+08 seconds	3.16E+03 days	8.65E+00 years
Rate of groundwater flow through aquifer	Q	2.54E-03 m ³ /s	2.19E+02 m ³ /day	8.01E+04 m ³ /year
*Contaminant flow velocity	v(contam)	3.12E-06 m/s	2.69E-01 m/day	9.82E+01 m/year
Time for contaminant to reach receptor	t(contam)	2.73E+08 seconds	3.16E+03 days	8.65E+00 years

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater

Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	tert butylbenzene		
Target Concentration	C _T	1.00E-03	mg/l

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

Ogata Banks	Equations in R&D Pub. 20
-------------	--------------------------

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Initial contaminant concentration in groundwater at plume core	C ₀	8.60E-02	mg/l
Half life for degradation of contaminant in water	t _{1/2}	8.99E+99	days
Calculated decay rate	λ	6.94E-101	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	8.60E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	8.50E+02	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.99E+99	days

Parameters values determined from options			
Partition coefficient	Kd	2.14E-01	l/kg
Longitudinal dispersivity	ax	11.111	m
Transverse dispersivity	ay	1.111	m
Vertical dispersivity	az	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	6.94E-101	d ⁻¹
Rate of contaminant flow due to retardation	u	8.99E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	6.17E-02	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	5.91E-02	mg/l
Attenuation factor (one way vertical dispersion, C ₀ /C _{1D})	AF	1.56E+00	
Attenuation factor (two way vertical dispersion, C ₀ /C _{2D})	AF	1.82E+00	

Remedial Targets

Remedial Target	LTC3	1.96E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		860	m	
Concentration of contaminant at compliance point	C _{1D} /C ₀	6.17E-02	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer foc 1.00E+00 fraction
Organic carbon partition coefficient Koc 2.14E-01 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{oc,rel} l/kg
Sorption coefficient for ionised species K_{oc,i} l/kg
pH value pH
acid dissociation constant pKa

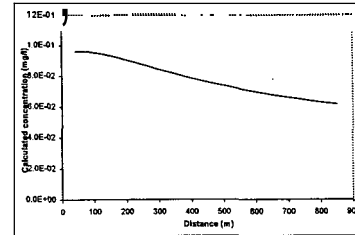
Source of parameter value

Soil water partition coefficient Kd 2.14E-01 l/kg

Dispersivity
Calculate dependent on distance to compliance point (0) 2
specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax 1.11E+01 m
Transverse dispersivity ay 1.11E+00 m
Vertical dispersivity az 1.11E-01 m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * z, ay = 0.001 * y
Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{0.41}; 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.

This sheet calculates the Tier3 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. 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 Tier 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

Calculated concentrations for distance-concentration graph

Ogata Banks
Distance Concentration

	mg/l
42.6	9.6E-02
102.6	9.6E-02
110.0	9.2E-02
212.6	9.0E-02
268.0	8.7E-02
297.6	8.4E-02
340.0	8.2E-02
382.6	8.0E-02
426.0	7.7E-02
467.6	7.6E-02
510.0	7.3E-02
652.6	7.2E-02
695.0	1.0E-02
637.6	6.8E-02
780.6	6.8E-02
765.0	6.4E-02
807.6	0.0E-02
850.0	6.2E-02

Site being assessed	Stonington
Completed by	AJ
Date	23/11/2005
Version	11

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant	Total Cyanide		
Target Concentration	C _T	1.00E-02	mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '2' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C ₀	1.40E-01	mg/l
Half life for degradation of contaminant in water	t _{1/2}	2.82E+01	days
Calculated decay rate	λ	2.38E-02	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.80E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	8.50E+02	m
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+99	days

Parameters values determined from options

Partition coefficient	Kd	9.90E+00	l/kg	see options
Longitudinal dispersivity	ax	11.114	m	see options
Transverse dispersivity	az	1.111	m	see options
Vertical dispersivity	ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	9.35E+01	fraction
Decay rate used	λ	2.38E-02	d ⁻¹
Rate of contaminant flow due to retardation	u	2.88E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{1D}	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C _{2D}	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C ₁ /C ₀)	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C ₂ /C ₀)	AF	#NUM!	

Remedial Targets

Remedial Target	LTCs	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of oontaminant at compliance point	C _{1D} /C ₀	#NUM!	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

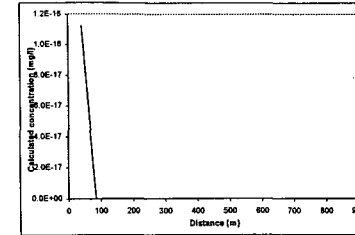
Soil water partition coefficient	Kd		l/kg
Soil water partition coefficient (option)			
Fraction of organic carbon in aquifer	f _{oc}	1.00E+00	fraction
Organic carbon partition coefficient	K _{oc}	9.90E+00	l/kg
Sorption coefficient for related species	K _{oc,r}		l/kg
Sorption coefficient for ionised species	K _{oc,i}		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	9.90E+00	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)		2	
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	1.11E+01	m
Transverse dispersivity	az	1.11E+00	m
Vertical dispersivity	ay	1.11E-01	m

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x. Xu & Eckstein (1995) report ax = 0.83(log₁₀ρ)^{0.433}; az = ax/10, ay = ax/100 are assumed

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Calculated concentrations for distance-concentration graph

Distance	Concentration
42.6	1.7E-16
86.0	9.0E-32
127.6	7.2E-47
212.0	4.4E-62
266.0	3.4E-82
297.6	2.7E-107
340.0	2.1E-122
382.6	1.6E-137
426.0	1.3E-152
487.6	1.0E-167
610.0	7.8E-183
662.6	6.2E-198
696.0	4.8E-213
837.6	3.8E-228
880.0	3.0E-243
722.6	2.4E-258
766.0	1.9E-273
807.6	#NUM!
860.0	#NUM!

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed	Billingston area 6
Completed by	Anna Jeffcoat
Date	23/11/2005
Version	11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: Zinc
Target Concentration: $1.00E-01$ mg/l

Select analytical solution (click on brown cell below, then on pull-down menu)
Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu) 1

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu) 0

Variable	Value	Unit	Source
C_0	$2.00E-01$	mg/l	
$t_{1/2}$	$9.90E+99$	days	
λ	$7.00E-101$	days ⁻¹	
Sz	$8.00E-011$	m	
Sy	$5.00E-011$	m	
d_a	$5.71E+01$	m	
ρ	$1.70E+001$	g/cm ³	
i	$1.82E-01$	fraction	
K	$7.00E+00$	m/d	
x	$8.50E+02$	m	
z	$0.00E+00$	m	
y	$0.00E+00$	m	
t	$9.90E+99$	days	time variant options only
K_d	$0.00E+00$	l/kg	see options
a_x	11.114	m	see options
a_z	1.111	m	see options
a_y	0.111	m	see options

Calculated Parameters

Variable	Value	Unit
v	$2.89E-01$	m/d
Rf	$1.00E+00$	fraction
λ	$7.00E-101$	d ⁻¹
u	$2.89E-01$	m/d
C_{e0}	$1.87E-01$	mg/l
C_{10}	$1.80E-01$	mg/l
AF	$1.56E+00$	
AF	$1.82E+00$	

Remedial Targets

Remedial Target	LTC3	Value	Unit	Source
Ogata Banks		$1.56E-01$	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		860	m	
Concentration of contaminant at compliance point after	C_{10}/C_0	$1.87E-01$	mg/l	Ogata Banks
		$9.9E+99$	days	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 0.0E+00

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

Calculate for non-polar organic chemicals

K_d		l/kg
f_{oc}	$1.00E+00$	fraction
K_{oc}	$0.00E+00$	l/kg
K_{ow}		l/kg
K_{ow}		l/kg
pH		
pK_a		
K_d	$0.00E+00$	l/kg

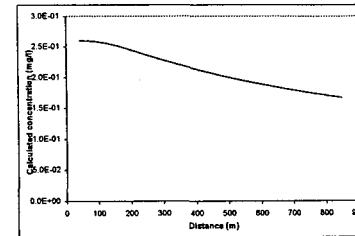
Dispersivity

Calculate dispersivity dependent on distance to compliance point (0) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Dispersivity	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity		$1.11E+01$	m
Transverse dispersivity		$1.11E+00$	m
Vertical dispersivity		$1.11E-01$	m

For calculated value, assumes $a_x = 0.1 * x$, $a_z = 0.01 * z$, $a_y = 0.001 * y$. Xu & Eckstein (1995) report $a_x = 0.83(\log_{10} x)^{0.75}$, $a_z = a_x/10$, $a_y = a_x/100$ are assumed



Calculated concentrations for distance-concentration graph

Depth/Concentration sheet

Distance Concentration

42.6	$2.70E-01$
86.0	$2.8E-01$
127.6	$2.8E-01$
170.0	$2.8E-01$
212.6	$2.4E-01$
268.0	$2.4E-01$
349.8	$2.3E-01$
868.0	$2.3E-01$
U7.6	$2.0E-01$
610.0	$2.0E-01$
662.6	$1.9E-01$
696.0	$1.9E-01$
837.5	$1.9E-01$
880.0	$1.8E-01$
722.6	$1.8E-01$
785.0	$1.7E-01$
607.6	$1.7E-01$
860.0	$1.7E-01$

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

This sheet calculates the Tier3 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 Tier 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 $9.0E+99$

Site being assessed	Blessington area 6
Completed by	Anna Jelfcoat
Date	23/11/2005
Version	11

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit

Contaminant: 1,2,4-trimethylbenzene
Target Concentration: C_T 1.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Initial contaminant concentration in groundwater at plume core	C_0	1.04E-01	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	3.80E+02	days
Calculated decay rate	λ	1.95E-03	days ⁻¹
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.00E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm ³
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	7.00E+00	m/d
Distance to compliance point	x	8.50E+02	m
Distance (laterally) to compliance point perpendicular to flow direction	z	0.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m
Time since pollutant entered groundwater	t	9.90E+09	days
Parameters values determined from options			
Partition coefficient	Kd	2.95E+01	l/kg
Longitudinal dispersivity	ax	11.114	m
Transverse dispersivity	az	1.111	m
Vertical dispersivity	ay	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	v	2.69E-01	m/d
Retardation factor	Rf	2.77E+02	fraction
Decay rate used	λ	1.95E-03	d ⁻¹
Rate of contaminant flow due to retardation	u	9.73E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{1D}	6.47E-142	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C_{2D}	6.20E-142	mg/l
Attenuation factor (one way vertical dispersion, C_{1D}/C_0)	AF	1.81E+140	
Attenuation factor (two way vertical dispersion, C_{2D}/C_0)	AF	1.68E+140	

Remedial Targets

Remedial Target	LYC3	1.41E+139	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	6.47E-142	mg/l	Ogata Banks
after		9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient Kd 2.95E+01 l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer foc 1.00E+00 fraction
Organic carbon partition coefficient Koc 2.95E+01 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow} l/kg
Sorption coefficient for ionised species $K_{ow,i}$ l/kg
pH value
acid dissociation constant pKa

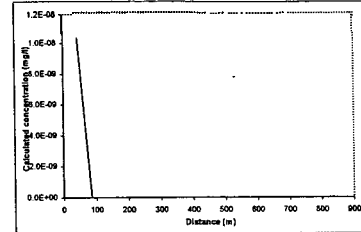
Soil water partition coefficient Kd 2.95E+01 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0) 2
specify dispersivity (1), or calc after Xu & Eckstein (2) ?
Longitudinal dispersivity ax 1.11E+01 m
Transverse dispersivity az 1.11E+00 m
Vertical dispersivity ay 1.11E-01 m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$
Xu & Eckstein (1995) report $ax = 0.63(\log_{10} Kd)^{0.5}$; $az = ax/10$, $ay = ax/100$ are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
42.6	1.0E-08
86.0	1.0E-16
129.6	9.9E-39
212.5	9.5E-37
256.0	9.3E-44
297.5	9.0E-51
340.0	8.6E-58
382.6	8.5E-66
426.0	8.3E-72
467.5	8.0E-79
610.0	7.8E-86
662.5	7.6E-93
698.0	7.4E-100
680.0	7.1E-114
768.0	6.9E-128
807.6	6.6E-135
860.0	6.5E-142

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.

This sheet calculates the Tier3 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. 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 Tier 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.

Site being assessed: Shillington
Completed by: AJ
Date: 23 11 2005
Version: 11

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant Target Concentration C_T 1.35 trimethylbenzene 1.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core C_0	2.39E-018	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.80E+02	days	
Calculated decay rate λ	1.93E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sx	8.00E+01	m	
Plume thickness at source Sy	5.00E+01	m	
Saturated aquifer thickness da	5.71E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	7.00E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction z	7.00E+00	m	
Distance (depth) to compliance point y	7.00E+00	m	
Time since pollutant entered groundwater t	9.90E+09	days	time variant options only
Partition coefficient Kd	2.95E+01	l/kg	see options
Longitudinal dispersivity ax	11.114	m	see options
Transverse dispersivity az	1.111	m	see options
Vertical dispersivity ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	2.89E-01	m/d
Retardation factor Rf	2.77E+02	fraction
Decay rate used λ	1.93E-03	d ⁻¹
Rate of contaminant flow due to retardation u	9.73E-04	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{10}	1.49E-141	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{20}	1.42E-141	mg/l
Attenuation factor (one way vertical dispersion, C_{10}/C_{T3}) AF	1.81E+140	
Attenuation factor (two way vertical dispersion, C_{20}/C_{T3}) AF	1.88E+140	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	1.35	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	850	m	
Concentration of contaminant at compliance point C_{10}/C_0 after	1.49E-141	mg/l	Ogata Banks
	9.9E+09	days	

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+09.

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

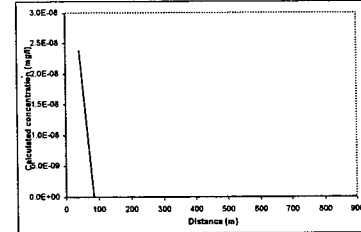
Calculate for non-polar organic chemicals

Soil water partition coefficient Kd	2.95E+01	l/kg
Fraction of organic carbon in aquifer foc	1.00E+00	fraction
Organic carbon partition coefficient Koc	2.95E+01	l/kg
Soil water partition coefficient Kd	2.95E+01	l/kg

Dispersivity

Longitudinal dispersivity ax	11.11E+01	m
Transverse dispersivity az	1.11E+00	m
Vertical dispersivity ay	1.11E-01	m

For calculated value, assumes $ax = 0.1 \cdot x$, $az = 0.01 \cdot z$, $ay = 0.001 \cdot y$. Xu & Eckstein (1995) report $ax = 0.83(\log_{10} x)^{0.4}$, $az = ax/10$, $ay = ax/100$ are assumed



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

Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
850	2.4E-16
111.6	1.1E-22
170.0	2.3E-29
212.6	2.2E-34
265.0	2.1E-43
297.6	2.1E-50
340.0	2.0E-57
382.6	2.0E-64
425.0	1.9E-78
510.0	1.8E-86
652.6	1.7E-92
896.0	1.7E-99
837.6	1.7E-106
1100.0	1.6E-113
722.6	1.6E-120
786.0	1.6E-127
889.0	1.6E-134

This sheet calculates the Tier3 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. 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 Tier 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+09.

Site being assessed: Blossington
 Completed by: AJ
 Date: 23/11/2005
 Version: 11

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R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 -Groundwater



Input Parameters (using pull down menu) Variable Value Unit Source

Contaminant: 1,4-Dichlorobenzene
Target Concentration: C_r 1.00E-02 mg/l

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

Ogata Banks Equations in R&D Pub. 20

EMU '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '2' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	2.10E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.60E+02	days	
Calculated decay rate λ	1.93E-03	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) S_z	8.00E+01	m	
Plume thickness at source S_y	5.60E+01	m	
Saturated aquifer thickness d_a	5.71E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	7.00E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance (lateral) to compliance point perpendicular to flow direction x	8.50E+02	m	
Distance (depth) to compliance point perpendicular to flow direction z	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient K_d	7.76E+00	l/kg	see options
Longitudinal dispersivity α_x	11.114	m	see options
Transverse dispersivity α_z	1.111	m	see options
Vertical dispersivity α_y	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	2.69E-01	m/d
Retardation factor R_f	7.35E+01	fraction
Decay rate used λ	1.93E-03	d ⁻¹
Rate of contaminant flow due to retardation u	3.69E-03	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	5.77E-67	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	5.53E-67	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	3.64E+65	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	3.78E+65	

Remedial Targets

Remedial Target	LTC3	3.84E+63	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C_{1D}/C_0	5.77E-67	mg/l	Ogata Banks
	after	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)
Soil water partition coefficient K_d 7.76E+00 l/kg
Entry for non-polar organic chemicals (option)
Fraction of organic carbon in aquifer f_{oc} 1.00E+00 fraction
Organic carbon partition coefficient K_{oc} 7.76E+00 l/kg
Entry for ionic organic chemicals (option)
Sorption coefficient for related species K_{ow} l/kg
Sorption coefficient for ionised species K_{ow} l/kg
pH value
acid dissociation constant pK_a

Soil water partition coefficient K_d 7.76E+00 l/kg

Dispersivity

Calculates dependent on distance to compliance point (0) 2

specify dispersivity (1), or calc after Xu & Eckstein (2) 7

Longitudinal dispersivity α_x 11.11E+01 m

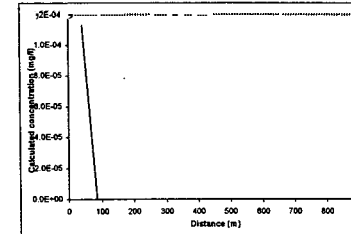
Transverse dispersivity α_z 1.11E+00 m

Vertical dispersivity α_y 1.11E-01 m

For calculated value, assumes $\alpha_x = 0.1 \times x$, $\alpha_z = 0.01 \times z$, $\alpha_y = 0.001 \times y$

Xu & Eckstein (1995) report $\alpha_x = 0.83(\log_{10} t)^{0.41}$; $\alpha_z = \alpha_x/10$, $\alpha_y = \alpha_x/100$ are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

Distance	Concentration
42.6	1.1E-04
85.0	6.1E-08
127.6	3.2E-11
110.0	1.7E-14
2126	8.9E-18
265.0	4.7E-21
248.6	1.3E-27
488.6	3.5E-34
481.6	1.8E-37
610.0	9.7E-41
652.6	6.1E-44
695.0	2.7E-47
437.6	1.4E-50
680.0	7.4E-54
722.6	3.9E-57
705.0	2.1E-60
807.6	1.1E-63
850.0	5.8E-67

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.

This sheet calculates the Tier3 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. 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 Tier 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: Blessington
Completed by: AJ
Date: 23 11 2005
Version: 11

R&D Publication 20 Remedial Targets Worksheet, Release 2.2a

Tier 3 -Groundwater



Input Parameters (using pull-down menu) Variable Value Unit Source

Contaminant Target Concentration C_T Aliphatic C8-C10 7.14E-04 mg/l

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

Ogata Banks Equations in R&D Pub. 20

Enter '1' to simulate vertical dispersion in one direction, '2' for two directions (pull down menu)

Enter '1' if biodegradation rate is for the substance in water, '0' if rate is for decay in field conditions (i.e. field data from aquifer) (pull down menu)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C_0	2.12E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.63E+02	days	
Calculated decay rate λ	3.80E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E-01	m	
Plume thickness at source Sy	5.80E+01	m	
Saturated aquifer thickness da	5.71E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm ³	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	7.00E-03	fraction	
Hydraulic conductivity of aquifer K	7.00E+00	m/d	
Distance to compliance point x	8.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction y	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+99	days	time variant options only
Partition coefficient Kd	1.15E+02	l/kg	see options
Longitudinal dispersivity ax	11.114	m	see options
Transverse dispersivity az	1.111	m	see options
Vertical dispersivity ay	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	2.69E-01	m/d
Retardation factor Rf	1.07E+03	fraction
Decay rate used λ	3.80E-04	d ⁻¹
Rate of contaminant flow due to retardation u	2.51E-04	m/d
Contaminant concentration at distance x , assuming one-way vertical dispersion C_{1D}	3.05E-123	mg/l
Contaminant concentration at distance x , assuming two-way vertical dispersion C_{2D}	2.92E-123	mg/l
Attenuation factor (one way vertical dispersion, C_0/C_{1D}) AF	6.95E+120	
Attenuation factor (two way vertical dispersion, C_0/C_{2D}) AF	7.25E+120	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target LTC3	4.96E+117	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	850	m	
Concentration of contaminant at compliance point after	C_{EP}/C_0 3.06E-123	mg/l	Ogata Banks
	9.9E+99	days	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Soil water partition coefficient Kd 1.15E+02 l/kg
 Entry for non-polar organic chemicals (option) Fraction of organic carbon in aquifer foc 1.00E+00 fraction
 Organic carbon partition coefficient Koc 1.15E+02 l/kg
 Entry for ionic organic chemicals (option) Sorption coefficient for related species K_{ow} l/kg
 Sorption coefficient for ionised species K_{ow} l/kg
 pH value pKa
 acid dissociation constant pKa

Soil water partition coefficient Kd 1.15E+02 l/kg

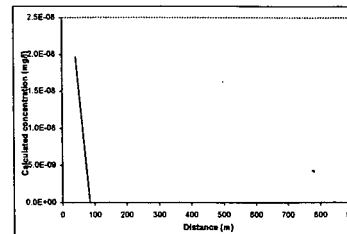
Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Dispersivity	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity ax		1.11E+01 m
Transverse dispersivity az		1.11E+00 m
Vertical dispersivity ay		1.11E-01 m

For calculated value, assumes $ax = 0.1 * x$, $az = 0.01 * x$, $ay = 0.001 * x$
 Xu & Eckstein (1995) report $ax = 0.63(\log_{10} \rho)^{0.114}$, $az = ax/10$, $ay = ax/100$ 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.

This sheet calculates the Tier3 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 Tier 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

Calculated concentrations for distance-concentration graph

Ogata Banks

Distance (m)	Concentration (mg/l)
42.5	2.0E-08
85.0	1.8E-14
127.6	1.7E-20
170.0	1.5E-26
212.5	1.4E-32
255.0	1.2E-38
297.6	1.1E-44
340.0	1.0E-50
382.5	9.0E-57
425.0	8.1E-63
467.6	7.3E-69
510.0	6.6E-75
552.5	6.0E-81
595.0	5.4E-87
637.5	4.9E-93
680.0	4.5E-99
722.5	4.1E-105
765.0	3.7E-111
807.6	3.4E-117
850.0	3.1E-123

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