

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 <sub>T</sub>	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 <sub>0</sub>	9.90E-09	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days	
Calculated decay rate	λ	3.80E-04	m <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	5.92E+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	8.90E+09	days	time variant options only
<b>Parameters values determined from options</b>				
Partition coefficient	Kd	9.12E+02	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	8.52E+03	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.61E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	6.81E-213	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	3.77E-213	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.45E+114	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	2.63E+114	

Remedial Targets

Remedial Target	LTC3	1.04E+111	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	6.81E-213	mg/l	Ogata Banks
	after	9.8E+89	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+89.

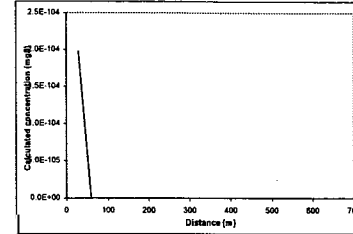
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	9.12E+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	9.12E+02 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K <sub>ow</sub>	l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>	l/kg
pH value	pH	
acid dissociation constant	pKa	
Soil water partition coefficient	Kd	9.12E+02 l/kg

Dispersivity		
Calculate dispersivity on distance to compliance point (0)		9.73
specify dispersivity (1), or calc after Xu & Eckstein (2) ?		
Longitudinal dispersivity	ax	9.73E+00 m
Transverse dispersivity	az	9.73E-01 m
Vertical dispersivity	ay	9.73E-02 m

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* x, ay = 0.001 \* x  
 Xu & Eckstein (1995) report az = 0.83(log<sub>10</sub>p)<sup>0.41</sup>; ax = az\*10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

	mg/l
29.6	2.0E-104
59.2	4.0E-110
88.8	7.8E-118
118.4	1.5E-121
148.0	3.0E-127
177.6	6.8E-133
207.2	1.1E-138
236.8	2.2E-144
266.4	4.3E-150
296.0	8.3E-156
325.6	1.6E-161
355.2	3.2E-167
384.8	6.2E-173
414.4	1.2E-178
444.0	2.4E-184
473.6	4.6E-190
503.2	9.0E-196
532.8	1.8E-201
562.4	3.6E-207
592.0	6.8E-213

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

Site being assessed: Bress Area 1 A Murphy K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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)

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core $C_0$	3.47E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.93E+03	days	
Calculated decay rate $\lambda$	3.80E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (lateral) to compliance point $x$	5.92E+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
<b>Parameters values determined from options</b>			
Partition coefficient $K_d$	1.82E+04	l/kg	see options
Longitudinal dispersivity $\alpha_x$		m	see options
Transverse dispersivity $\alpha_z$		m	see options
Vertical dispersivity $\alpha_y$		m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $R_f$	1.70E+05	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	8.08E-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, $C_0/C_{1D}$ ) $AF$	#NUM!	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	#NUM!	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target	LTCS	#NUM!	mg/l
Ogata Banks			
Distance to compliance point	892	m	
Concentration of contaminant at compliance point after	$C_{1D}/C_0$	#NUM!	mg/l
	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)

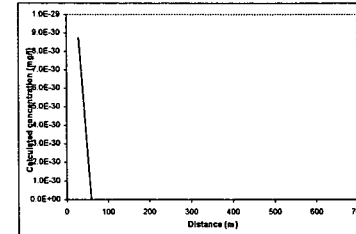
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient $K_d$		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 $K_{oc}$	1.82E+04	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 $pH$		
acid dissociation constant $pK_a$		
Soil water partition coefficient $K_d$	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 $\alpha_x$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity $\alpha_z$	9.73E+00	m
Vertical dispersivity $\alpha_y$	9.73E-02	m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
	mg/l
29.8	8.8E-30
69.2	2.2E-57
88.8	5.5E-65
148.8	3.4E-149
177.6	8.2E-168
207.2	2.0E-195
236.8	6.0E-223
266.4	1.2E-250
296.0	3.0E-278
325.6	#NUM!
366.2	#NUM!
384.8	#NUM!
414.4	#NUM!
444.0	#NUM!
473.6	#NUM!
503.2	#NUM!
532.8	#NUM!
562.4	#NUM!
592.0	#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: Bless Area 1 A Murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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<sub>T</sub> 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 <sub>0</sub>	9.90E-99	mg/l	
Half life for degradation of contaminant in water t <sub>1/2</sub>	1.83E+03	days	
Calculated decay rate λ	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) Sz	1.90E+02	m	
Plume thickness at source Sy	1.02E+01	m	
Saturated aquifer thickness da	1.08E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.25E-02	fraction	
Hydraulic conductivity of aquifer K	2.00E+01	m/d	
Distance to compliance point x	5.92E+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	time variant options only
Partition coefficient Kd	5.75E+00	l/kg	see options
Longitudinal dispersivity ax	9.730	m	see options
Transverse dispersivity az	0.973	m	see options
Vertical dispersivity ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	1.37E+00	m/d
Retardation factor Rf	5.47E+01	fraction
Decay rate used λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation u	2.51E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C <sub>1D</sub>	2.30E-102	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C <sub>2D</sub>	1.27E-102	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>T</sub> ) AF	4.30E+03	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>T</sub> ) AF	7.77E+03	

Remedial Targets

Remedial Target	LTC3	3.07E+00	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	2.30E-102	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)

Soil water partition coefficient Kd 5.75E+00 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 5.75E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub> l/kg  
Sorption coefficient for ionised species K<sub>ow</sub> l/kg  
pH value pH  
acid dissociation constant pKa

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

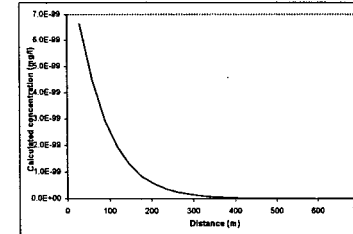
Dispersivity

Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity ax 9.73E+00 m  
Transverse dispersivity az 9.73E-01 m  
Vertical dispersivity ay 9.73E-02 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<sub>10</sub>t)<sup>0.41</sup>; az = az/10, ay = ay/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet,  
Distance Concentration

Distance	Concentration (mg/l)
29.6	6.7E-99
59.2	4.5E-99
88.8	3.0E-99
118.4	2.0E-99
148.0	1.3E-99
177.6	8.4E-100
107.2	5.6E-100
236.8	3.6E-100
259.4	2.3E-100
296.0	1.5E-100
328.8	1.0E-100
365.2	6.6E-101
384.8	4.3E-101
414.4	2.8E-101
444.0	1.9E-101
473.6	1.2E-101
503.2	8.0E-102
632.8	6.3E-102
662.4	3.8E-102
692.0	2.3E-102

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

Sic being assessed: Sites Area 1 A murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12





Tier 3 - Groundwater



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

Contaminant: Aliphatic 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	C <sub>0</sub>	3.47E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.85E+03	days	
Calculated decay rate	λ	1.90E-04	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	5.92E+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	2.29E+06	l/kg	see options
Longitudinal dispersivity	ax		m	see options
Transverse dispersivity	az		m	see options
Vertical dispersivity	ay		m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	6.42E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>EO</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>ED</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>ED</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>ED</sub> )	AF	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		692	m	
Concentration of contaminant at compliance point after	C <sub>ED</sub> /C <sub>0</sub>	#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

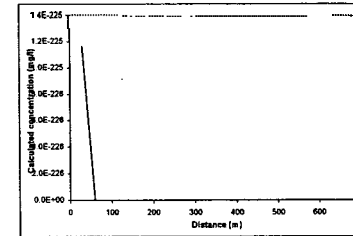
Entry if specify partition coefficient (option)	Kd		l/kg
Soil water partition coefficient	Kd	2.29E+06	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	2.29E+06	l/kg
Organic carbon partition coefficient	K <sub>ow</sub>		l/kg
Entry for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

Dispersivity

Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	ax	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity	ax		9.73E+00 m
Transverse dispersivity	az		9.73E-01 m
Vertical dispersivity	ay		9.73E-02 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<sub>10</sub>ax)<sup>0.5</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
29.6	1.2E-225
69.2	#NUM!
88.8	#NUM!
118.4	#NUM!
146.0	#NUM!
177.6	#NUM!
207.2	#NUM!
236.6	#NUM!

298.8	#NUM!
325.6	#NUM!
356.2	#NUM!
384.8	#NUM!
414.4	#NUM!

484.0	#NUM!
603.2	#NUM!
632.8	#NUM!
662.4	#NUM!
692.0	#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	Bloss Area 1 A Murphy K20
Completed by	AJ
Date	24/11/2005
Version	12

Tier 3 - Groundwater



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

Contaminant: Ammoniacal 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)

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	$C_0$	6.40E+00	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	2.19E+03	days	
Calculated decay rate	$\lambda$	3.17E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	$Sz$	1.92E+02	m	
Plume thickness at source	$Sy$	1.02E+01	m	
Saturated aquifer thickness	$da$	1.08E+01	m	
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point	$x$	5.92E+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	time variant options only
Parameters values determined from options				
Partition coefficient	$Kd$	5.00E-01	l/kg	see options
Longitudinal dispersivity	$ax$	9.730	m	see options
Transverse dispersivity	$az$	0.873	m	see options
Vertical dispersivity	$ay$	0.087	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	5.67E+00	fraction
Decay rate used	$\lambda$	3.17E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.42E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	1.82E+00	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	1.06E+00	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	3.33E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	8.02E+00	

Remedial Targets

Remedial Target	LTC3	3.99E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.82E+00	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	$Koc$	5.00E-01	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{ow}$		l/kg
Sorption coefficient for ionized species	$K_{ow,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		

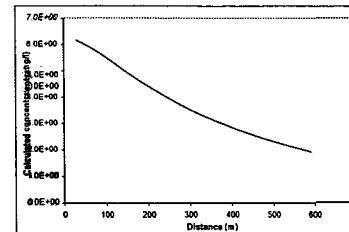
Soil water partition coefficient  $Kd$  5.00E-01 l/kg

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	9.73E+00	m
Transverse dispersivity	$az$			0.73E-01	m
Vertical dispersivity	$ay$			0.73E-02	m

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



Calculated concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
29.6	6.2E+00
69.2	6.9E+00
88.8	6.6E+00
118.4	6.3E+00
148.0	6.0E+00
177.8	4.6E+00
207.2	4.3E+00
236.8	4.1E+00
266.4	3.8E+00
296.0	3.5E+00
325.6	3.3E+00
355.2	3.1E+00
384.8	2.9E+00
414.4	2.8E+00
444.0	2.6E+00
473.6	2.4E+00
603.2	2.3E+00
632.8	2.2E+00
662.4	2.0E+00
692.0	1.9E+00

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

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: Bross Area 1 A Murphy K20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

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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 $\lambda$	7.53E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	1.00E+02	m	
Plume thickness at source $Sy$	1.00E+01	m	
Saturated aquifer thickness $ds$	1.08E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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
<b>Parameters values determined from options</b>			
Partition coefficient $Kd$	5.13E+01	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	4.80E+02	fraction
Decay rate used $\lambda$	7.53E-04	days <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	2.86E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	5.19E-33	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	2.87E-33	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.93E+31	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	3.48E+31	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target $LTC3$	1.92E+32	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	592	m	
Concentration of contaminant at compliance point	5.19E-33	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

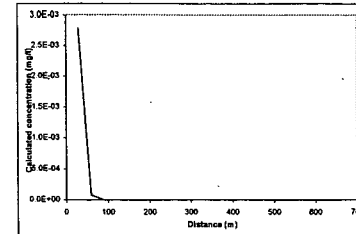
Entry if specify partition coefficient (option)  
Soil water partition coefficient  $Kd$  5.13E+01 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer  $foc$  1.00E+00 fraction  
Organic carbon partition coefficient  $Koc$  5.13E+01 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{ow}$  l/kg  
pH value  $pH$   
acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  5.13E+01 l/kg

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

Dispersivity	ax	ay	Calc value Xu & Eckstein
Longitudinal dispersivity	9.73E+00		m
Transverse dispersivity	0.973E-01		m
Vertical dispersivity	0.973E-02		m

For calculated value, assumes  $ax = 0.1 * x$ ,  $az = 0.01 * x$ ,  $ay = 0.001 * x$   
Xu & Eckstein (1995) report  $ax = 0.63(\log_{10} x)^{0.5}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration (mg/l)
0	10
10	10
20	10
30	10
40	10
50	10
60	10
70	10
80	10
90	10
100	10
110	10
120	10
130	10
140	10
150	10
160	10
170	10
180	10
190	10
200	10
210	10
220	10
230	10
240	10
250	10
260	10
270	10
280	10
290	10
300	10
310	10
320	10
330	10
340	10
350	10
360	10
370	10
380	10
390	10
400	10
410	10
420	10
430	10
440	10
450	10
460	10
470	10
480	10
490	10
500	10
510	10
520	10
530	10
540	10
550	10
560	10
570	10
580	10
590	10
600	10
610	10
620	10
630	10
640	10
650	10
660	10
670	10
680	10
690	10
700	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. 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 Acre 1 Murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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  $C_T$  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 $\lambda$	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	1.90E+02	m	
Plume thickness at source $Sy$	31.00E+01	m	
Saturated aquifer thickness $Sa$	1.08E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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
Partition coefficient $Kd$	9.12E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	9.730	m	see options
Transverse dispersivity $\alpha_z$	0.973	m	see options
Vertical dispersivity $\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	8.62E+01	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.59E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	4.74E-104	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	2.82E-104	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	2.09E+05	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	3.78E+05	

Remedial Targets

Remedial Target	LTC3	1.49E+02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	4.74E-104	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

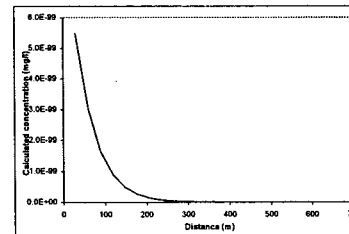
Soil water partition coefficient $Kd$		l/kg
Fraction of organic carbon in aquifer $foc$	1.00E+00	fraction
Organic carbon partition coefficient $Koc$	9.12E+00	l/kg
Sorption coefficient for related species $K_{oc}$		l/kg
Sorption coefficient for ionised species $K_{oc,i}$		l/kg
pH value $pH$		
acid dissociation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

Soil water partition coefficient  $Kd$  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 $\alpha_x$	Enter value	Calc value Xu & Eckstein	9.73E+00	m
Transverse dispersivity $\alpha_z$			9.73E-01	m
Vertical dispersivity $\alpha_y$			9.73E-02	m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$ . Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} C_0)^{0.4}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

29.8	6.5E-99
69.2	3.0E-99
88.8	1.7E-99
118.4	9.0E-100
148.0	4.8E-100
177.6	2.6E-100
207.2	1.4E-100
236.8	7.6E-101
266.4	4.1E-101
296.0	2.2E-101
325.6	1.2E-101
355.2	6.4E-102
384.8	3.4E-102
414.4	1.9E-102
444.0	1.0E-102
473.6	6.5E-103
503.2	3.0E-103
532.8	1.6E-103
562.4	8.7E-104
592.0	4.7E-104

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 A Murphy K20  
Completed by: RJ  
Date: 24/11/2005  
Version: 12

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
Initial contaminant concentration in groundwater at plume core $C_0$	3.47E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.83E+03	days	
Calculated decay rate $\lambda$	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_z$	1.80E+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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.82E+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	time variant options only
Parameters values determined from options			
Partition coefficient $K_d$	1.82E+01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	9.730	m	see options
Transverse dispersivity $\alpha_z$	0.973	m	see options
Vertical dispersivity $\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $R_f$	1.71E+02	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	8.04E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{E0}$	1.99E-11	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{E0}$	1.10E-11	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ ) $AF$	1.75E+09	
Attenuation factor (two way vertical dispersion, $C_0/C_{E0}$ ) $AF$	3.16E+09	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target	LYC3 4.29E+06	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	592	m	
Concentration of contaminant at compliance point after	$C_{E0}/C_0$ 1.99E-11	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)

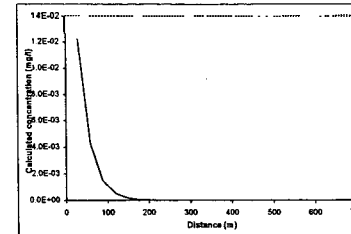
Calculate for non-polar organic chemicals

Soil water partition coefficient $K_d$		l/kg
Entry for non-polar organic chemicals (option) $f_{oc}$	1.00E+00	fraction
Fraction of organic carbon in aquifer $K_{oc}$	1.82E+01	l/kg
Organic carbon partition coefficient $K_{ow}$		l/kg
Entry for ionic organic chemicals (option) $K_{oc}$		l/kg
Sorption coefficient for related species $K_{oc}$		l/kg
Sorption coefficient for ionised species $pK_a$		
pH value		
acid dissociation constant		
Soil water partition coefficient $K_d$	1.82E+01	l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)		
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2	
Longitudinal dispersivity $\alpha_x$	9.73E+00	m
Transverse dispersivity $\alpha_z$	0.973E-01	m
Vertical dispersivity $\alpha_y$	0.097E-02	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  $\alpha_x = 0.63(\log_{10} C_0)^{0.11}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
29.8	1.2E-02
69.2	4.3E-03
88.8	1.6E-03
118.4	6.2E-04
148.0	1.8E-04
177.6	6.1E-05
207.2	2.1E-05
236.8	7.1E-06
259.4	2.4E-06
296.0	6.4E-07
326.8	2.9E-07
366.2	9.9E-08

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 Aloa 1 A Murphy K20  
Compiled by: AJ  
Date: 24/11/2005  
Version: 12



Tier 3 -Groundwater



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

Contaminant: Aromatic C21-C35  
Target Concentration: C<sub>T</sub> 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 <sub>0</sub>	3.47E-02	mg/l	
Half life for degradation of contaminant in water t <sub>1/2</sub>	3.65E+03	days	
Calculated decay rate λ	1.90E-04	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.25E-02		
Hydraulic conductivity of aquifer K	2.00E+01	m/d	
Distance to compliance point x	5.92E+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	0.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient Kd	4.57E+02	l/kg	see options
Longitudinal dispersivity ax	9.730	m	see options
Transverse dispersivity az	0.973	m	see options
Vertical dispersivity ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	1.37E+00	m/d
Retardation factor Rf	4.27E+03	fraction
Decay rate used λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation u	3.22E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C <sub>1D</sub>	7.44E-54	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C <sub>2D</sub>	4.12E-54	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> ) AF	4.85E+51	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> ) AF	8.43E+51	

Remedial Targets

Remedial Target	Value	unit	Source
Remedial Target	LTCS 3.33E+48	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	692	m	
Concentration of contaminant at compliance point after	C <sub>2D</sub> /C <sub>0</sub> 7.44E-54	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 specific partition coefficient (option)

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

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient K<sub>oc</sub> 4.57E+02 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow</sub>

Sorption coefficient for ionised species K<sub>ow</sub>

pH value pH

acid dissociation constant pKa

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

Dispersivity

Calculate dispersivity dependent on distance to compliance point (D)

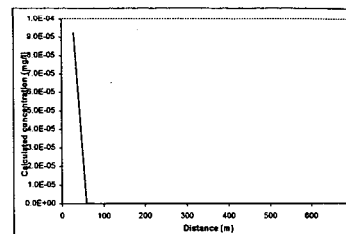
specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax 9.73E+00 m

Transverse dispersivity az 9.73E-01 m

Vertical dispersivity ay 9.73E-02 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<sub>10</sub>ρ<sub>0</sub>)<sup>0.14</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

29.6	9.3E-06
59.2	2.5E-07
86.8	6.5E-10
148.0	4.8E-18
177.6	1.1E-17
M7.2	2.9E-20
238.8	7.6E-23
268.4	2.0E-26
298.0	6.1E-28
326.0	1.3E-30
356.2	3.5E-33
384.8	9.0E-38
414.4	2.4E-38
444.0	6.1E-41
473.6	1.6E-43
603.2	4.2E-48
632.8	1.1E-48
662.4	2.8E-51
692.0	7.4E-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 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: Bixss Area 1 A Murphy K2D  
Completed by: AJ  
Date: 24/11/2005  
Version: 12



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  
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) 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 $C_0$	2.00E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.38E+03	days	
Calculated decay rate $\lambda$	5.10E-04	day <sup>-1</sup>	
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 $ds$	1.08E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.52E+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 $Kd$	5.01E+03	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	4.68E+04	fraction
Decay rate used $\lambda$	5.10E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	2.93E-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	592		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  $Kd$  5.01E+03 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer  $foc$  1.00E+00 fraction  
Organic carbon partition coefficient  $Koc$  5.01E+03 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 pH  
acid dissociation constant  $pKa$  l/kg

Soil water partition coefficient  $Kd$  5.01E+03 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0) 2

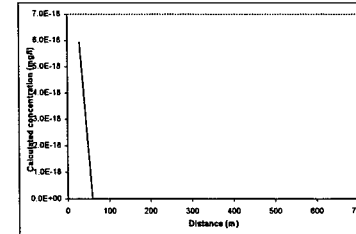
specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity  $ax$  Enter value Calc value Xu & Eckstein 9.73E+00 m

Transverse dispersivity  $az$  9.73E-01 m

Vertical dispersivity  $ay$  9.73E-02 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
29.6	6.9E-18
69.2	1.8E-34
88.8	6.2E-61
118.4	1.5E-87
148.0	4.4E-84
177.6	1.3E-100
207.2	3.8E-117
236.8	1.0E-133
266.4	3.0E-150
296.0	8.8E-167
325.6	2.6E-183
355.2	7.4E-200
384.8	2.1E-216
414.4	6.2E-233
444.0	1.8E-249
473.6	6.2E-266
503.2	1.8E-282
532.8	#NUM!
562.4	#NUM!
592.0	#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 Aica 1 Murphys K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater



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

Contaminant: Bis (2 ethylhexyl)phthalate  
 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	$C_0$	4.20E-02	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	3.89E+02	days	
Calculated decay rate	$\lambda$	1.78E-03	days <sup>-1</sup>	
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	$da$	1.08E+01	m	
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point	$x$	5.92E+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	$Kd$	5.89E+02	l/kg	see options
Longitudinal dispersivity	$ax$	9.730	m	see options
Transverse dispersivity	$az$	0.973	m	see options
Vertical dispersivity	$ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	5.50E+03	fraction
Decay rate used	$\lambda$	1.78E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.50E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{E0}$	1.21E-209	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{E2}$	6.71E-210	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ )	$AF$	3.46E+207	
Attenuation factor (two way vertical dispersion, $C_0/C_{E2}$ )	$AF$	6.26E+207	

Remedial Targets

Remedial Target	LYCS	3.46E+205	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{E0}/C_0$	1.21E-209	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)	$foc$	1.00E+00	fraction
Fraction of organic carbon in aquifer	$Koc$	5.89E+02	l/kg
Organic carbon partition coefficient	$K_{ow,n}$		l/kg
Entry for ionic organic chemicals (option)	$K_{ow,i}$		l/kg
Sorption coefficient for related species	$pH$		
Sorption coefficient for ionised species	$pKa$		
pH value			
acid dissociation constant			

Soil water partition coefficient  $Kd$  5.89E+02 l/kg

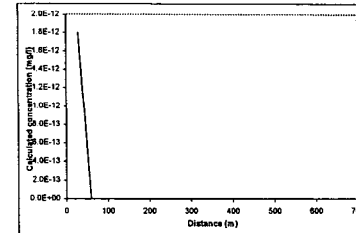
Dispersivity

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	m
Transverse dispersivity	$az$		9.73E-01	m
Vertical dispersivity	$ay$		9.73E-02	m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

	mg/l
29.9	1.8E-12
59.2	7.7E-23
88.9	3.3E-33
118.4	1.4E-43
148.0	6.7E-54
177.0	2.4E-64
207.2	1.0E-74
236.8	4.1E-85
266.4	1.7E-95
296.0	7.2E-106
325.9	3.0E-116
355.2	1.3E-126
384.8	6.3E-137
414.4	2.2E-147
444.0	9.3E-158
473.0	3.9E-168
503.2	1.6E-178
532.8	6.9E-189
562.4	2.9E-199
592.0	1.2E-209

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

SAC being assessed: Biss Area 1 (Biphys) x20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

R&D Publication20 Remedial Targets Worksheet, Release 2.2a  
Tier 3 -Groundwater



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

Contaminant Chrysene  
Target Concentration  $C_T$  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

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	$\lambda$	3.47E-04	days <sup>-1</sup>	
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	$d_a$	1.90E+01	m	
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point	$x$	5.92E+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	$K_d$	7.24E+02	l/kg	see options
Longitudinal dispersivity	$\alpha_x$	9.730	m	see options
Transverse dispersivity	$\alpha_z$	0.873	m	see options
Vertical dispersivity	$\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$R_f$	6.77E+03	fraction
Decay rate used	$\lambda$	3.47E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.03E-04	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{E0}$	6.59E-97	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{E2}$	3.65E-97	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ )	$AF$	3.03E+95	
Attenuation factor (two way vertical dispersion, $C_0/C_{E2}$ )	$AF$	5.48E+95	

Remedial Targets

Remedial Target	LTC3	4.90E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		892	m	
Concentration of contaminant at compliance point after	$C_{E0}/C_0$	6.69E-97	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)

Entry for ionic organic chemicals (option)

Entry for ionised species (option)

Entry for acid dissociation constant (option)

Entry for sorption coefficient for related species (option)

Entry for pH value (option)

Entry for acid dissociation constant (option)

Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

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Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

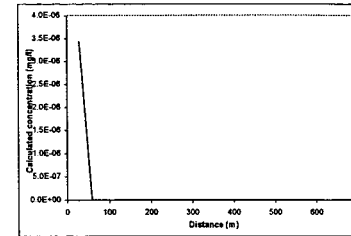
Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)

Entry for soil water partition coefficient (option)



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
29.6	3.4E-06
69.2	6.9E-11
88.8	1.0E-15
118.4	1.7E-20
148.0	2.8E-25
177.6	4.7E-30
207.2	7.9E-35
236.8	1.3E-39
266.4	2.2E-44
296.0	3.7E-49
325.6	6.1E-54
355.2	1.0E-58
384.8	1.6E-63
414.4	2.9E-68
444.0	4.9E-73
473.6	8.2E-78

Site being assessed: Bloss Area 1 Murphys G20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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

Tier 3 - Groundwater



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

Contaminant: Fluoride  
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+00	mg/l	Source of parameter value
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days	
Calculated decay rate	$\lambda$	7.00E-101	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.92E-01	fraction	
Hydraulic gradient	$i$	1.25E-02		
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point	$x$	5.92E+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	$K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity	$\alpha_x$		m	see options
Transverse dispersivity	$\alpha_z$		m	see options
Vertical dispersivity	$\alpha_y$		m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$R_f$	1.00E+00	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.37E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{ED}$	1.74E+00	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{ED}$	9.63E-01	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{ED}$ )	AF	1.55E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{ED}$ )	AF	2.89E+00	

Remedial Targets

Remedial Target	LYCS	1.55E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	$C_{ED}/C_0$	1.74E+00	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)

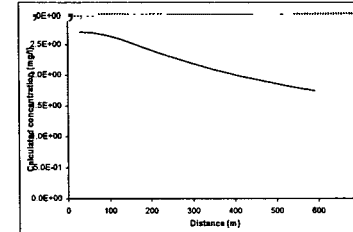
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	$K_d$		l/kg
Soil water partition coefficient	$K_{ow}$		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	$pK_a$		
pH value			
acid dissociation constant			
Soil water partition coefficient	$K_d$	0.00E+00	l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	$\alpha_x$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	$\alpha_z$		9.73E+00 m
Vertical dispersivity	$\alpha_y$		9.73E-01 m
			9.73E-02 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
29.6	2.7E+00
69.2	2.7E+00
88.8	2.7E+00
118.4	2.6E+00
148.0	2.6E+00
177.6	2.6E+00
207.2	2.4E+00
230.1	2.3E+00
266.4	2.3E+00
296.0	2.2E+00
326.0	2.1E+00
355.2	2.1E+00
384.8	2.0E+00
414.4	2.0E+00
444.0	1.9E+00
603.2	1.9E+00
632.1	1.8E+00
662.4	1.8E+00
692.0	1.7E+00

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

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: Bliss Area 1 A mursty K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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)

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 $C_0$	5.00E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	8.80E+02	days	
Calculated decay rate $\lambda$	7.88E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_0$	2.19E+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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	0.18E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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	time variant options only
Parameters values determined from options			
Partition coefficient $K_d$	1.38E+02	l/kg	see options
Longitudinal dispersivity $\alpha_x$	9.730	m	see options
Transverse dispersivity $\alpha_z$	0.973	m	see options
Vertical dispersivity $\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $R_f$	1.29E+03	fraction
Decay rate used $\lambda$	7.88E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.09E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	4.04E-60	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	2.23E-60	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.24E+59	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	2.24E+59	

Remedial Targets

Remedial Target LTC3	1.24E+56	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	592	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	4.04E-60	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  $K_d$  1.38E+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  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{ow}$  l/kg  
pH value  $pH$   
acid dissociation constant  $pK_a$

Soil water partition coefficient  $K_d$  1.38E+02 l/kg

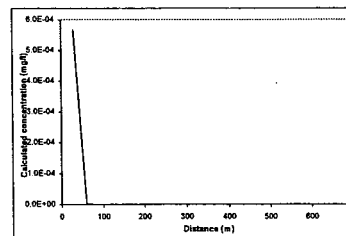
Dispersivity

Calculate dependent on distance to compliance point (0) 2

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

Longitudinal dispersivity  $\alpha_x$  9.73E+00 m  
Transverse dispersivity  $\alpha_z$  0.973E-01 m  
Vertical dispersivity  $\alpha_y$  0.973E-02 m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} x)^{0.75}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  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.

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 Concentration

29.6	5 mg/l <sub>4</sub>
69.2	6.4E-07
88.8	7.2E-10
118.4	8.0E-13
148.0	8.8E-16
177.6	9.7E-19
207.2	1.1E-21
236.8	1.2E-24
266.4	1.3E-27
296.0	1.4E-30
325.6	1.6E-33
355.2	1.8E-36
384.8	1.9E-39
414.4	2.2E-42
444.0	2.4E-45
473.6	2.6E-48
503.2	2.9E-51
532.8	3.1E-54
562.4	3.3E-57
592.0	4.0E-60

Site being assessed: Bliss Area 1 Nurphys K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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

Tier 3 - Groundwater



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

Contaminant Fluorene  
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)

Variable	Value	Unit	Source
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 $\lambda$	5.78E-03	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (latera) to compliance point perpendicular to flow direction $x$	5.92E+02	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 $Kd$	2.63E+01	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	2.47E+02	fraction
Decay rate used $\lambda$	5.78E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	5.57E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{ep}$	3.34E-73	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{ep}$	1.85E-73	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{ep}$ ) $AF$	8.97E+71	
Attenuation factor (two way vertical dispersion, $C_0/C_{ep}$ ) $AF$	1.82E+72	

Remedial Targets

Remedial Target	LYCS	6.84E+66	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{ep}/C_0$	3.34E-73	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

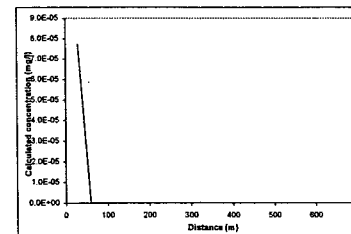
Entry if specify partition coefficient (option)  $Kd$  2.63E+01 l/kg  
Soil water partition coefficient  
Entry for non-polar organic chemicals (option)  $foc$  1.00E+00 fraction  
Fraction of organic carbon in aquifer  
Organic carbon partition coefficient  $Koc$  2.63E+01 l/kg  
Entry for ionic organic chemicals (option)  $K_{ow}$   
Sorption coefficient for related species  
Sorption coefficient for ionized species  $K_{ow}$  l/kg  
pH value  
acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  2.63E+01 l/kg

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

Longitudinal dispersivity  $ax$  9.73E+00 m  
Transverse dispersivity  $az$  0.973E-01 m  
Vertical dispersivity  $ay$  0.973E-02 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
110	7.7E-06
69.2	2.0E-08
88.8	5.1E-12
118.4	1.3E-16
148.0	3.2E-19
177.6	8.1E-23
207.2	2.0E-26
236.8	5.1E-30
266.4	1.3E-33
296.0	3.2E-37
325.6	8.1E-41
355.2	2.0E-44

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 (Murphys K20)  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

R&D Publication20 Remedial Targets Worksheet, Release 2.2a

Tier 3 -Groundwater



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

Contaminant: Lead  
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 $C_0$	17.50E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	1.00E-02	m	
Plume thickness at source $Sy$	1.00E-01	m	
Saturated aquifer thickness $da$	1.00E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.25E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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 $Kd$	3.16E+04	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	2.95E+05	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.65E-06	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	4.84E-02	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	2.95E-02	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.55E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	2.80E+00	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target	1.00E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	592	m	
Concentration of contaminant at compliance point	4.84E-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)

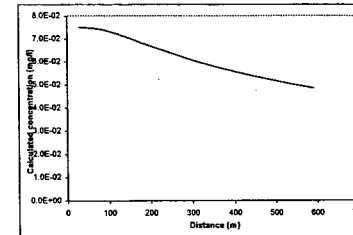
Calculate for non-polar organic chemicals

Soil water partition coefficient $Kd$	3.16E+04	l/kg
Entry for specific 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 $Koc$	3.16E+04	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species $K_{oc}$		l/kg
Sorption coefficient for ionized species $K_{ow}$		l/kg
pH value		
acid dissociation constant $pKa$		
Soil water partition coefficient $Kd$	3.16E+04	l/kg

Dispersivity

Calculate dependant on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2	
Longitudinal dispersivity $ax$	9.73E+00	m
Transverse dispersivity $az$	0.973E-01	m
Vertical dispersivity $ay$	0.097E-02	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

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
29.6	7.6E-02
67.2	7.6E-02
88.8	7.4E-02
146.5	7.0E-02
177.6	6.8E-02
207.2	6.6E-02
236.8	6.4E-02
266.4	6.3E-02
296.0	6.1E-02
325.6	5.9E-02
355.2	5.8E-02
384.8	5.6E-02
414.4	5.6E-02
444.0	5.4E-02
473.6	5.3E-02
503.2	5.1E-02
532.8	5.0E-02
562.4	4.9E-02
592.0	4.8E-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 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 A Murphy K20  
Compiled by: AJ  
Date: 24 11 2005  
Version: 12



R&D 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<sub>T</sub> 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)

Initial contaminant concentration in groundwater at plume core C<sub>0</sub> 1.30E+00 mg/l  
Half life for degradation of contaminant in water t<sub>1/2</sub> 4.00E+02 days  
Calculated decay rate λ 1.73E-03 days<sup>-1</sup>  
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<sup>3</sup>  
Effective porosity of aquifer n 1.82E-01 fraction  
Hydraulic gradient i 2.125E-02  
Hydraulic conductivity of aquifer K 2.00E+01 m/d  
Distance to compliance point x 5.92E+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 5.13E+01 V/kg *see options*  
Longitudinal dispersivity ax 9.730 m *see options*  
Transverse dispersivity az 0.973 m *see options*  
Vertical dispersivity ay 0.097 m *see options*

Calculated Parameters Variable

Groundwater flow velocity v 1.37E+00 m/d  
Retardation factor Rf 4.80E+02 fraction  
Decay rate used λ 1.73E-03 d<sup>-1</sup>  
Rate of contaminant flow due to retardation u 2.86E-03 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion C<sub>EO</sub> 4.49E-53 mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion C<sub>ED</sub> 2.48E-53 mg/l  
Attenuation factor (one way vertical dispersion, C<sub>0</sub>/C<sub>ED</sub>) AF 2.89E+52  
Attenuation factor (two way vertical dispersion, C<sub>0</sub>/C<sub>ED</sub>) AF 5.23E+52

Remedial Targets

Remedial Target LYC3 1.91E+47 mg/l For comparison with measured groundwater concentration.  
Ogata Banks  
Distance to compliance point 692 m  
Concentration of contaminant at compliance point C<sub>ED</sub>/C<sub>0</sub> 4.49E-53 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 5.13E+01 V/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 5.13E+01 V/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub> V/kg  
Sorption coefficient for ionised species K<sub>ow</sub> V/kg  
pH value pH V/kg  
acid dissociation constant pKa V/kg

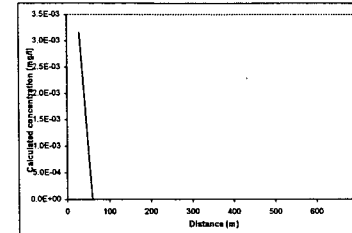
Soil water partition coefficient Kd 5.13E+01 V/kg

Dispersivity

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

Longitudinal dispersivity ax 9.73E+00 m  
Transverse dispersivity az 9.73E-01 m  
Vertical dispersivity ay 9.73E-02 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<sub>10</sub>x)<sup>0.414</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

Distance Concentration

Distance (m)	Concentration (mg/l)
29.8	3.2E-03
69.2	7.7E-06
88.8	1.8E-08
118.4	4.4E-11
148.0	1.0E-13
177.6	2.6E-16
207.2	5.8E-19
236.8	1.4E-21
266.4	3.3E-24
296.0	7.7E-27
325.6	1.8E-29
355.2	4.3E-32
384.8	1.0E-34
414.4	2.6E-37
444.0	5.8E-40
473.6	1.3E-42
503.2	3.0E-45
532.8	7.0E-48
562.4	1.6E-50
592.0	4.0E-53

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 Bilus Area 1 Mistrys K20  
Completed by AJ  
Date 24 11 2005  
Version 12

Tier 3 - Groundwater

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

Contaminant	Phenol
Target Concentration	C <sub>T</sub> 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)

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 <sub>0</sub>	5.00E-01	mg/l	see options
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.00E+01	days	see options
Calculated decay rate	λ	6.93E-02	days <sup>-1</sup>	see options
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.90E+02	m	see options
Plume thickness at source	Sy	1.00E+01	m	see options
Saturated aquifer thickness	da	1.00E+01	m	see options
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	see options
Effective porosity of aquifer	n	1.02E-01	fraction	see options
Hydraulic gradient	i	1.25E-02		see options
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	see options
Distance to compliance point	x	5.82E+02	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	1.05E-01	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.99E+00	fraction
Decay rate used	λ	6.93E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	6.94E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	3.32E-17	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.83E-17	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.51E+16	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	2.73E+16	

Remedial Targets

Remedial Target	LTC3	7.94E+12	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		692	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	3.32E-17	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)

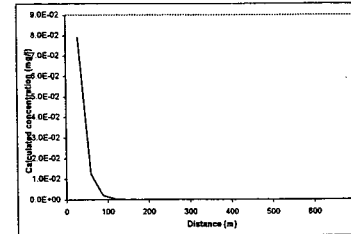
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	1.05E-01	l/kg
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	1.05E-01	l/kg
Sorption coefficient for related species	K <sub>oc,r</sub>		l/kg
Sorption coefficient for ionized species	K <sub>oc,i</sub>		l/kg
pH	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	ax	9.73E+00 m
Transverse dispersivity	az	9.73E-01 m
Vertical dispersivity	ay	9.73E-02 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<sub>10</sub>t)<sup>0.43</sup>, az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
29.6	7.9E-02
69.2	1.3E-02
88.8	2.0E-03
118.4	3.1E-04
148.0	4.7E-05
177.8	7.3E-06
296.8	1.1E-08
268.4	2.7E-08
296.0	4.1E-09
325.6	6.4E-10
366.2	9.8E-11
384.8	1.5E-11
414.4	2.4E-12
444.0	3.7E-13
471.6	5.7E-14
503.2	8.8E-15
532.8	1.4E-15
562.4	2.1E-16
682.0	3.3E-17

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: Binn Area 1 A Murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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



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

Contaminant Phosphorus  
Target Concentration  $C_T$  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
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 $\lambda$	7.00E-101	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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
Partition coefficient $Kd$	0.00E+00	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.37E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	6.65E-01	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	3.98E-01	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.55E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	2.80E+00	

Remedial Targets

Remedial Target	LYC3	3.41E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	6.66E-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)  $Kd$  0.00E+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  $Koc$  0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  $Kow$  0.00E+00 l/kg  
Sorption coefficient for related species  
Sorption coefficient for ionised species  $Kow$  0.00E+00 l/kg  
pH value  
acid dissociation constant  $pKa$  0.00E+00 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) ?

Longitudinal dispersivity  $ax$  9.73E+00 m

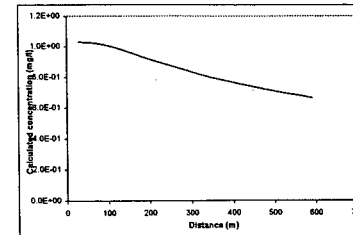
Transverse dispersivity  $az$  9.73E-01 m

Vertical dispersivity  $ay$  9.73E-02 m

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

Xu & Eckstein (1995) report  $ax = 0.63(\log_{10} K_{ow})^{1.5}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed

time variant options only



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

mg/l	
29.8	1.0E+00
69.2	1.0E+00
88.8	1.0E+00
118.4	9.9E-01
148.0	9.7E-01
177.6	9.4E-01
207.2	9.1E-01
236.8	8.9E-01
266.4	8.6E-01
296.0	8.4E-01
325.6	8.1E-01
355.2	7.9E-01
384.8	7.7E-01
414.4	7.6E-01
444.0	7.4E-01
473.6	7.2E-01
503.2	7.1E-01
532.8	6.9E-01
562.4	6.8E-01
592.0	6.6E-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 Boss Area 1 A Murphy K20  
Completed by AJ  
Date 24 11 2005  
Version 12

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  $C_T$  9.25E-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) 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-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.90E+03	days	
Calculated decay rate $\lambda$	1.82E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	1.00E+02	m	
Plume thickness at source $Sy$	1.00E+01	m	
Saturated aquifer thickness $da$	1.09E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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
<b>Parameters values determined from options</b>			
Partition coefficient $Kd$	1.38E+02	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.29E+03	fraction
Decay rate used $\lambda$	1.82E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.06E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{20}$	1.94E-24	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{20}$	9.07E-25	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{20}$ ) $AF$	3.86E+23	
Attenuation factor (two way vertical dispersion, $C_0/C_{20}$ ) $AF$	8.62E+23	

Remedial Targets

Remedial Target	LYCS	2.29E+16	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	$C_{20}/C_0$	1.64E-24	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  $Kd$  1.38E+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  $Koc$  1.38E+02 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{oc}$  l/kg  
pH value  $pH$   
acid dissociation constant  $pKa$

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

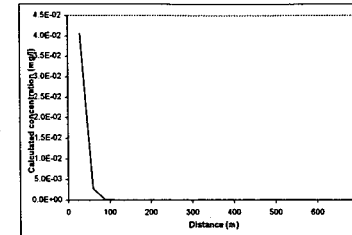
Dispersivity

Calculates dependent on distance to compliance point (0) 2

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

Longitudinal dispersivity $ax$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity $az$		9.73E+00 m
Vertical dispersivity $ay$		9.73E-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



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 Murphy's K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

Distance	Concentration
	mg/l
29.6	4.1E-02
69.2	2.8E-03
88.8	1.8E-04
118.4	1.2E-05
148.0	8.1E-07
177.6	6.3E-08
207.2	3.8E-09
236.8	2.3E-10
266.4	1.5E-11
296.0	1.0E-12
325.6	6.6E-14
355.2	4.4E-16
384.8	2.9E-18
414.4	1.9E-17
444.0	1.3E-18
473.6	8.4E-20
503.2	5.6E-21
532.8	3.7E-22
562.4	2.5E-23
592.0	1.6E-24

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

Tier 3 - Groundwater



Input Parameters (using pull 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): 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 $C_0$	2.00E-03	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+02	m	
Distance (laterally) 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 $K_d$	9.55E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	9.730	m	see options
Transverse dispersivity $\alpha_z$	0.973	m	see options
Vertical dispersivity $\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $R_f$	9.02E+01	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.52E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{E0}$	1.29E-03	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{E0}$	7.14E-04	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ ) $AF$	1.55E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{E0}$ ) $AF$	2.80E+00	

Remedial Targets

Remedial Target	LTC3	1.55E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{E0}/C_0$	1.29E-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

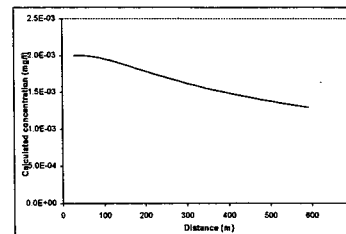
Entry if specify partition coefficient (option)  $K_d$  9.55E+00 l/kg  
Soil water partition coefficient  
Entry for non-polar organic chemicals (option)  $f_{oc}$  1.00E+00 fraction  
Fraction of organic carbon in aquifer  
Organic carbon partition coefficient  $K_{oc}$  9.55E+00 l/kg  
Entry for ionic 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  $pK_a$

Soil water partition coefficient  $K_d$  9.55E+00 l/kg

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

Variable	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity $\alpha_x$		9.73E+00	m
Transverse dispersivity $\alpha_z$		9.73E-01	m
Vertical dispersivity $\alpha_y$		9.73E-02	m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} t)^{0.41}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

29.8	2.0E-03
69.2	2.0E-03
88.8	2.0E-W
119.4	1.9E-03
148.0	1.9E-03
177.6	1.8E-03
207.2	1.8E-03
236.8	1.7E-W
266.4	1.7E-W
296.0	1.6E-03
325.6	1.6E-03
355.2	1.6E-03
384.8	1.6E-W
414.4	1.6E-W
444.0	1.4E-03
473.9	1.4E-03
503.2	1.4E-03
532.8	1.3E-W
562.4	1.3E-W
592.0	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: Biss Area 1 A mirahy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

R&D Publication 20 Remedial Targets Worksheet, Release 22a

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)

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	$\lambda$	7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	$S_z$	1.80E+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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point	$x$	5.82E+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	$K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity	$\alpha_x$		m	see options
Transverse dispersivity	$\alpha_z$		m	see options
Vertical dispersivity	$\alpha_y$		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  $K_d$  0.00E+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  $K_{oc}$  0.00E+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  $K_d$  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	$\alpha_x$	Enter value	Calc value	Xu & Eckstein	
Transverse dispersivity	$\alpha_z$			9.73E-01	m
Vertical dispersivity	$\alpha_y$			9.73E-02	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  $\alpha_x = 0.83(\log_{10} t)^{0.41}$ ;  $\alpha_z = \alpha_z/10$ ,  $\alpha_y = \alpha_y/100$  are assumed

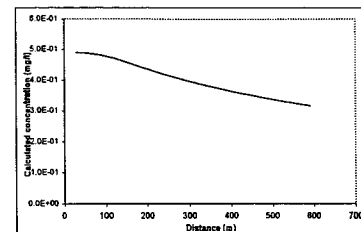
Calculated Parameters

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$R_f$	1.00E+00	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.37E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	3.16E-01	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.75E-01	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	AF	1.55E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	AF	2.80E+00	

Remedial Targets

Remedial Target	LTC3	1.55E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{exp}/C_0$	3.16E-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.



Calculated concentrations for distance-concentration graph

Ogata Banks  
Distance/Concentration

	mg/l
29.8	4.9E-01
69.2	4.8E-01
88.8	4.8E-01
118.4	4.7E-01
148.0	4.6E-01
177.8	4.5E-01
207.2	4.3E-01
236.1	4.2E-01
296.4	4.1E-01
296.0	4.0E-01
328.8	3.9E-01
366.2	3.8E-01
384.8	3.7E-01
414.4	3.6E-01
444.0	3.6E-01
473.6	5.4E-01
W3.2	3.4E-01
632.8	3.3E-01
662.4	3.2E-01
692.0	3.2E-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: Bliss Area 1 A Murphy K20  
Completed by: RJ  
Date: 24/11/2005  
Version: 12

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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  
Half life for degradation of contaminant in water  $t_{1/2}$  9.90E+99 days  
Calculated decay rate  $\lambda$  7.00E-101 days<sup>-1</sup>  
Width of plume in aquifer at source (perpendicular to flow)  $S_z$  3.90E+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  $\rho$  2.170E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-01 fraction  
Hydraulic gradient  $i$  1.25E-02  
Hydraulic conductivity of aquifer  $K$  2.00E+01 m/d  
Distance to compliance point  $x$  5.92E+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

Parameters values determined from options  
Partition coefficient  $K_d$  0.00E+00 l/kg see options  
Longitudinal dispersivity  $\alpha_x$  9.730 m see options  
Transverse dispersivity  $\alpha_z$  0.973 m see options  
Vertical dispersivity  $\alpha_y$  0.097 m see options

Calculated Parameters Variable

Groundwater flow velocity  $v$  1.37E+00 m/d  
Retardation factor  $R_f$  1.00E+00 fraction  
Decay rate used  $\lambda$  7.00E-101 d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $u$  1.37E+00 m/d  
Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{1D}$  2.71E+01 mg/l  
Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{2D}$  1.50E+01 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ )  $AF$  1.55E+00  
Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  2.80E+00

Remedial Targets

Remedial Target  $C_{1D}$  3.10E+02 mg/l For comparison with measured groundwater concentration.  
Ogata Banks  
Distance to compliance point 592 m  
Concentration of contaminant at compliance point  $C_{1D}/C_0$  2.71E+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)  $K_d$  0.00E+00 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  $K_{oc}$  0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  $K_{oc,i}$  0.00E+00 l/kg  
Sorption coefficient for related species  
Sorption coefficient for ionised species  $K_{oc,i}$  0.00E+00 l/kg  
pH value  
acid dissociation constant  $pK_a$

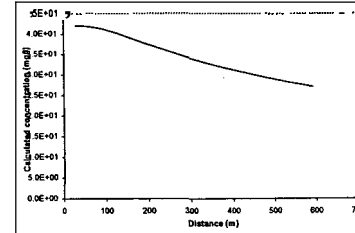
Soil water partition coefficient  $K_d$  0.00E+00 l/kg

Dispersivity

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

Longitudinal dispersivity  $\alpha_x$  9.73E+00 m  
Transverse dispersivity  $\alpha_z$  0.973E-01 m  
Vertical dispersivity  $\alpha_y$  9.73E-02 m

For calculated value, assumes  $\alpha_x = 0.1 \cdot x$ ,  $\alpha_z = 0.01 \cdot z$ ,  $\alpha_y = 0.001 \cdot y$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} C_0)^{0.4}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks Distance-Concentration

29.6	4.2E+01
69.2	4.2E+01
88.8	4.1E+01
148.0	4.0E+01
177.8	3.8E+01
207.2	3.7E+01
286.8	3.6E+01

296.0	3.4E+01
325.6	3.3E+01
355.2	3.2E+01
384.8	3.2E+01
414.4	3.1E+01
444.0	3.0E+01
473.0	2.9E+01
503.2	2.8E+01
532.8	2.8E+01
582.0	2.8E+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: Blets Area 1 A mwhpy K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12





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 <sub>T</sub> 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)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C <sub>0</sub> 9.90E-09	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub> 6.94E-101	days	
Calculated decay rate	λ 6.94E-101	days <sup>-1</sup>	
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 1.09E+01	m	
Bulk density of aquifer materials	ρ 1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 1.25E-02	fraction	
Hydraulic conductivity of aquifer	K 2.00E+01	m/d	
Distance to compliance point	x 5.92E+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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd 2.14E-01	l/kg	see options
Longitudinal dispersivity	ax 9.730	m	see options
Transverse dispersivity	az 0.973	m	see options
Vertical dispersivity	ay 0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	6.94E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	6.39E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	3.53E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>T</sub> )	AF	1.55E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>T</sub> )	AF	2.80E+00	

Remedial Targets

Remedial Target	LTC3	1.59E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	6.39E-09	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 2.14E-01 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient K<sub>oc</sub> 2.14E-01 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow</sub> 1.00E+00 l/kg

Sorption coefficient for ionised species K<sub>ow</sub> 1.00E+00 l/kg

pH value pH 7.00

acid dissociation constant pKa 4.75

Soil water partition coefficient Kd 2.14E-01 l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)

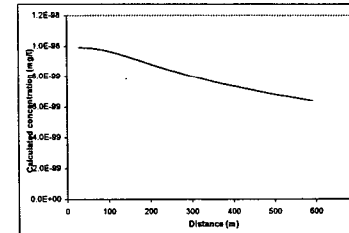
specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity ax 9.73E+00 m

Transverse dispersivity az 0.973E-01 m

Vertical dispersivity ay 0.097E-02 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<sub>10</sub>xy)<sup>0.425</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

Distance	Concentration
28.6	9.9E-09
69.2	9.9E-09
88.8	9.7E-09
118.4	9.6E-09
148.0	9.3E-09
177.6	9.0E-09
207.2	8.8E-09
236.8	8.6E-09
266.4	8.3E-09
296.0	8.0E-09
326.8	7.8E-09
356.2	7.6E-09
386.8	7.4E-09
416.4	7.3E-09
444.0	7.1E-09
473.6	6.9E-09
503.2	6.8E-09
532.8	6.7E-09
562.4	6.6E-09
592.0	6.4E-09

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 A, Murphy K20
Completed by	AJ
Date	24.11.2005
Version	12

Tier 3 - Groundwater



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

Contaminant	2-methylnaphthalene		
Target Concentration	C <sub>T</sub>	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 <sub>0</sub>	1.00E-03	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	2.58E+02	days
Calculated decay rate	λ	2.69E-03	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	5.92E+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	7.24E+00	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	6.87E+01	fraction
Decay rate used	λ	2.69E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.00E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.13E-23	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	6.27E-24	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	8.81E+19	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	1.58E+20	

Remedial Targets

Remedial Target	LTC3	0.91E+17	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.13E-23	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 <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>		l/kg
pH	pH		
acid dissociation constant	pKa		

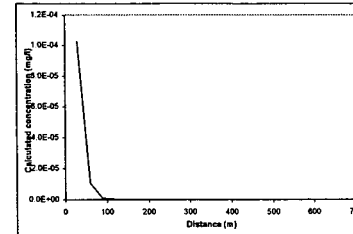
Soil water partition coefficient

Kd	7.24E+00	l/kg
----	----------	------

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	9.73E+00	m
Transverse dispersivity	az	9.73E-01	m
Vertical dispersivity	ay	9.73E-02	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<sub>10</sub>ax)<sup>0.425</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

	mg/l
29.8	1.0E-04
59.2	1.1E-05
88.8	1.1E-06
118.4	1.1E-07
148.0	1.1E-08
177.6	1.1E-09
207.2	1.1E-10
236.8	1.1E-11
266.4	1.1E-12
296.0	1.1E-13
325.6	1.1E-14
355.2	1.1E-15
384.8	1.1E-16
414.4	1.1E-17
444.0	1.1E-18
473.6	1.1E-19
503.2	1.1E-20
532.8	1.1E-21
562.4	1.1E-22
592.0	1.1E-23

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: Bress Area 1 Murphys K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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	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  $\sigma$  to simulate vertical dispersion in one direction, Z for two directions (pull down menu)

Initial contaminant concentration in groundwater at plume core

Half life for degradation of contaminant in water

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

$\sigma$  if rate is for decay in field conditions (i.e. field data from equifer) (pull down menu)

Width of plume in equifer at source (perpendicular to flow)

Plume thickness at source

Porosity

Bulk density of aquifer materials

Effective porosity of aquifer

Hydraulic conductivity of aquifer

Distance to compliance point

Distance (tabern) to compliance point perpendicular to flow direction

Distance (depth) to compliance point perpendicular to flow direction

Parameters values determined from options

Partition coefficient

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

Calculated Parameters Variable

Groundwater flow velocity

Retardation factor

Decay rate used

Rate of contaminant flow due to retardation

Contaminant concentration at distance x, assuming one-way vertical dispersion

Contaminant concentration at distance x, assuming two-way vertical dispersion

Attenuation factor (one way vertical dispersion, C<sub>0</sub>/C<sub>x</sub>)

Attenuation factor (two way vertical dispersion, C<sub>0</sub>/C<sub>pl</sub>)

Remedial Targets

Remedial Target: 1.0E-03

Opata Banks

Distance to compliance point

Concentration of contaminant at compliance point after

Opata Banks

Opata Banks

Opata Banks

Opata Banks

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

Calculates 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

Soil water partition coefficient

Sorption coefficient for ionized 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  $\alpha_x = 0.1 \times \alpha_z = 0.01 \times \alpha_y = 0.001 \times \alpha$

Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} \alpha)^{0.75}$ ,  $\alpha_z = \alpha/10$ ,  $\alpha_y = \alpha/100$  are assumed

Enter value

Calc value

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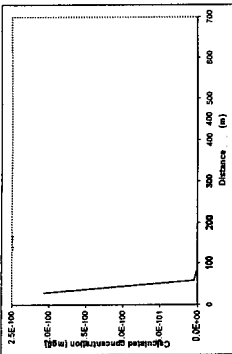
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Note graph has units shown, distance vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the aquifer. It is assumed that the aquifer is homogeneous and isotropic. By using 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: Opata Banks T.A. Murphy & Co  
Compiled by: AJ  
Date: 11/03/05  
Version: 1.2

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R&D Publication20 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 <sub>T</sub> 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 <sub>0</sub> 3.47E-02	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub> 3.65E+03	days	
Calculated decay rate	λ 1.90E-04	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 1.25E-02	fraction	
Hydraulic conductivity of aquifer	K 2.00E+01	m/d	
Distance (latera) to compliance point perpendicular to flow direction	x 5.92E+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
Partition coefficient	Kd 2.29E+06	l/kg	see options
Longitudinal dispersivity	ax 9.730	m	see options
Transverse dispersivity	az 0.973	m	see options
Vertical dispersivity	ay 0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	V	1.37E+00	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	6.42E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	#NUM!	

Remedial Targets

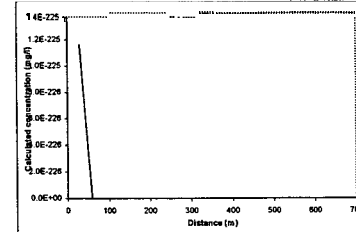
Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	692		m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	#NUM!	mg/l	Ogata Banks
after	9.9E+99		days	

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)

Method	Value	Unit
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)	foc	fraction
Fraction of organic carbon in aquifer		
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>	l/kg
Sorption coefficient for related species	K <sub>ow</sub>	l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>	l/kg
pH value	pKa	
acid dissociation constant		
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	9.73E+00 m
Transverse dispersivity	az	9.73E-01 m
Vertical dispersivity	ay	9.73E-02 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<sub>10</sub>ax)<sup>0.75</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
29.6	1.2E-226
69.2	#NUM!
88.8	#NUM!
118.4	#NUM!
148.0	#NUM!
177.6	#NUM!
207.2	#NUM!
236.8	#NUM!
266.4	#NUM!
296.0	#NUM!
325.6	#NUM!
355.2	#NUM!
384.8	#NUM!
414.4	#NUM!
444.0	#NUM!
473.6	#NUM!
503.2	#NUM!
532.8	#NUM!
562.4	#NUM!
592.0	#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	Bloss Area 1 A Murphy 420
Completed by	AJ
Date	24 11 2005
Version	12



R8D Publication20 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 <sub>T</sub>	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 <sub>0</sub>	3.47E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.85E+03	days
Calculated decay rate	λ	1.90E-04	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance (lateral) to compliance point	x	5.92E+02	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	5.75E+01	l/kg
Longitudinal dispersivity	ax	9.730	m
Transverse dispersivity	az	0.973	m
Vertical dispersivity	ay	0.097	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	5.38E+02	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.55E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	3.02E-15	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.67E-15	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	1.15E+13	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	2.07E+13	

Remedial Targets

Remedial Target	LYCS	Value	Unit	Source
Ogata Banks		8.19E+08	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>D</sub>	3.02E-15	mg/l	Ogata Banks
after		9.9E+99	days	

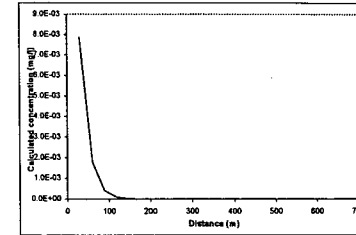
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

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

Method	Value	Unit
Calculate for non-polar organic chemicals		
Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	fraction
Organic carbon partition coefficient	Koc	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K <sub>ow</sub>	l/kg
Sorption coefficient for ionised species	K <sub>oc,i</sub>	l/kg
pH value	pH	
acid dissociation constant	pKa	

Soil water partition coefficient	Kd	5.75E+01	l/kg
<i>Dispersivity</i>			
Calculates dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	9.73E+00	m
Transverse dispersivity	az	9.73E-01	m
Vertical dispersivity	ay	9.73E-02	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<sub>10</sub>ax)<sup>0.75</sup>; 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 1.0E+99.

Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration
	mg/l
29.8	7.8E-07
69.2	1.8E-07
88.8	4.0E-04
148.8	8.9E-06
177.6	4.4E-06
207.2	9.6E-07
236.8	2.1E-07
266.4	4.7E-08
296.0	1.0E-08
325.6	2.3E-09
355.2	5.1E-10
414.4	1.1E-10
444.0	2.6E-11
473.8	6.6E-12
503.2	1.2E-12
532.8	2.7E-13
562.4	6.1E-14
592.0	1.4E-14
621.6	3.0E-15

Site being assessed: Bliss Area 1 A Murphy 420  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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)

Initial contaminant concentration in groundwater at plume core	$C_0$	6.40E+00	mg/l	Source of parameter value
Half life for degradation of contaminant in water	$t_{1/2}$	2.19E+03	days	
Calculated decay rate	$\lambda$	3.17E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	$Sx$	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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point	$x$	5.92E+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	time variant options only
Parameters values determined from options				
Partition coefficient	$Kd$	5.00E-01	W/kg	see options
Longitudinal dispersivity	$ax$	9.730	m	see options
Transverse dispersivity	$az$	0.973	m	see options
Vertical dispersivity	$ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	5.87E+00	fraction
Decay rate used	$\lambda$	3.17E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.42E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	1.92E+00	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.06E+00	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	3.33E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	6.02E+00	

Remedial Targets

Remedial Target	LTC3	3.59E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.92E+00	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  $Kd$  5.00E-01 W/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 W/kg  
Entry for ionic organic chemicals (option)  
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

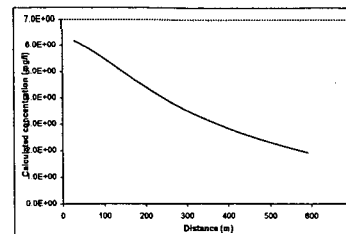
Soil water partition coefficient  $Kd$  5.00E-01 W/kg

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	9.73E+00	m
Transverse dispersivity	$az$			9.73E-01	m
Vertical dispersivity	$ay$			9.73E-02	m

For calculated value, assumes  $ax = 0.1 \cdot x$ ,  $az = 0.01 \cdot x$ ,  $ay = 0.001 \cdot x$ . Xu & Eckstein (1995) report  $ax = 0.63(\log_{10} x)^{0.43}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



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

Calculated concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
29.6	6.2E+00
69.2	6.9E+00
88.8	6.6E+00
118.4	6.3E+00
148.0	6.0E+00
177.6	4.8E+00
207.2	4.3E+00
236.8	4.1E+00
266.4	3.8E+00
296.0	3.6E+00
325.6	3.3E+00
355.2	3.1E+00
384.8	2.9E+00
414.4	2.8E+00
444.0	2.6E+00
473.6	2.4E+00
603.2	2.3E+00
632.8	2.2E+00
662.4	2.0E+00
692.0	1.9E+00

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: Bloss Area 1 A Murphy K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12



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: 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	9.80E-09	mg/l	
Half life for degradation of contaminant in water	1.83E+03	days	
Calculated decay rate	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	1.90E+02	m	
Plume thickness at source	1.90E+01	m	
Saturated aquifer thickness	1.08E+01	m	
Bulk density of aquifer materials	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	1.82E-01	fraction	
Hydraulic gradient	1.25E-02	fraction	
Hydraulic conductivity of aquifer	2.00E+01	m/d	
Distance to compliance point	5.92E+02	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	time variant options only
Partition coefficient	5.75E+00	l/kg	see options
Longitudinal dispersivity	9.730	m	see options
Transverse dispersivity	0.973	m	see options
Vertical dispersivity	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	5.47E+01	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.51E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	2.30E-102	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.27E-102	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	4.30E+03	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	7.77E+03	

Remedial Targets

Remedial Target	LTC3	3.07E+00	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	2.30E-102	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.

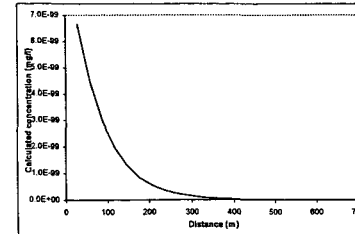
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	5.75E+00	l/kg
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	5.75E+00	l/kg
Soil water partition coefficient	Kd	5.75E+00	l/kg
Longitudinal dispersivity	ax	9.73E+00	m
Transverse dispersivity	az	9.73E-01	m
Vertical dispersivity	ay	9.73E-02	m

Calculate dependent on distance to compliance point (0)		2	
Specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	9.73E+00	m
Transverse dispersivity	az	9.73E-01	m
Vertical dispersivity	ay	9.73E-02	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<sub>10</sub> t)<sup>0.44</sup>; az = az/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
29.6	6.7E-09
59.2	4.6E-09
88.8	3.0E-09
118.4	2.0E-09
148.0	1.3E-09
207.2	6.6E-100
236.8	3.6E-100
266.4	2.3E-100
296.0	1.6E-100
325.6	1.0E-100
388.8	4.6E-101
444.0	2.0E-101
473.6	1.2E-101
503.2	8.0E-102
632.8	8.0E-102
692.0	2.3E-102

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: Blits Area 1 A Murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater



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

Contaminant	Aromatic C10-C12		
Target Concentration	C <sub>T</sub>	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 <sub>0</sub>	9.90E-09	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days	
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	5.92E+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	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	9.12E+00	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	8.62E+01	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.59E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	4.74E-104	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.62E-104	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	2.09E+05	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	3.78E+05	

Remedial Targets

Remedial Target	LTC3	1.49E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	4.74E-104	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)

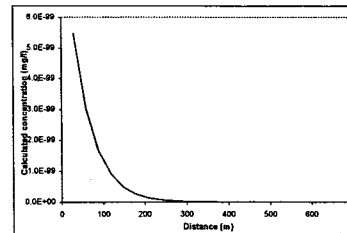
Calculate for non-polar organic chemicals

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 <sub>ow</sub>	l/kg
Sorption coefficient for ionised species	K <sub>oc</sub>	l/kg
pH value	pH	
acid dissociation constant	pKa	
Soil water partition coefficient	Kd	9.12E+00 l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)		
specify dispersivity (1), or calc after Xu & Eckstein (2) ?		
Longitudinal dispersivity	ax	9.73E+00 m
Transverse dispersivity	az	9.73E-01 m
Vertical dispersivity	ay	9.73E-02 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<sub>10</sub>x)<sup>0.75</sup>; az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
	mg/l
29.6	5.6E-09
69.2	3.0E-09
88.8	1.7E-09
188.0	4.8E-100
177.6	2.6E-100
208.0	7.4E-100
168.4	4.1E-101
296.0	2.2E-101
326.1	1.2E-101
366.2	6.4E-102
384.6	3.4E-102
414.4	1.9E-102
444.0	1.0E-102
413.6	5.5E-103
603.0	3.0E-103
562.4	8.7E-104
592.0	4.7E-104

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	Elles Area 1 A Murphy K20
Completed by	AJ
Date	24/1/2005
Version	12

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Tier 3 - Groundwater



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

Contaminant Target Concentration  $C_T$  Aromatic 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)

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	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days	days
Calculated decay rate	$\lambda$	3.80E-04	days	days
Width of plume in aquifer at source (perpendicular to flow)	$Sz$	1.80E+02	m	m
Plume thickness at source	$Sy$	1.00E+01	m	m
Saturated aquifer thickness	$da$	1.08E+01	m	m
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction	fraction
Hydraulic gradient	$i$	1.25E-02	fraction	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	m/d
Distance to compliance point	$x$	5.92E+02	m	m
Distance (laterally) to compliance point perpendicular to flow direction	$z$	0.00E+00	m	m
Distance (depth) to compliance point perpendicular to flow direction	$y$	0.00E+00	m	m
Time since pollutant entered groundwater	$t$	9.90E+99	days	days
Parameters values determined from options				
Partition coefficient	$Kd$	1.82E+01	W/kg	see options
Longitudinal dispersivity	$ax$	9.730	m	see options
Transverse dispersivity	$az$	0.973	m	see options
Vertical dispersivity	$ay$	0.087	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	1.71E+02	fraction
Decay rate used	$\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	8.04E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	1.99E-11	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.10E-11	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	1.75E+09	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	3.16E+09	

Remedial Targets

Remedial Target	LTC3	1.25E+06	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.99E-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)

Soil water partition coefficient  $Kd$  1.82E+01 W/kg

Entry for non-polar organic chemicals (option)

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

Organic carbon partition coefficient  $Koc$  1.82E+01 W/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species  $K_{ow}$  W/kg

Sorption coefficient for ionized species  $K_{ow}$  W/kg

pH value  $pH$

acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  1.82E+01 W/kg

Dispersivity

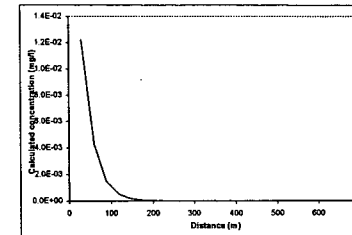
Calculate dispersivity dependent on distance to compliance point (0)

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

Longitudinal dispersivity	$ax$	Enter value	Calc value Xu & Eckstein	m
Transverse dispersivity	$az$		9.73E+00	m
Vertical dispersivity	$ay$		9.73E-01	m
			9.73E-02	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

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Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
29.6	1.2E-02
63.2	4.3E-03
88.8	1.6E-03
118.4	6.2E-04
148.0	1.8E-04
177.6	6.1E-05
207.2	2.1E-05
236.8	7.1E-06
266.4	2.4E-06
296.0	8.4E-07
325.6	2.9E-07
355.2	9.9E-08
384.8	3.4E-08
414.4	1.2E-08
444.0	4.0E-09
473.6	1.4E-09
503.2	4.8E-10
532.8	1.7E-10
562.4	6.8E-11
592.0	2.0E-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: Gless A161 A Murphy 620  
 Compiled by: AJ  
 Date: 24 11 2005  
 Version: 12

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:  $C_T$  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 $t_{1/2}$	3.85E+03	days	
Calculated decay rate $\lambda$	1.90E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_0$	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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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
Partition coefficient $K_d$	4.57E+02	l/kg	see options
Longitudinal dispersivity $\alpha_x$	9.730	m	see options
Transverse dispersivity $\alpha_z$	0.973	m	see options
Vertical dispersivity $\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	4.27E+03	fraction
Decay rate used $\lambda$	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	3.22E-04	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	7.44E-54	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	4.12E-54	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	4.66E+51	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	8.43E+51	

Remedial Targets

Remedial Target	LYCS	3.33E+08	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	7.44E-54	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 $K_d$		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 $K_{oc}$	4.57E+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		
acid dissociation constant $pK_a$		

Soil water partition coefficient  $K_d$  4.57E+02 l/kg

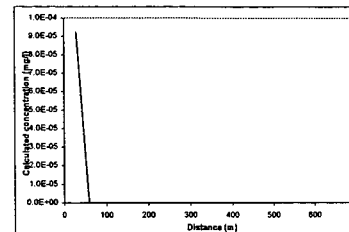
Dispersivity

Calculate dependant on distance to compliance point (0)

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

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity $\alpha_x$		9.73E+00	m
Transverse dispersivity $\alpha_z$		0.973E-01	m
Vertical dispersivity $\alpha_y$		0.73E-02	m

For calculated value, assumes  $\alpha_x = 0.1 \cdot x$ ,  $\alpha_z = 0.01 \cdot z$ ,  $\alpha_y = 0.001 \cdot y$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} x)^{0.4}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

29.6	9.3E-05
69.2	2.5E-07
88.8	6.5E-10
118.4	1.7E-12
148.0	4.4E-16
177.6	1.1E-17
207.2	2.9E-20
236.8	7.6E-23
266.4	2.0E-26
296.0	6.1E-29
325.6	1.3E-30
355.2	3.5E-33
384.8	9.0E-36
414.4	2.4E-38
444.0	6.1E-41
473.6	1.6E-43
503.2	4.2E-46
532.8	1.1E-48
562.4	2.8E-51
592.0	7.4E-54

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: Boss Area 1 A Murphy K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12



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

Tier 3 - Groundwater



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

Contaminant: Benzo(a)anthracene  
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

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	see options
Half life for degradation of contaminant in water	$t_{1/2}$	1.36E+03	days	see options
Calculated decay rate	$\lambda$	5.10E-04	days <sup>-1</sup>	see options
Width of plume in aquifer at source (perpendicular to flow)	$Sz$	1.30E+02	m	see options
Plume thickness at source	$Sy$	1.00E+01	m	see options
Saturated aquifer thickness	$da$	1.08E+01	m	see options
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>	see options
Effective porosity of aquifer	$n$	1.82E-01	fraction	see options
Hydraulic gradient	$i$	1.25E-02	fraction	see options
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	see options
Distance to compliance point	$x$	5.92E+02	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
<b>Parameters values determined from options</b>				
Partition coefficient	$Kd$	5.01E+03	l/kg	see options
Longitudinal dispersivity	$ax$	9.730	m	see options
Transverse dispersivity	$az$	0.973	m	see options
Vertical dispersivity	$ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	4.68E+04	fraction
Decay rate used	$\lambda$	5.10E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.83E-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, $C_1/C_0$ )	$AF$	#NUM!	
Attenuation factor (two way vertical dispersion, $C_2/C_0$ )	$AF$	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	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

Entry if specify partition coefficient (option)

Soil water partition coefficient  $Kd$  5.01E+03 l/kg

Entry for non-polar organic chemicals (option)

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

Organic carbon partition coefficient  $Koc$  5.01E+03 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 pH

acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  5.01E+03 l/kg

Dispersivity

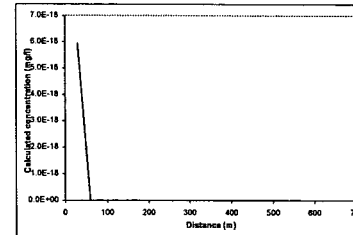
Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity  $ax$  9.73E+00 m

Transverse dispersivity  $az$  0.973E-01 m

Vertical dispersivity  $ay$  0.097E-02 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

29.8	6.9E-18
93.2	1.8E-34
58.8	6.2E-41
118.4	1.5E-47
148.0	4.4E-54
177.6	1.3E-100
207.2	3.6E-117
236.8	1.0E-133
264.4	3.0E-150
296.0	8.8E-167
326.8	2.6E-183
356.2	7.4E-200
384.8	2.1E-216
414.4	6.2E-233
444.0	1.8E-249
473.6	6.2E-266
503.2	1.6E-282
532.8	#NUM!
562.4	#NUM!
592.0	#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: Bless Area 1 Muttonys K20  
Completed by: AJ  
Date: 24.11.2005  
Version: 12

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Tier 3 - Groundwater



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

Contaminant: Bis (2 ethylhexyl)phthalate  
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	$C_0$	4.20E-02	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	3.89E+02	days
Calculated decay rate	$\lambda$	1.78E-03	days <sup>-1</sup>
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	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	0.125E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	5.92E+02	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
Parameters values determined from options			
Partition coefficient	Kd	5.89E+02	l/kg
Longitudinal dispersivity	ax	9.730	m
Transverse dispersivity	az	0.873	m
Vertical dispersivity	av	0.097	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	5.50E+03	fraction
Decay rate used	$\lambda$	1.78E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.50E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	1.21E-209	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	6.71E-210	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	AF	3.46E+207	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	AF	6.28E+207	

Remedial Targets

Remedial Target	LTC3	1.48E+205	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{1D}/C_D$	1.21E-209	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  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub>  
Organic carbon partition coefficient K<sub>oc</sub>  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub>  
Sorption coefficient for ionised species K<sub>ow</sub>  
pH value pH  
acid dissociation constant pKa

Soil water partition coefficient Kd 5.89E+02 l/kg

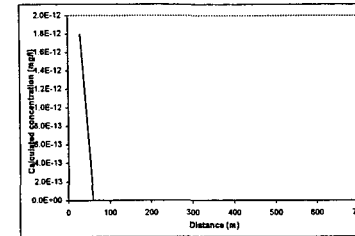
Dispersivity

Calculate dependent on distance to compliance point (D)

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

Longitudinal dispersivity ax 9.73E+00 m  
Transverse dispersivity az 9.73E-01 m  
Vertical dispersivity av 9.73E-02 m

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* x, av = 0.001 \* x  
Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>a)<sup>0.111</sup>, az = az/10, av = av/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
29.8	1.8E-12
69.2	7.7E-23
88.8	3.3E-33
118.4	1.4E-43
148.0	6.7E-54
177.6	2.4E-64
207.2	1.0E-74
236.8	4.1E-86
266.4	1.7E-96
296.0	7.2E-106
325.6	3.0E-116
355.2	1.3E-126
384.8	5.3E-137
414.4	2.2E-147
444.0	9.3E-158
473.6	3.9E-168
503.2	1.6E-178
532.8	6.9E-189
562.4	2.9E-199
592.0	1.2E-209

Site being assessed: Bass Area 1: Murphy's K20  
Compiled by: AJ  
Date: 24/11/2005  
Version: 12

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:  $C_T$  6.29E-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 $C_0$	2.00E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.20E+03	days	
Calculated decay rate $\lambda$	3.47E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	3.80E+02	m	
Plume thickness at source $Sy$	3.10E+01	m	
Saturated aquifer thickness $da$	1.08E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+01	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.92E+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 $Kd$	7.24E+02	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	6.77E+03	fraction
Decay rate used $\lambda$	3.47E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	2.03E-04	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	6.59E-97	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	3.55E-97	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	3.03E+95	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	5.48E+95	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target	1.90E+00	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	592	m	
Concentration of contaminant at compliance point	6.69E-97	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  $Kd$  7.24E+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  $Koc$  7.24E+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

acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  7.24E+02 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

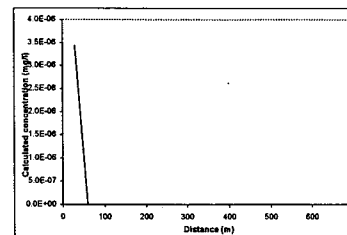
specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity  $ax$  9.73E+00 m

Transverse dispersivity  $az$  0.973E+01 m

Vertical dispersivity  $ay$  0.973E-02 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

Distance	Concentration
29.6	3.4E-06
59.2	6.9E-11
88.8	1.0E-15
118.4	1.7E-20
148.0	2.8E-25
177.8	4.7E-30
207.2	7.9E-35
236.8	1.3E-39
266.4	2.2E-44
296.0	3.7E-49
325.6	6.1E-54
355.2	1.0E-58
384.8	1.7E-63
414.4	2.9E-68
444.0	4.9E-73
473.6	8.2E-78
503.2	1.4E-82
532.8	2.3E-87
562.4	3.9E-92
592.0	6.6E-97

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: Bloss Area 1 Murphy's K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12



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  $C_0$  5.00E-01 mg/l  
Half life for degradation of contaminant in water  $t_{1/2}$  6.80E+02 days  
Calculated decay rate  $\lambda$  7.88E-04 days<sup>-1</sup>  
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  $\rho$  1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-01 fraction  
Hydraulic gradient  $i$  1.25E-02 fraction  
Hydraulic conductivity of aquifer  $K$  2.00E+01 m/d  
Distance to compliance point  $x$  5.92E+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  $K_d$  1.38E+02 l/kg see options  
Longitudinal dispersivity  $\alpha_x$  9.730 m see options  
Transverse dispersivity  $\alpha_z$  0.973 m see options  
Vertical dispersivity  $\alpha_y$  0.097 m see options

Calculated Parameters Variable  
Groundwater flow velocity  $v$  1.37E+00 m/d  
Retardation factor  $R_f$  1.29E+03 fraction  
Decay rate used  $\lambda$  7.88E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $u$  1.06E-03 m/d  
Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{1D}$  4.04E-00 mg/l  
Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{2D}$  2.22E-00 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ )  $AF$  1.24E+59  
Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  2.24E+59

Remedial Targets	Remedial Target	Value	Unit	Source
Ogata Banks	LTC3	1.24E+60	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		592	m	
Concentration of contaminant at compliance point after	$C_{2D}/C_0$	4.04E-60	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

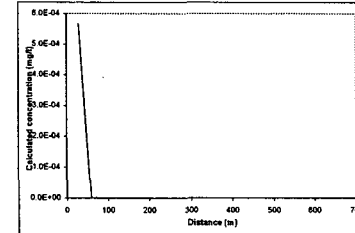
Entry if specify partition coefficient (option)  $K_d$  1.38E+02 l/kg  
Soil water partition coefficient (option)  $K_{ow}$  1.00E+00 fraction  
Fraction of organic carbon in aquifer  $f_{oc}$  1.00E+00 fraction  
Organic carbon partition coefficient  $K_{oc}$  1.38E+02 l/kg  
Entry for ionic organic chemicals (option)  $K_{ow}$  l/kg  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $pH$  l/kg  
pH value  $pK_a$  l/kg  
acid dissociation constant

Soil water partition coefficient  $K_d$  1.38E+02 l/kg

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

Enter value	Calc value Xu & Eckstein	Unit
	9.73E+00	m
	9.73E-01	m
	9.73E-02	m

For calculated value, assumes  $\alpha_x = 0.1 \times x$ ,  $\alpha_z = 0.01 \times z$ ,  $\alpha_y = 0.001 \times y$  and Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} pK_a)^{0.41}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
29.6	6.7E-04
59.2	6.4E-07
88.8	7.2E-10
118.4	8.0E-13
148.0	8.8E-16
177.6	9.7E-19
207.2	1.1E-21
236.8	1.2E-24
266.4	1.3E-27
296.0	1.4E-30
325.6	1.5E-33
355.2	1.6E-36
384.8	1.7E-39
414.4	2.2E-42
444.0	2.4E-45
473.6	2.6E-48
503.2	2.9E-51
532.8	3.2E-54
562.4	3.5E-57
592.0	4.0E-60

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: Bross Area 1 Munphys K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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

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

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  $\lambda$  5.78E-03 days<sup>-1</sup>  
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  $\rho$  1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-01 fraction  
Hydraulic gradient  $i$  1.28E-02 fraction  
Hydraulic conductivity of aquifer  $K$  2.00E+01 m/d  
Distance to compliance point  $x$  5.92E+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  
Parameters values determined from options  
Partition coefficient  $K_d$  2.63E+01 l/kg see options  
Longitudinal dispersivity  $\alpha_x$  9.730 m see options  
Transverse dispersivity  $\alpha_z$  0.873 m see options  
Vertical dispersivity  $\alpha_y$  0.097 m see options

Calculated Parameters Variable

Groundwater flow velocity  $v$  1.37E+00 m/d  
Retardation factor  $R_f$  2.47E+02 fraction  
Decay rate used  $\lambda$  5.78E-03 d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $u$  5.57E-03 m/d  
Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{E1}$  3.34E-73 mg/l  
Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{E2}$  1.85E-73 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{E1}$ )  $AF$  8.97E+71  
Attenuation factor (two way vertical dispersion,  $C_0/C_{E2}$ )  $AF$  1.82E+72

Remedial Targets Remedial Target LTCS 6.61E+08 mg/l For comparison with measured groundwater concentration, Ogata Banks

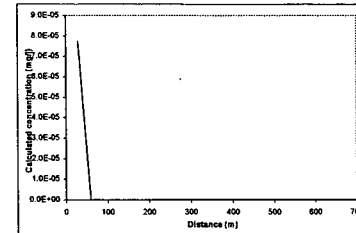
Distance to compliance point 592 m  
Concentration of contaminant at compliance point after  $C_{E1}/C_0$  3.34E-73 mg/l Ogata Banks  
after 9.9E+99 days

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)  $K_d$  2.63E+01 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  $K_{oc}$  2.63E+01 l/kg  
Entry for ionic organic chemicals (option)  $K_{ow}$  1.00E+00 l/kg  
Sorption coefficient for related species  
Sorption coefficient for ionised species  $K_{ow}$  1.00E+00 l/kg  
pH value  
acid dissociation constant  $pK_a$   
Soil water partition coefficient  $K_d$  2.63E+01 l/kg  
Dispersivity  
Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?  
Longitudinal dispersivity  $\alpha_x$  9.73E+00 m  
Transverse dispersivity  $\alpha_z$  0.873E-01 m  
Vertical dispersivity  $\alpha_y$  9.73E-02 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  $\alpha_x = 0.83(\log_{10} x)^{0.111}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration  
mg/l

29.6	7.7E-06
59.2	2.0E-06
88.8	6.1E-07
133.4	1.3E-07
148.0	3.2E-08
377.1	8.1E-23
207.2	2.0E-26
296.0	6.1E-30
296.0	3.2E-37
126.6	6.1E-41
155.2	1.3E-45
384.5	6.1E-48
414.4	1.3E-51
444.0	3.2E-56
471.1	8.2E-59
601.2	2.1E-62
632.6	5.2E-66
662.0	1.3E-69

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 Muirphys K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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

Tier 3 - Groundwater



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

Contaminant **Lead**  
Target Concentration **C<sub>T</sub>** **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 <sub>0</sub>	7.50E-02	mg/l	see options
Half life for degradation of contaminant in water t <sub>1/2</sub>	9.90E+99	days	see options
Calculated decay rate λ	7.00E-101	days <sup>-1</sup>	see options
Width of plume in aquifer at source (perpendicular to flow) Sz	1.90E+02	m	see options
Plume thickness at source Sy	1.00E+01	m	see options
Saturated aquifer thickness da	1.00E+01	m	see options
Bulk density of aquifer materials ρ	1.70E+00	g/cm <sup>3</sup>	see options
Effective porosity of aquifer n	1.82E-01	fraction	see options
Hydraulic gradient i	1.25E-02	fraction	see options
Hydraulic conductivity of aquifer K	2.00E+01	m/d	see options
Distance to compliance point x	5.82E+02	m	see options
Distance (laterally) 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	3.16E+04	l/kg	see options
Longitudinal dispersivity ax	9.730	m	see options
Transverse dispersivity az	0.973	m	see options
Vertical dispersivity ay	0.097	m	see options

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

Calculate for non-polar organic chemicals

Soil water partition coefficient Kd	3.16E+04	l/kg
Fraction of organic carbon in aquifer f <sub>oc</sub>	1.00E+00	fraction
Organic carbon partition coefficient K <sub>oc</sub>	3.16E+04	l/kg
Soil water partition coefficient K <sub>d</sub>	3.16E+04	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)

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

Dispersivity	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity ax		9.73E+00 m
Transverse dispersivity az		9.73E-01 m
Vertical dispersivity ay		9.73E-02 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<sub>10</sub>x)<sup>0.414</sup>; az = ax/10, ay = az/100 are assumed

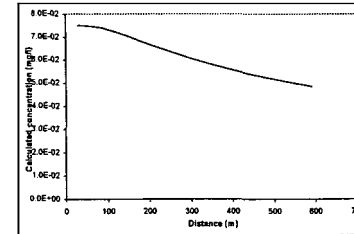
Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity v	1.37E+00	m/d
Retardation factor Rf	2.95E+05	fraction
Decay rate used λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation u	4.85E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C <sub>1D</sub>	4.84E-02	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C <sub>2D</sub>	2.88E-02	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> ) AF	1.55E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> ) AF	2.80E+00	

Remedial Targets

Remedial Target	LTC3	1.65E-02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		592	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	4.84E-02	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.



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
29.6	7.5E-02
69.2	7.6E-02
P.6	7.4E-02
118.4	7.2E-02
148.0	7.0E-02
177.6	6.8E-02
207.2	6.6E-02
236.8	6.4E-02
266.4	6.3E-02
296.0	6.1E-02
325.6	6.0E-02
366.2	6.0E-02
384.8	6.0E-02
414.4	6.0E-02
444.0	6.0E-02
473.6	6.0E-02
503.2	6.0E-02
532.8	6.0E-02
562.4	6.0E-02
602.0	6.0E-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: Blets Area 1 A Murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12



R&D Publication20 Remedial TargetsWorksheet, Release2.2a

Tier 3 -Groundwater



InputParameters (using pull down menu) Variable Value Unit Source

Contaminant 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	$C_0$	1.30E+00	mg/l	Source of parameter value
Half life for degradation of contaminant in water	$t_{1/2}$	4.00E+02	days	
Calculated decay rate	$\lambda$	1.73E-03	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point perpendicular to flow direction	$x$	5.82E+02	m	
Distance (depth) to compliance point perpendicular to flow direction	$z$	1.00E+00	m	
Time since pollutant entered groundwater	$t$	9.90E+99	days	time variant options only
<b>Parameters values determined from options</b>				
Partition coefficient	$Kd$	5.13E+01	l/kg	see options
Longitudinal dispersivity	$ax$	9.730	m	see options
Transverse dispersivity	$az$	0.973	m	see options
Vertical dispersivity	$ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	4.80E+02	fraction
Decay rate used	$\lambda$	1.73E-03	days <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.88E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	4.49E-53	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	2.48E-53	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	2.88E+52	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	5.23E+52	

Remedial Targets

Remedial Target	LTC3	1.91E+47	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point after	$C_{1D}/C_0$	4.49E-53	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

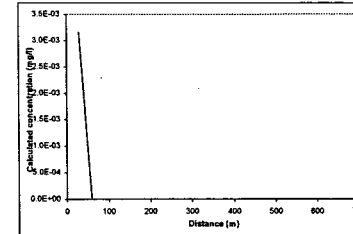
Entry if specify partition coefficient (option)  
Soil water partition coefficient  $Kd$  5.13E+01 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer  $foc$  1.00E+00 fraction  
Organic carbon partition coefficient  $Koc$  5.13E+01 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{oc}$  l/kg  
Sorption coefficient for ionized species  $K_{oc,i}$  l/kg  
pH value pH  
acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  5.13E+01 l/kg

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

Longitudinal dispersivity  $ax$  9.73E+00 m  
Transverse dispersivity  $az$  0.973E-01 m  
Vertical dispersivity  $ay$  0.097E-02 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



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: Glos Area 1 Multiphase K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
29.6	3.2E-03
63.2	7.7E-04
88.8	1.8E-04
118.4	4.4E-11
148.0	1.0E-13
177.6	2.5E-16
207.2	5.8E-19
236.8	1.4E-21
266.4	3.3E-24
296.0	7.7E-27
326.9	1.8E-29
366.2	4.3E-32
384.8	1.0E-34
414.4	2.6E-37
444.0	5.8E-40
473.9	1.4E-42
603.2	3.3E-46
632.8	7.9E-48
662.4	1.9E-50
692.0	4.5E-53

Tier 3 -Groundwater

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

Contaminant	Phenol		
Target Concentration	C <sub>T</sub>	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
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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 <sub>0</sub>	5.00E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.00E+01	days	
Calculated decay rate	λ	6.93E-02	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sx	1.00E+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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	5.92E+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 determined from options			
Partition coefficient	Kd	1.05E-01	l/kg see options
Longitudinal dispersivity	ax	9.730	m see options
Transverse dispersivity	ay	0.973	m see options
Vertical dispersivity	az	0.097	m see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.98E+00	fraction
Decay rate used	λ	6.93E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	6.94E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	3.32E-17	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.93E-17	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.51E+16	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	2.73E+16	

Remedial Targets

Remedial Target	LTC3	7.64E+12	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of oontaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	3.32E-17	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

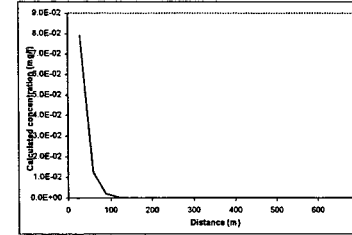
Entry if specify partition coefficient (option)	Kd	1.05E-01	l/kg
Soil water partition coefficient			
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer			
Organic carbon partition coefficient	Koc	1.05E-01	l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species			
Sorption coefficient for ionised species	K <sub>ow</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		

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

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

Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein	9.73E+00	m
Transverse dispersivity	ay			9.73E-01	m
Vertical dispersivity	az			9.73E-02	m

For calculated value, assume ax = 0.1 \* x, az = 0.01 \* x, ay = 0.001 \* x. Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>D)<sup>0.43</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
	mg/l
29.6	7.9E-02
69.2	1.5E-02
88.8	2.0E-03
118.4	3.1E-04
148.0	4.7E-05
177.0	7.3E-06
207.2	1.1E-06
236.8	1.7E-07
266.4	2.7E-08
296.0	4.1E-09
325.6	6.4E-10
355.2	9.8E-11
384.8	1.6E-11
414.4	2.4E-12
444.0	3.7E-13
473.0	6.7E-14
503.2	1.0E-14
532.8	1.4E-15
562.4	2.1E-16
592.0	3.3E-17

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	Bloss Aica 1 A Murphy K20
Completed by	AJ
Date	24/11/2005
Version	12

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

Tier 3 - Groundwater



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

Contaminant	Phosphorus		
Target Concentration	C <sub>T</sub>	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
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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 <sub>0</sub>	5.103E+00	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point perpendicular to flow direction	x	5.82E+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	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.997	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.37E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>00</sub>	6.65E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>00</sub>	3.68E-01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>00</sub> )	AF	1.55E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>00</sub> )	AF	2.80E+00	

Remedial Targets

Remedial Target	LICS	3.44E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	C <sub>00</sub> /C <sub>0</sub>	6.65E-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)

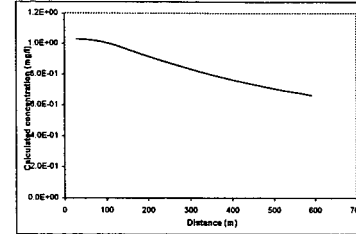
Calculate for non-polar organic chemicals

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 <sub>ow</sub>	0.00E+00 l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>	0.00E+00 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) ?		
Longitudinal dispersivity	ax	9.73E+00 m
Transverse dispersivity	az	9.73E-01 m
Vertical dispersivity	ay	9.73E-02 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<sub>10</sub>Q<sup>-0.41</sup>); az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
29.6	1.0E+00
69.2	1.0E+00
88.8	1.0E+00
118.4	9.9E-01
148.0	9.7E-01
177.8	9.4E-01
208.8	9.9E-01
210.4	8.6E-01
296.0	8.4E-01
325.8	8.1E-01
352.2	7.9E-01
384.8	7.7E-01
414.4	7.6E-01
444.0	7.4E-01
473.9	7.2E-01
603.2	7.1E-01
632.8	6.9E-01
662.4	6.8E-01
692.0	6.6E-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: Site Area 1 A Murphy 620  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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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 Pyrene  
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

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-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.80E+03	days	
Calculated decay rate $\lambda$	1.82E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.82E+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 $Kd$	1.38E+02	l/kg	see options
Longitudinal dispersivity $\alpha_x$	9.730	m	see options
Transverse dispersivity $\alpha_z$	0.973	m	see options
Vertical dispersivity $\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.29E+03	fraction
Decay rate used $\lambda$	1.82E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.06E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	1.64E-24	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	9.07E-25	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	3.66E+23	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	6.82E+23	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target $C_{1D}/C_0$	2.29E+19	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	682	m	
Concentration of contaminant at compliance point after	1.64E-24	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)

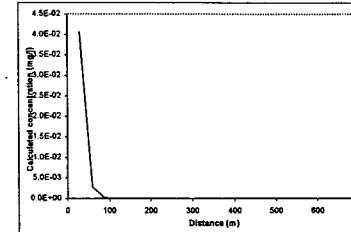
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) Soil water partition coefficient $Kd$	1.38E+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 $Koc$	1.38E+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		
acid dissociation constant $pKa$		
Soil water partition coefficient $Kd$	1.38E+02	l/kg

Dispersivity  
Calculate 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 $\alpha_x$		9.73E+00	m
Transverse dispersivity $\alpha_z$		0.973E+01	m
Vertical dispersivity $\alpha_y$		0.973E+02	m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} t)^{0.4}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration	mg/l
29.8	4.1E-02	
69.2	2.8E-03	
88.8	1.8E-04	
146.0	8.2E-05	
177.6	6.3E-06	
207.2	3.6E-07	
230.6	2.3E-10	
259.4	1.6E-11	
296.0	1.0E-12	
325.6	6.6E-14	
356.2	4.4E-16	
384.8	2.9E-18	
414.4	1.9E-17	
444.0	1.3E-18	
473.0	8.4E-20	
603.2	6.6E-21	
632.8	3.7E-22	
662.4	2.6E-23	
602.0	1.6E-24	

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 Murphys K20
Completed by	AJ
Date	24 11 2005
Version	12

**Tier 3 - Groundwater**

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

Contaminant	Selenium
Target Concentration	C <sub>T</sub> 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 <sub>0</sub>	12.00E+03	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E+101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	5.82E+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
<i>Parameters values determined from options</i>				
Partition coefficient	Kd	9.55E+00	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	ay	0.973	m	see options
Vertical dispersivity	az	0.097	m	see options

**Calculated Parameters**

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	9.02E+01	fraction
Decay rate used	λ	7.00E+101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.52E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.29E-03	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	7.14E-04	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	Af	1.55E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	Af	2.80E+00	

**Remedial Targets**

Remedial Target	1.00E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	592	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.29E-03	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)  
 Soil water partition coefficient Kd 9.55E+00 l/kg  
 Entry for non-polar organic chemicals (option)  
 Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
 Organic carbon partition coefficient K<sub>oc</sub> 9.55E+00 l/kg  
 Entry for ionic organic chemicals (option)  
 Sorption coefficient for related species K<sub>ow</sub> l/kg  
 Sorption coefficient for ionised species K<sub>ow,i</sub> l/kg  
 pH value pH  
 acid dissociation constant pKa

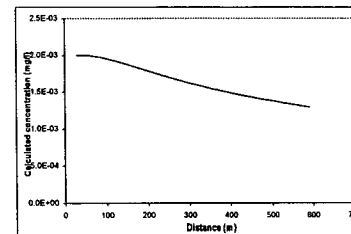
Soil water partition coefficient Kd 9.55E+00 l/kg

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	9.73E+00	m
Transverse dispersivity	ay			9.73E-01	m
Vertical dispersivity	az			9.73E-02	m

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* x, ay = 0.001 \* x  
 Xu & Eckstein (1995) report ax = 0.83(ρ<sub>0</sub>ρ<sub>w</sub>)<sup>0.414</sup>, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance Concentration	mg/l
	29.6 2.0E-03
	68.2 2.0E-03
	88.8 2.0E-03
	118.4 1.9E-03
	146.0 1.5E-01
	177.6 1.8E-03
	207.2 1.8E-03
	236.8 1.7E-03
	266.4 1.7E-03
	296.0 1.6E-03
	325.6 1.6E-03
	355.2 1.5E-03
	384.8 1.6E-01
	414.4 1.6E-03
	444.0 1.4E-03
	473.0 1.4E-03
	502.2 1.4E-03
	532.8 1.3E-03
	562.4 1.3E-03
	592.0 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 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	Site: Area 1 A multipy x20
Compiled by	AJ
Date	24 11 2005
Version	12

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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 <sub>r</sub> 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 <sub>0</sub>	4.90E-011	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	5.92E+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	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.37E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	3.16E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.75E-01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.55E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	2.80E+00	

Remedial Targets Remedial Target LTC3 1.65E+00 mg/l For comparison with measured groundwater concentration.

Distance to compliance point	592	m
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub> 3.16E-01	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 Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

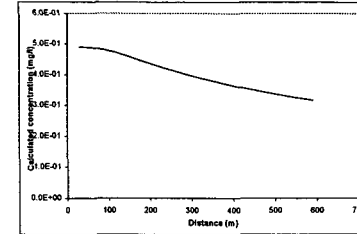
Entry if specify partition coefficient (option)

Soil water partition coefficient	Kd	0.00E+00	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	0.00E+00	l/kg
Organic carbon partition coefficient	K <sub>oc, n</sub>		l/kg
Entry for ionic organic chemicals (option)	K <sub>oc, i</sub>		l/kg
Sorption coefficient for related species	K <sub>oc, r</sub>		l/kg
Sorption coefficient for ionised species	pH		
pH value	pKa		
acid dissociation constant			

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

Longitudinal dispersivity	ax	9.73E+00	m
Transverse dispersivity	az	9.73E-01	m
Vertical dispersivity	ay	9.73E-02	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<sub>10</sub>x)<sup>0.75</sup>; 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
29.6	4.9E-01
69.2	4.9E-01
64.8	4.8E-01
118.4	4.7E-01
188.9	4.8E-01
207.2	4.5E-01
236.8	4.2E-01
264.4	4.1E-01
296.0	4.0E-01
326.6	3.9E-01
366.2	3.8E-01
384.8	3.7E-01
414.4	3.6E-01
444.0	3.5E-01
473.8	3.4E-01
503.2	3.4E-01
532.8	3.3E-01
682.0	3.2E-01

Site being assessed: Boss Area 1 A murphy K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

R&D Publication20 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) 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 $C_0$	4.20E+01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	1.90E+02	m	
Plume thickness at source $dy$	1.00E+01	m	
Saturated aquifer thickness $da$	1.08E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	9.92E+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 $K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	9.730	m	see options
Transverse dispersivity $\alpha_z$	0.973	m	see options
Vertical dispersivity $\alpha_y$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $R_f$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.37E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	2.71E+01	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	1.50E+01	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.55E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	2.80E+00	

Remedial Targets

Remedial Target	LTC3	3.10E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{2D}/C_0$	2.71E+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

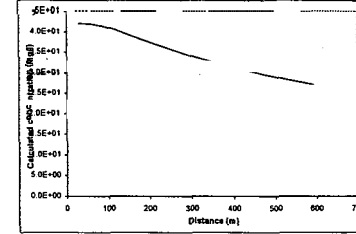
Entry if specify partition coefficient (option)  $K_d$  0.00E+00 l/kg  
Soil water partition coefficient  
Entry for non-polar organic chemicals (option)  $f_{oc}$  1.00E+00 fraction  
Fraction of organic carbon in aquifer  
Organic carbon partition coefficient  $K_{oc}$  0.00E+00 l/kg  
Entry for ionic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

Soil water partition coefficient  $K_d$  0.00E+00 l/kg

Dispersivity Calculate dependant on distance to compliance point (D) 2.22

specify dispersivity (1), or calc after Xu & Eckstein (2) ?  
Enter value Calc value Xu & Eckstein  
Longitudinal dispersivity  $\alpha_x$  9.73E+00 m  
Transverse dispersivity  $\alpha_z$  9.73E-01 m  
Vertical dispersivity  $\alpha_y$  9.73E-02 m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} \rho)^{0.75}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  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.

This sheet calculates the Tier3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the distance 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
29.8	4.2E+01
59.2	4.2E+01
88.8	4.1E+01
118.4	4.0E+01
148.0	3.9E+01
177.6	3.8E+01
207.2	3.7E+01
236.8	3.6E+01
266.4	3.5E+01
296.0	3.4E+01
325.6	3.3E+01
355.2	3.2E+01
384.8	3.1E+01
414.4	3.0E+01
444.0	2.9E+01
473.6	2.8E+01
503.2	2.7E+01
532.8	2.6E+01
562.4	2.5E+01
592.0	2.7E+01

Site being assessed Bess Area 1 A Murphy K20  
Compiled by AJ  
Date 24 11 2005  
Version 12



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

Tier 3 - Groundwater

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

Contaminant Sulphide  
Target Concentration C<sub>t</sub> 2.50E-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 <sub>0</sub>	1.50E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+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+001	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	5.92E+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	0.00E+00	l/kg	see options
Longitudinal dispersivity	α <sub>x</sub>	9.730	m	see options
Transverse dispersivity	α <sub>z</sub>	0.973	m	see options
Vertical dispersivity	α <sub>y</sub>	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.37E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	9.68E-02	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	5.35E-02	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.55E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	2.89E+00	

Remedial Targets Remedial Target LYCS 3.87E-04 mg/l For comparison with measured groundwater concentration.

Distance to compliance point	592	m
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub> 9.68E-02	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

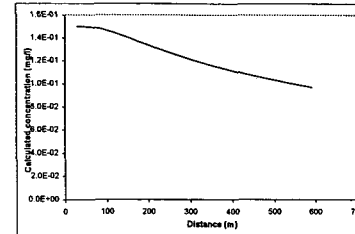
Entry if specify partition coefficient (option)  
Soil water partition coefficient Kd 0.00E+00 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>oc,s</sub> l/kg  
Sorption coefficient for ionised species K<sub>oc,i</sub> 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) 2 specify dispersivity (1), or calc after Xu & Eckstein (2)?

Longitudinal dispersivity α<sub>x</sub> 9.73E+00 m  
Transverse dispersivity α<sub>z</sub> 9.73E-01 m  
Vertical dispersivity α<sub>y</sub> 9.73E-02 m

For calculated value, assumes α<sub>x</sub> = 0.1 \* x, α<sub>z</sub> = 0.01 \* x, α<sub>y</sub> = 0.001 \* x  
Xu & Eckstein (1995) report α<sub>x</sub> = 0.83(log<sub>10</sub>x)<sup>0.41</sup>, α<sub>z</sub> = α<sub>x</sub>/10, α<sub>y</sub> = α<sub>x</sub>/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

29.6	1.6E-01
59.2	1.6E-01
88.8	1.6E-01
118.4	1.4E-01
148.0	1.4E-01
177.6	1.4E-01
207.2	1.3E-01
236.8	1.3E-01
266.4	1.3E-01
296.0	1.2E-01
325.6	1.2E-01
355.2	1.2E-01
384.8	1.1E-01
414.4	1.1E-01
444.0	1.1E-01
473.6	1.1E-01
503.2	1.0E-01
532.8	1.0E-01
562.4	9.9E-02
592.0	9.7E-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: Glass Area 1 A. Murphy #20  
Completed by: AJ  
Date: 24.11.2005  
Version: 12

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 <sub>T</sub>	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 <sub>0</sub>	9.90E+99	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.99E+99	days	
Calculated decay rate	λ	6.94E-101	m	
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	1.08E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point perpendicular to flow direction	x	5.82E+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	time variant options only
<b>Parameters values determined from options</b>				
Partition coefficient	Kd	2.14E-01	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.097	m	see options

Calculated Parameters

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	6.94E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	6.39E-99	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	3.53E-99	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.55E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	2.80E+00	

Remedial Targets

Remedial Target	LTC3	1.65E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		692	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	6.39E-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)

Soil water partition coefficient Kd

2.14E-01	l/kg
----------	------

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub>

1.00E+00	fraction
----------	----------

Organic carbon partition coefficient K<sub>oc</sub>

2.14E-01	l/kg
----------	------

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow</sub>

	l/kg
--	------

Sorption coefficient for ionised species K<sub>ow,i</sub>

	l/kg
--	------

pH value

--	--

acid dissociation constant pKa

--	--

Soil water partition coefficient Kd

2.14E-01	l/kg
----------	------

Dispersivity

Calculate dispersivity on distance to compliance point (0)

2
---

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

Longitudinal dispersivity

ax	Enter value	Calc value Xu & Eckstein	
		9.73E+00	m

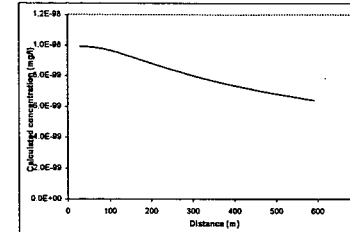
Transverse dispersivity

az		9.73E-01	m
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Vertical dispersivity

ay		9.73E-02	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<sub>10</sub>μ<sup>0.4</sup>); az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
29.9	3.7E-99
61.2	9.9E-99
88.8	9.7E-99
111.4	9.6E-99
148.0	9.3E-99
177.6	9.0E-99
207.2	8.8E-99
236.8	8.6E-99
268.4	8.3E-99
296.0	8.0E-99
326.6	7.8E-99
356.2	7.6E-99
384.8	7.4E-99
414.4	7.3E-99
444.0	7.1E-99
473.6	6.9E-99
603.2	6.8E-99
632.8	6.7E-99
662.4	6.6E-99
692.0	6.4E-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 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: Bliss Area 1 A Murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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

Tier 3 - Groundwater



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

Contaminant: 2-methylnaphthalene  
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	$C_0$	1.00E-03	mg/l	Source of parameter value
Half life for degradation of contaminant in water	$t_{1/2}$	2.58E+02	days	
Calculated decay rate	$\lambda$	2.69E-03	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance (lateral) to compliance point	$x$	5.82E+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	$Kd$	7.24E+00	l/kg	see options
Longitudinal dispersivity	$ax$	9.730	m	see options
Transverse dispersivity	$az$	0.973	m	see options
Vertical dispersivity	$ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	8.87E+01	fraction
Decay rate used	$\lambda$	2.69E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.00E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{E0}$	1.13E-23	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{E0}$	8.27E-24	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ )	$AF$	8.81E+19	
Attenuation factor (two way vertical dispersion, $C_0/C_{E0}$ )	$AF$	1.59E+20	

Remedial Targets

Remedial Target	LTC3	8.91E+17	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		592	m	
Concentration of contaminant at compliance point	$C_{E0}/C_0$	1.13E-23	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

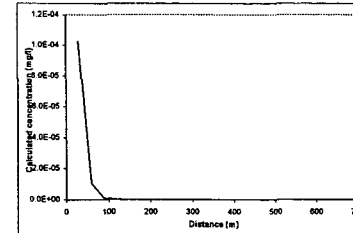
Soil water partition coefficient	$Kd$	7.24E+00	l/kg
Fraction of organic carbon in aquifer	$foc$	1.00E+00	fraction
Organic carbon partition coefficient	$Koc$	7.24E+00	l/kg
Soil water partition coefficient	$Kd$	7.24E+00	l/kg
Longitudinal dispersivity	$ax$	9.73E+00	m
Transverse dispersivity	$az$	9.73E-01	m
Vertical dispersivity	$ay$	9.73E-02	m

Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity	$ax$	9.73E+00	m
Transverse dispersivity	$az$	9.73E-01	m
Vertical dispersivity	$ay$	9.73E-02	m

For calculated value, assumes  $ax = 0.1 \cdot x$ ,  $az = 0.01 \cdot x$ ,  $ay = 0.001 \cdot x$   
Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} x)^{1.15}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

29.8	1.0E-04
59.2	1.1E-06
88.8	1.1E-06
118.4	1.1E-07
148.0	1.1E-08

207.8	1.1E-09
239.8	1.1E-11
268.4	1.1E-12
296.0	1.1E-13
325.4	1.1E-14
316.2	1.1E-16
384.8	1.1E-16
414.4	1.1E-17
444.0	1.1E-18
473.1	1.1E-19
503.2	1.1E-20
632.8	1.1E-21
682.4	1.1E-22
892.0	1.1E-23

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	Elbow Area 1 Murphy's K20
Completed by	AJ
Date	24 11 2005
Version	12

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: 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-09	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.83E+03	days	
Calculated decay rate $\lambda$	3.80E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	5.82E+02	m	
Distance (laterals) to compliance point perpendicular to flow direction $z$	3.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction $y$	3.00E+00	m	
Time since pollutant entered groundwater $t$	9.90E+99	days	
Parameters values determined from options			
Partition coefficient $Kd$	1.15E+02	l/kg	see options
Longitudinal dispersivity $ax$	9.730	m	see options
Transverse dispersivity $az$	0.973	m	see options
Vertical dispersivity $ay$	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.07E+03	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.28E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{e0}$	1.63E-132	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{e2}$	9.03E-133	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{e0}$ ) $AF$	6.06E+33	
Attenuation factor (two way vertical dispersion, $C_0/C_{e2}$ ) $AF$	1.10E+34	

Remedial Targets

Remedial Target	LTC3	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks		4.38E+00	mg/l	
Distance to compliance point		592	m	
Concentration of contaminant at compliance point after	$C_{e0}/C_0$	1.63E-132	mg/l	Ogata Banks
		9.8E+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  $Kd$

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer  $foc$

Organic carbon partition coefficient  $Koc$

Entry for ionic organic chemicals (option)

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  $Kd$

Dispersivity

Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity  $ax$

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  $ax = 0.83(\log_{10} Kd)^{0.41}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed

time variant options only

see options

see options

see options

see options

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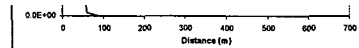
see options

see options

Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

29.6	2.1E-100
69.2	4.38E-02
88.8	8.9E-104
118.4	1.8E-108
137.0	3.0E-109
207.2	1.6E-110
218.8	3.1E-112
268.4	1.38E-114
296.0	1.38E-116
386.9	8.9E-119
384.8	1.1E-120
414.4	2.2E-122
444.0	4.6E-124
473.9	9.3E-126
503.2	1.8E-127
662.4	8.0E-139
592.0	1.8E-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 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: Blass Area 1 A Murphy K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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 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) 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  $\lambda$  3.90E-04 days<sup>-1</sup>  
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  $\rho$  1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-01 fraction  
Hydraulic gradient  $i$  1.25E-02 fraction  
Hydraulic conductivity of aquifer  $K$  2.00E+01 m/d  
Distance to compliance point  $x$  5.92E+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+991 days

Parameters values determined from options  
Partition coefficient  $K_d$  9.12E+02 V/kg  
Longitudinal dispersivity  $\lambda_x$  9.730 m  
Transverse dispersivity  $\lambda_z$  0.673 m  
Vertical dispersivity  $\lambda_y$  0.097 m

Calculated Parameters Variable  
Groundwater flow velocity  $v$  1.37E+00 m/d  
Retardation factor  $R_f$  8.52E+03 fraction  
Decay rate used  $\lambda$  3.80E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $u$  1.61E-04 m/d  
Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{1D}$  6.81E-213 mg/l  
Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{2D}$  3.77E-213 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ )  $AF$  1.45E+114  
Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  2.83E+114

Remedial Targets  
Remedial Target LYC3 1.04E+114 mg/l For comparison with measured groundwater concentration.  
Ogata Banks

Distance to compliance point 692 m  
Concentration of contaminant at compliance point  $C_{1D}/C_0$  6.81E-213 mg/l Ogata Banks  
after 9.9E+999 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  $K_d$  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  $K_{oc}$  9.12E+02 V/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  V/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  V/kg  
pH value pH  
acid dissociation constant pKa

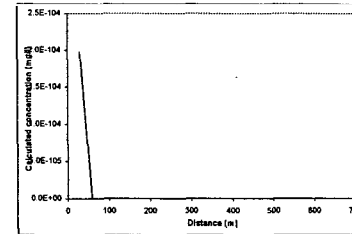
Soil water partition coefficient  $K_d$  9.12E+02 V/kg

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

Longitudinal dispersivity  $\lambda_x$  9.73E+00 m  
Transverse dispersivity  $\lambda_z$  9.73E-01 m  
Vertical dispersivity  $\lambda_y$  9.73E-02 m

For calculated value, assumes  $\lambda_x = 0.1 * x$ ,  $\lambda_z = 0.01 * z$ ,  $\lambda_y = 0.001 * y$   
Xu & Eckstein (1995) report  $\lambda_x = 0.83(\log_{10} pK_a)^{0.5}$ ,  $\lambda_z = \lambda_x/10$ ,  $\lambda_y = \lambda_x/100$  are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
29.6	2.0E-104
59.2	4.0E-110
88.8	7.8E-116
118.4	1.6E-121
148.0	3.0E-127
177.6	6.8E-133
207.2	1.1E-138
236.8	2.2E-144
266.4	4.3E-150
296.0	8.3E-156
325.6	1.6E-161
355.2	3.2E-167
384.8	6.2E-173
414.4	1.2E-178
444.0	2.4E-184
473.6	4.8E-190
503.2	9.0E-196
532.8	1.8E-201
562.4	3.6E-207
592.0	6.8E-213

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 A Murphy K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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 <sub>T</sub> 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 <sub>0</sub>	3.47E-02	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.63E+02	days	
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	5.92E+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+04	l/kg	see options
Longitudinal dispersivity	ax	9.730	m	see options
Transverse dispersivity	az	0.973	m	see options
Vertical dispersivity	ay	0.097	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.70E+05	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	8.08E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	#NUM!	

Remedial Targets	Remedial Target	LTCS	#NUM!	mg/l	For comparison with measured groundwater concentration.
	Ogata Banks				
	Distance to compliance point		692	m	
	Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	#NUM!	mg/l	Ogata Banks
			9.8E+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

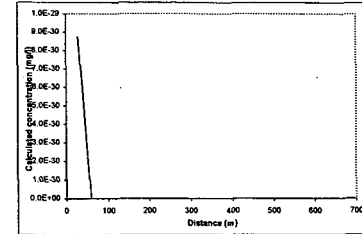
Soil water partition coefficient	Kd	1.82E+04	l/kg
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	1.82E+04	l/kg
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>oc1</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		

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

Longitudinal dispersivity	ax	9.73E+00	m
Transverse dispersivity	az	9.73E-01	m
Vertical dispersivity	ay	9.73E-02	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<sub>10</sub>p)<sup>0.44</sup>; az = az/10, ay = ay/100 are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks	From calculation sheet	Distance	Concentration
			mg/l
		29.6	8.8E-30
		59.2	2.2E-27
		88.8	5.6E-25
		118.4	1.4E-22
		148.0	3.4E-19
		177.6	8.2E-16
		207.2	2.0E-13
		236.8	5.0E-10
		266.4	1.2E-07
		296.0	3.0E-04
		325.6	#NUM!
		355.2	#NUM!
		384.8	#NUM!
		414.4	#NUM!
		444.0	#NUM!
		473.6	#NUM!
		503.2	#NUM!
		532.8	#NUM!
		562.4	#NUM!
		592.0	#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	Bloss Area 1 A Murphy K20
Completed by	AJ
Date	24 11 2005
Version	12

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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		
Target Concentration	C <sub>T</sub>	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, 'W' 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 <sub>0</sub>	5.50E+01	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.21E+03	days
Calculated decay rate	λ	3.17E-04	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.33E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance (lateral) to compliance point perpendicular to flow direction	x	1.20E+03	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
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	5.00E-01	l/kg
Longitudinal dispersivity	ax	12.536	m
Transverse dispersivity	az	1.254	m
Vertical dispersivity	ay	0.125	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.46E+00	m/d
Retardation factor	Rf	5.67E+00	fraction
Decay rate used	λ	3.17E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	5.33E+00	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	3.13E+00	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	1.03E+01	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	1.76E+01	

Remedial Targets

Remedial Target	LTC3	1.24E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	6.33E+00	mg/l	Ogata Banks
	aRer	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  
 Entry for non-polar organic chemicals (option)  
 Fraction of organic carbon in aquifer foc  
 Organic carbon partition coefficient Koc  
 Entry for ionic organic chemicals (option)  
 Sorption coefficient for related species K<sub>oc,1</sub>  
 Sorption coefficient for ionised species K<sub>oc,2</sub>  
 pH value pH  
 acid dissociation constant pKa

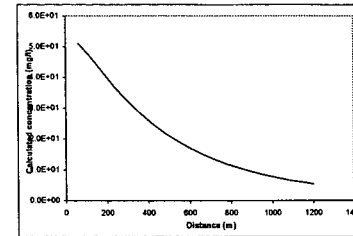
Soil water partition coefficient Kd 5.00E-01 l/kg

Dispersivity

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

Enter value	Calc value Xu & Eckstein	Unit
ax	1.25E+01	m
az	1.25E+00	m
ay	1.25E-01	m

For calculated value, assumes α<sub>x</sub> = 0.1 \* x, α<sub>z</sub> = 0.01 \* z, α<sub>y</sub> = 0.001 \* y  
 Xu & Eckstein (1995) report α<sub>x</sub> = 0.83(log<sub>10</sub>t)<sup>0.11</sup>, α<sub>z</sub> = α<sub>z</sub>/10, α<sub>y</sub> = α<sub>y</sub>/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

Site being assessed: Bless Area 4 Downshire well K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

Distance	Concentration
60.0	5.1E+01
120.0	4.7E+01
180.0	4.2E+01
240.0	3.7E+01
300.0	3.2E+01
360.0	2.8E+01
420.0	2.5E+01
480.0	2.2E+01
540.0	1.9E+01
600.0	1.7E+01
660.0	1.5E+01
720.0	1.3E+01
760.0	1.2E+01
840.0	1.0E+01
900.0	9.3E+00
960.0	8.3E+00
1020.0	7.4E+00
1080.0	6.6E+00
1140.0	5.9E+00
1170.0	5.3E+00

R&D Publication20 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 <sub>T</sub> 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 <sub>0</sub> 9.90E-09	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub> 1.83E+03	days	
Calculated decay rate	λ 3.80E-04	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 1.33E-02	fraction	
Hydraulic conductivity of aquifer	K 2.00E+01	m/d	
Distance (lateral) to compliance point	x 8.120E+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+09	days	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient	Kd 5.75E+00	l/kg	see options
Longitudinal dispersivity	ax 12.536	m	see options
Transverse dispersivity	az 1.254	m	see options
Vertical dispersivity	ay 0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.48E+00	m/d
Retardation factor	Rf	5.47E+01	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.87E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.55E-105	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	9.11E-108	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	6.39E+08	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.09E+07	

Remedial Targets

Remedial Target	LTCS	4.98E+03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.66E-105	mg/l	Ogata Banks
	after	9.9E+09	days	

Caution 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 Kd 5.75E+00 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient K<sub>oc</sub> 5.75E+00 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow</sub> 1.25E+01 l/kg

Sorption coefficient for ionised species K<sub>ow</sub> 1.25E+00 l/kg

pH value pH 7.0

acid dissociation constant pKa 4.0

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

Dispersivity

Calculate dependant on distance to compliance point (0)

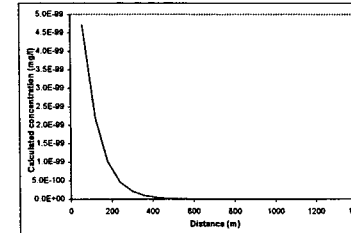
specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity ax Enter value Calc value Xu & Eckstein 1.25E+01 m

Transverse dispersivity az 1.25E+00 m

Vertical dispersivity ay 1.25E-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(log<sub>10</sub> t)<sup>0.5</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
60.0	4.7E-09
120.0	2.2E-09
180.0	1.0E-09
240.0	4.6E-10
300.0	2.0E-10
360.0	9.3E-11
420.0	4.2E-11
480.0	1.9E-11
540.0	8.6E-12
600.0	3.9E-12
660.0	1.8E-12
720.0	8.0E-13
780.0	3.6E-13
840.0	1.7E-13
900.0	7.6E-14
960.0	3.5E-14
1020.0	1.6E-14
1080.0	3.4E-15
1200.0	1.6E-15

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+09.

Site being assessed: Bless Area 4 Devonshire well K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

Tier 3 -Groundwater

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

Contaminant	Aromatic C10-C12		
Target Concentration	C <sub>T</sub>	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 <sub>0</sub>	9.90E-09	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.85E+03	days
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+03	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 <sup>3</sup>
Effective porosity of aquifer	p	1.82E-01	fraction
Hydraulic gradient	h	1.33E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	1.20E+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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd	9.12E+00	l/kg
Longitudinal dispersivity	ax	12.538	m
Transverse dispersivity	az	1.254	m
Vertical dispersivity	ay	0.125	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.46E+00	m/d
Retardation factor	Rf	8.62E+01	fraction
Decay rate used	λ	3.80E-04	days <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.70E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.30E-108	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	7.81E-109	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	7.84E+09	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.30E+10	

Remedial Targets

Remedial Target	LTC3	6.48E+08	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.30E-108	mg/l	Ogata Banks
after		9.9E+09	days	

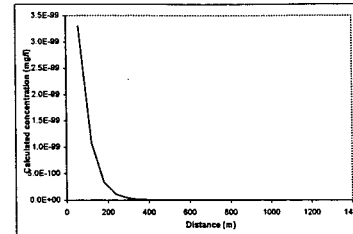
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+09.

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	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 <sub>ow</sub>
Sorption coefficient for ionised species	K <sub>oc</sub>
pH value	pH
acid dissociation constant	pKa

Soil water partition coefficient	Kd	9.12E+00	l/kg
<b>Dispersivity</b>			
Calculates dependent on distance to compliance point (0)			
specific dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	12.538	m
Transverse dispersivity	az	1.254	m
Vertical dispersivity	ay	0.125	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<sub>10</sub>ax)<sup>0.75</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration
60.0	3.3E-09
120.0	1.1E-09
180.0	3.6E-100
240.0	1.1E-100
300.0	3.6E-101
360.0	1.1E-101
420.0	3.6E-102
480.0	1.1E-102
540.0	3.6E-103
600.0	1.1E-103
660.0	3.6E-104
720.0	1.1E-104
780.0	3.6E-105
840.0	1.2E-105
900.0	3.7E-106
960.0	1.2E-106
1020.0	3.9E-107
1080.0	1.2E-107
1140.0	4.0E-108
1200.0	1.3E-108

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+09.

Site being assessed: Bloss Area 4 Downhole well K20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

R&D Publication20 Remedial Targets Worksheet, Release 2.2a

Tier 3 -Groundwater



InputParameters(using pull-down menu) Variable Value Unit Sour.

Contaminant	Total Cyanide	
Target Concentration	C <sub>T</sub>	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	9.90E+09	mg/l	
Half life for degradation of contaminant in water	2.92E+01	days	
Calculated decay rate	2.38E-02	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	8.00E+01	m	
Plume thickness at source	2.10E+01	m	
Saturated aquifer thickness	2.17E+01	m	
Bulk density of aquifer materials	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	1.82E-01	fraction	
Hydraulic gradient	1.33E-02	fraction	
Hydraulic conductivity of aquifer	2.00E+01	m/d	
Distance to compliance point	1.20E+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+09	days	
<b>Parameters values determined from options</b>			
Partition coefficient	7.94E+09	l/kg	see options
Longitudinal dispersivity	12.536	m	see options
Transverse dispersivity	1.254	m	see options
Vertical dispersivity	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.46E+00	m/d
Retardation factor	Rf	7.42E+10	fraction
Decay rate used	λ	2.38E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.97E-11	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>0</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>0</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>0</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>0</sub> )	AF	#NUM!	

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1200		m	
Concentration of contaminant at compliance point	C <sub>0</sub> /C <sub>0</sub>	#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.

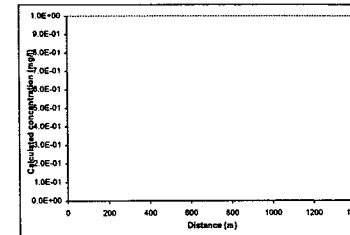
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	7.94E+09 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+09 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K <sub>ow</sub>	l/kg
Sorption coefficient for ionised species	K <sub>oc</sub>	l/kg
pH value	pH	
acid dissociation constant	pKa	

Source of parameter value

Soil water partition coefficient	Kd	7.94E+09	l/kg
<b>Dispersivity</b>			
Calculate dispersivity dependent on distance to compliance point (0) or specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	1.25E+01	m
Transverse dispersivity	az	1.25E+00	m
Vertical dispersivity	ay	1.25E-01	m
For calculated value, assumes ax = 0.1 * x, az = 0.01 * z, ay = 0.001 * x			
Xu & Eckstein (1995) report ax = 0.83(log <sub>10</sub> d) <sup>0.43</sup> , az = ax/10, ay = ax/100 are assumed			



Calculated concentrations for distance-concentration graph

Distance	Concentration	mg/l
80.0	#NUM!	
120.0	#NUM!	
180.0	#NUM!	
240.0	#NUM!	
300.0	#NUM!	
360.0	#NUM!	
420.0	#NUM!	
480.0	#NUM!	
540.0	#NUM!	
600.0	#NUM!	
660.0	#NUM!	
720.0	#NUM!	
780.0	#NUM!	
840.0	#NUM!	
900.0	#NUM!	
960.0	#NUM!	
1020.0	#NUM!	
1080.0	#NUM!	
1140.0	#NUM!	
1200.0	#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+09.

Site being assessed: Bless Arca 4 Downwind well K20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

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

Tier 3 - Groundwater



Input Parameters (using pull down menu) Variable Value Unit

Contaminant: Aromatic C12-C16  
Target Concentration C<sub>T</sub>: 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 <sub>0</sub>	9.90E-09	mg/l	
Half life for degradation of contaminant in water t <sub>1/2</sub>	1.83E+03	days	
Calculated decay rate λ	3.80E-04	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.33E-02	fraction	
Hydraulic conductivity of aquifer K	2.00E+01	m/d	
Distance (lateral) to compliance point x	1.20E+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+09	days	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient Kd	1.82E+01	l/kg	see options
Longitudinal dispersivity αx	12.536	m	see options
Transverse dispersivity αz	1.254	m	see options
Vertical dispersivity αy	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	1.46E+00	m/d
Retardation factor Rf	1.71E+02	fraction
Decay rate used λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation u	8.55E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C <sub>1D</sub>	1.14E-116	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C <sub>2D</sub>	6.68E-116	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> ) AF	8.72E+16	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> ) AF	1.48E+17	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	LTC3	6.29E+13	mg/l
Distance to compliance point	1200	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	1.14E-116	mg/l
	t	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 Kd 1.82E+01 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient K<sub>oc</sub> 1.82E+01 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow</sub> 1.82E+01 l/kg

Sorption coefficient for ionised species K<sub>ow,i</sub> 1.82E+01 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 (1)

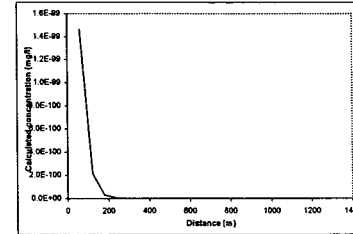
specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity αx 1.25E+01 m

Transverse dispersivity αz 1.25E+00 m

Vertical dispersivity αy 1.25E-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(log<sub>10</sub> t)<sup>0.14</sup>; αz = αx/10, αy = αx/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+09.

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

Distance	Concentration
60.0	1.6E-09
120.0	2.1E-100
160.0	3.1E-101
240.0	4.3E-102
300.0	6.1E-103
360.0	8.5E-104
420.0	1.2E-104
480.0	1.7E-105
540.0	2.4E-106
600.0	3.3E-107
6W.0	4.7E-108
720.0	6.6E-109
750.0	9.4E-110
840.0	1.3E-110
900.0	1.9E-111
960.0	1.1E-112
1020.0	3.9E-113
1080.0	5.6E-114
1200.0	1.1E-116

Site being assessed: Bress Area 4 Devonshire well K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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	7.14E-24	mg/l	

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

Equations in R&D Pub. 20

Organic Barite

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

Half life for degradation of contaminant in water

Width of plume in aquifer at source (perpendicular to flow)

Saturated aquifer thickness

Bulk density of aquifer materials

Effective porosity of aquifer

Hydraulic conductivity of aquifer

Distance (length) to compliance point perpendicular to flow direction

Distance (depth) to compliance point perpendicular to flow direction

Time since pollutant entered groundwater

Parameters values determined from options

Partition coefficient

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

See options

See options

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

Calculate for non-polar organic chemicals

Enter if specific partition coefficient (option)

Soil water partition coefficient

Enter for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer

Organic carbon partition coefficient

Enter for toxic organic chemicals (option)

Soil water partition coefficient

Enter for toxic organic chemicals (option)

Soil water partition coefficient

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Soil water partition coefficient

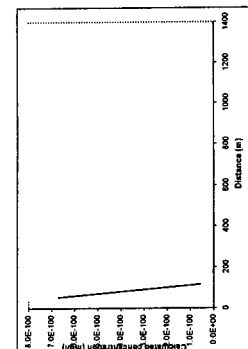
Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient



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 Tier2 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source. These 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 rate as 0.0E-99.

Calculated concentrations for distance-concentration graph

Distance	0	200	400	600	800	1000	1200	1400
Concentration (mg/l)	0.5	0.1	0.01	0.001	0.0001	1E-05	1E-06	1E-07

Site being assessed: Shaz Area 4 Downshore wall 420  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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For comparison with measured groundwater concentration.

Remedial Targets

Remedial Target	1.0E-09	mg/l
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Optima Barite

Distance to compliance point	1200	m
Concentration of contaminant at compliance point after	1.84E-122	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 Aromatic 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

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 $t_{1/2}$	3.65E+03	days	
Calculated decay rate $\lambda$	1.90E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sx$	8.00E+01	m	
Plume thickness at source $Sy$	2.10E+01	m	
Saturated aquifer thickness $ds$	2.17E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.33E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	1.20E+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 $K_d$	4.57E+02	l/kg	see options
Longitudinal dispersivity $\alpha_x$	12.536	m	see options
Transverse dispersivity $\alpha_z$	1.254	m	see options
Vertical dispersivity $\alpha_y$	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.46E+00	m/d
Retardation factor $Rf$	4.27E+03	fraction
Decay rate used $\lambda$	1.90E-04	days <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	3.42E-04	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{E0}$	6.46E-190	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{E2}$	3.80E-190	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ ) $AF$	1.53E+91	
Attenuation factor (two way vertical dispersion, $C_0/C_{E2}$ ) $AF$	2.60E+91	

Remedial Targets

Remedial Target	LTC3	1.09E+08	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	$C_{E0}/C_D$	6.46E-190	mg/l	Ogata Banks
after		9.8E+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

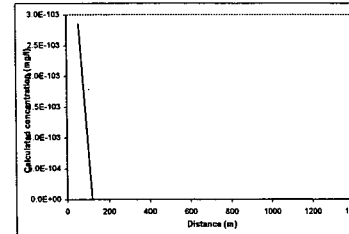
Entry if specify partition coefficient (option)  
Soil water partition coefficient  $K_d$  4.57E+02 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer  $f_{oc}$  1.00E+00 fraction  
Organic carbon partition coefficient  $K_{oc}$  4.57E+02 l/kg  
Entry for ionic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

Soil water partition coefficient  $K_d$  4.57E+02 l/kg

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

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity $\alpha_x$		1.25E+01	m
Transverse dispersivity $\alpha_z$		1.25E+00	m
Vertical dispersivity $\alpha_y$		1.25E-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  $\alpha_z = 0.63(\log_{10} x)^{0.4}$ ;  $\alpha_x = \alpha_x/10$ ,  $\alpha_y = \alpha_y/100$  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.

Site being assessed: Bess Area 4 Downshale well 620  
Completed by: AJ  
Date: 24 11 2005  
Version: 12



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

60.0	2.77E-033
180.0	8.2E-108
240.0	6.1E-117
300.0	1.7E-121
150.0	4.6E-128
420.0	1.2E-130
480.0	3.4E-135
540.0	9.2E-140
600.0	6.9E-149
780.0	5.2E-158
840.0	1.4E-162
900.0	3.9E-167
960.0	1.1E-171
1020.0	3.0E-176
1080.0	8.4E-181
1140.0	2.3E-185
1200.0	6.5E-190



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	$1.00E-02$	mg/l	

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

Ogata Banks	Equations in R&D Pub. 20
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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 $C_0$	$9.90E-09$	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	$9.90E+99$	days	
Calculated decay rate $\lambda$	$7.00E-101$	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sx$	$8.00E+01$	m	
Plume thickness at source $Sy$	$2.10E+01$	m	
Saturated aquifer thickness $da$	$2.17E+01$	m	
Bulk density of aquifer materials $\rho$	$1.70E+00$	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	$1.82E-01$	fraction	
Hydraulic gradient $i$	$1.33E-02$	fraction	
Hydraulic conductivity of aquifer $K$	$2.00E+01$	m/d	
Distance to compliance point $x$	$1.20E+03$	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 $Kd$	$1.17E+02$	l/kg	see options
Longitudinal dispersivity $ax$	12.536	m	see options
Transverse dispersivity $az$	1.254	m	see options
Vertical dispersivity $ay$	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	$1.46E+00$	m/d
Retardation factor $Rf$	$1.10E+03$	fraction
Decay rate used $\lambda$	$7.00E-101$	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	$1.33E-03$	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	$4.09E-09$	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	$2.41E-09$	mg/l
Attenuation factor (one way vertical dispersion, $C_{1D}/C_0$ ) $AF$	$2.42E+00$	
Attenuation factor (two way vertical dispersion, $C_{2D}/C_0$ ) $AF$	$4.11E+00$	

Remedial Targets

Remedial Target	LTC3	2.42E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1200		m	
Concentration of contaminant at compliance point	$4.09E-09$		mg/l	Ogata Banks
after	$9.9E+99$		days	

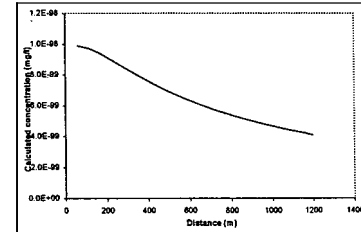
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is  $9.9E+99$ .

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

Method	Value	Unit
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 $Kow$		l/kg
Sorption coefficient for ionised species $Kwi$		l/kg
pH value $pH$		
acid dissociation constant $pKa$		

Dispersivity	Value	Unit
Longitudinal dispersivity $ax$	$1.25E+01$	m
Transverse dispersivity $az$	$1.25E+00$	m
Vertical dispersivity $ay$	$1.25E-01$	m

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



Calculated concentrations for distance-concentration graph

Distance	Concentration (mg/l)
60.0	$8.9E-09$
120.0	$9.7E-09$
180.0	$9.3E-09$
240.0	$8.8E-09$
300.0	$8.3E-09$
360.0	$7.9E-09$
420.0	$7.4E-09$
480.0	$7.0E-09$
540.0	$6.6E-09$
600.0	$6.3E-09$
660.0	$6.0E-09$
720.0	$5.7E-09$
780.0	$5.4E-09$
840.0	$5.2E-09$
900.0	$5.0E-09$
960.0	$4.8E-09$
1020.0	$4.6E-09$
1080.0	$4.4E-09$
1140.0	$4.2E-09$
1200.0	$4.1E-09$

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 4 Downshire well K20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

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

Tier 3 - Groundwater



Input Parameters (using pull-down menu)

Contaminant	Flouride
Target Concentration	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
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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 $C_0$	1.70E+00	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.33E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (lateral) to compliance point perpendicular to flow direction $x$	1.20E+03	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
<b>Parameters values determined from options</b>			
Partition coefficient $Kd$	0.00E+00	l/kg	see options
Longitudinal dispersivity $ax$	12.536	m	see options
Transverse dispersivity $ay$	1.254	m	see options
Vertical dispersivity $az$	0.125	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity $v$	1.46E+00	m/d
Retardation factor $Rf$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.46E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	7.03E-01	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	4.13E-01	mg/l
Attenuation factor (one way vertical dispersion, $C_{1D}/C_0$ ) $AF$	2.42E+00	
Attenuation factor (two way vertical dispersion, $C_{2D}/C_0$ ) $AF$	4.11E+00	

Remedial Targets

Remedial Target	LTC3	4.42E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	7.03E-01	mg/l	Ogata Banks
after		9.9E+99	days	

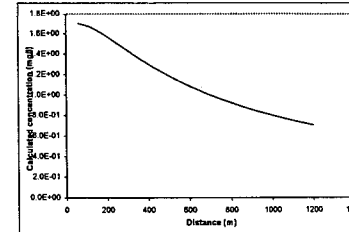
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

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 $K_{ow}$	0.00E+00 l/kg
Sorption coefficient for ionised species $K_{ow,i}$	0.00E+00 l/kg
pH value	
acid dissociation constant $pKa$	

Soil water partition coefficient $Kd$	0.00E+00	l/kg
<b>Dispersivity</b>		
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 1.25E+01 m
Transverse dispersivity $ay$		1.25E+00 m
Vertical dispersivity $az$		1.25E-01 m

For calculated value, assumes  $ax = 0.1 * x$ ,  $ax = 0.01 * x$ ,  $ay = 0.001 * x$ ,  $ax$  & Eckstein (1995) report  $ax = 0.83(\log_{10} t)^{0.41}$ ;  $ax = ax*10$ ,  $ay = ay*100$  are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
60.0	1.7E+00
120.0	1.7E+00
180.0	1.6E+00
240.0	1.5E+00
300.0	1.4E+00
360.0	1.4E+00
420.0	1.3E+00
480.0	1.2E+00
540.0	1.1E+00
600.0	1.1E+00
660.0	1.0E+00
720.0	9.8E-01
780.0	9.3E-01
840.0	8.8E-01
900.0	8.5E-01
960.0	8.2E-01
1020.0	7.9E-01
1080.0	7.6E-01
1140.0	7.3E-01
1200.0	7.0E-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	Bless Area 4 Devonshire well K20
Completed by	AJ
Date	24 11 2005
Version	12

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R8D Publication20 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 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 $C_0$	6.00E-03	mg/l	...
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	...
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	...
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	...
Effective porosity of aquifer $n$	1.82E-01	fraction	...
Hydraulic gradient $i$	1.33E-02	fraction	...
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	...
Distance to compliance point $x$	1.20E+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
<b>Parameters values determined from options</b>			
Partition coefficient $K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	12.536	m	see options
Transverse dispersivity $\alpha_z$	1.254	m	see options
Vertical dispersivity $\alpha_y$	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.46E+00	m/d
Retardation factor $Rf$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$ 1.46E+00 m/d		
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	2.48E-03	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	1.48E-03	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	2.42E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	4.11E+00	

Remedial Targets

Remedial Target	LTCS	4.94E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1200		m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	2.48E-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  $K_d$  0.00E+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  $K_{oc}$  0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  0.00E+00 l/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  0.00E+00 l/kg  
pH value  
acid dissociation constant  $pK_a$  0.00E+00 l/kg

Soil water partition coefficient  $K_d$  0.00E+00 l/kg

Dispersivity

Calculate dependent on, distance to compliance point (D) 2

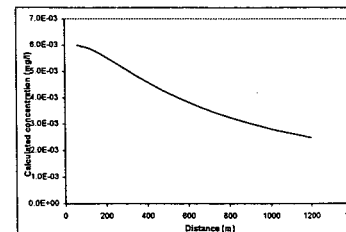
specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity  $\alpha_x$  Enter value Calc value Xu & Eckstein 1.25E+01 m

Transverse dispersivity  $\alpha_z$  1.25E+00 m

Vertical dispersivity  $\alpha_y$  1.25E-01 m

For calculated value, assumes  $\alpha_x = 0.1 \cdot x$ ,  $\alpha_z = 0.01 \cdot z$ ,  $\alpha_y = 0.001 \cdot y$   
Xu & Eckstein (1995) report  $\alpha_x = 0.03(\log_{10} \mu)^{0.4}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
1200.0	6.9E-03
1110.0	6.6E-03
240.0	6.3E-03
3W.0	6.1E-03
380.0	4.8E-03
420.0	4.5E-03
480.0	4.3E-03
540.0	4.0E-03
600.0	3.8E-03
660.0	3.6E-03
720.0	3.6E-03
7100.0	3.3E-03
840.0	3.2E-03
900.0	3.0E-03
960.0	2.9E-03
1020.0	2.8E-03
10100.0	2.7E-03
1140.0	2.6E-03
1200.0	2.6E-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: Bloss Arca 4 Downshire well 620  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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 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	$C_0$	9.90E-09	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+01	days
Calculated decay rate	$\lambda$	6.93E-02	days <sup>-1</sup>
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	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction
Hydraulic gradient	$i$	1.33E-02	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d
Distance to compliance point	$x$	1.20E+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
<b>Parameters values determined from options</b>			
Partition coefficient	$Kd$	1.05E-01	l/kg
Longitudinal dispersivity	$ax$	12.538	m
Transverse dispersivity	$az$	1.254	m
Vertical dispersivity	$ay$	0.125	m

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.48E+00	m/d
Retardation factor	$Rf$	1.98E+00	fraction
Decay rate used	$\lambda$	6.93E-02	days <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	7.39E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{2D}$	5.69E-128	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{3D}$	3.35E-128	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{2D}$ )	$AF$	1.74E+29	
Attenuation factor (two way vertical dispersion, $C_0/C_{3D}$ )	$AF$	2.88E+29	

Remedial Targets

Remedial Target	LTCS	8.70E+25	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	$C_{2D}/C_0$	5.69E-128	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  $Kd$  1.05E-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  $Koc$  1.05E-01 l/kg

Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg

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

pH value

acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  1.05E-01 l/kg

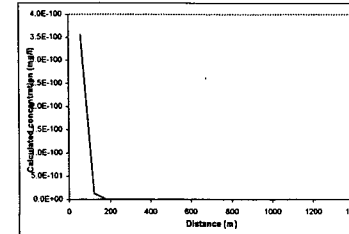
Dispersivity  
Calculates dependent on distance to compliance point (0) 2  
specify dispersivity (1), or calc after Xu & Eckstein (2) 7

Longitudinal dispersivity  $ax$  12.538 m

Transverse dispersivity  $az$  1.254 m

Vertical dispersivity  $ay$  0.125 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks

60.0	3.0E+00
120.0	1.3E-101
180.0	4.4E-103
240.0	1.6E-104
300.0	6.1E-106
360.0	1.7E-107
420.0	6.9E-109
480.0	2.0E-110
540.0	6.9E-112
600.0	2.4E-113
660.0	8.1E-116
720.0	2.6E-118
780.0	9.6E-118
840.0	3.3E-119
900.0	1.1E-120
960.0	3.9E-122
1020.0	1.4E-123
1080.0	4.7E-125
1140.0	1.6E-126
1200.0	6.7E-128

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+09.

Site being assessed Bloss Area 4 Devernare well K20  
Completed by AJ  
Date 24/11/2005  
Version 12

Tier 3 - Groundwater



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

Contaminant	Strontium
Target Concentration	C <sub>r</sub> 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
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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 <sub>0</sub> 5.70E-01	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub> 9.90E+99	days	
Calculated decay rate	λ 7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz 2.00E+01	m	
Plume thickness at source	Sy 2.10E+01	m	
Saturated aquifer thickness	ds 2.17E+01	m	
Bulk density of aquifer materials	p 1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 1.33E-02	fraction	
Hydraulic conductivity of aquifer	K 2.00E+01	m/d	
Distance to compliance point	x 1.20E+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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd 0.00E+00	l/kg	see options
Longitudinal dispersivity	ax 12.538	m	see options
Transverse dispersivity	az 1.254	m	see options
Vertical dispersivity	ay 0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.46E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.46E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	2.36E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.39E-01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	2.42E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	4.11E+00	

Remedial Targets

Remedial Target	LTC3	2.42E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	2.36E-01	mg/l	Ogata Banks
after		9.9E+99	days	

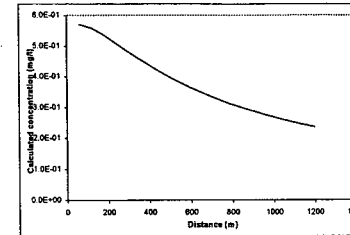
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

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 <sub>ow</sub> 0.00E+00 l/kg
Sorption coefficient for ionised species	K <sub>oc,i</sub> 0.00E+00 l/kg
pH value	pH
acid dissociation constant	pKa
Soil water partition coefficient	Kd 0.00E+00 l/kg

Dispersivity	
Calculates dispersivity dependent on distance to compliance point (0)	2
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	
Longitudinal dispersivity	ax 1.25E+01 m
Transverse dispersivity	az 1.25E+00 m
Vertical dispersivity	ay 1.25E-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(log<sub>10</sub>ax)<sup>0.4</sup>; ax = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
80.0	6.7E-01
120.0	6.6E-01
180.0	6.4E-01
240.0	6.1E-01
300.0	4.8E-01
360.0	4.6E-01
420.0	4.3E-01
480.0	4.0E-01
540.0	3.8E-01
600.0	3.6E-01
660.0	3.6E-01
720.0	3.3E-01
780.0	3.1E-01
840.0	3.0E-01
900.0	2.9E-01
960.0	2.7E-01
1020.0	2.6E-01
1080.0	2.5E-01
1140.0	2.4E-01
1200.0	2.4E-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 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 Aica 4 Downship well K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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

Tier 3 - Groundwater



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

Contaminant Sulphide  
Target Concentration  $C_T$  2.50E-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 $C_0$	2.00E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+09	days	
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.33E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (lateral) to compliance point perpendicular to flow direction $x$	1.20E+03	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
<b>Parameters values determined from options</b>			
Partition coefficient $K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	12.536	m	see options
Transverse dispersivity $\alpha_z$	1.254	m	see options
Vertical dispersivity $\alpha_y$	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.46E+00	m/d
Retardation factor $Rf$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	days <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.46E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	8.27E-02	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	4.86E-02	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	2.42E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	4.11E+00	

Remedial Targets			
Remedial Target	1.1E-03	8.98E-04	mg/l
Ogata Banks			
Distance to compliance point	1200	m	
Concentration of contaminant at compliance point after	$C_{EP}/C_0$	8.27E-02	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)  
Soil water partition coefficient  $K_d$  0.00E+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  $K_{oc}$  0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  l/kg  
pH value  
acid dissociation constant  $pK_a$

Soil water partition coefficient  $K_d$  0.00E+00 l/kg

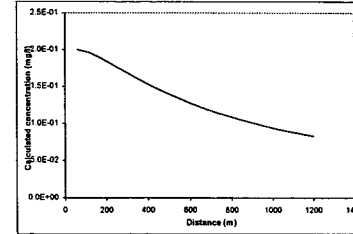
Dispersivity

Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity  $\alpha_x$  1.25E+01 m  
Transverse dispersivity  $\alpha_z$  1.25E+00 m  
Vertical dispersivity  $\alpha_y$  1.25E-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  $\alpha_z = 0.83(\log_{10} t)^{0.4}$ ,  $\alpha_x = \alpha_z/10$ ,  $\alpha_y = \alpha_z/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

60.0	2.0E-01
120.0	2.0E-01
180.0	1.8E-01
240.0	1.8E-01
300.0	1.7E-01
420.0	1.6E-01
480.0	1.4E-01
640.0	1.3E-01
900.0	1.3E-01
960.0	1.2E-01
720.0	1.2E-01
780.0	1.1E-01
840.0	1.1E-01
900.0	1.0E-01
960.0	9.6E-02
1020.0	9.3E-02
1080.0	8.9E-02
1140.0	8.4E-02
1200.0	8.1E-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 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: Doss Area 4 Downshire well K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater

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

Contaminant	Aliphatic C8-C10		
Target Concentration	C <sub>T</sub>	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)

Initial contaminant concentration in groundwater at plume core	C <sub>0</sub>	9.90E-09	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.65E+03	days
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	S <sub>x</sub>	8.00E+01	m
Plume thickness at source	S <sub>y</sub>	2.10E+01	m
Saturated aquifer thickness	d <sub>a</sub>	2.17E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.33E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	1.20E+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 <sub>d</sub>	1.15E+02	l/kg
Longitudinal dispersivity	α <sub>x</sub>	12.536	m
Transverse dispersivity	α <sub>z</sub>	1.254	m
Vertical dispersivity	α <sub>y</sub>	0.125	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.46E+00	m/d
Retardation factor	Rf	1.07E+03	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.36E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	8.56E-159	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	5.03E-159	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.16E+60	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.87E+60	

Remedial Targets

Remedial Target	LYC3	8.28E+66	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1200	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	8.56E-159	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	K <sub>d</sub>		l/kg
Entry if specify partition coefficient (option)			
Soil water partition coefficient	K <sub>d</sub>		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	f <sub>oc</sub>	1.00E+00	fraction
Organic carbon partition coefficient	K <sub>oc</sub>	1.15E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		

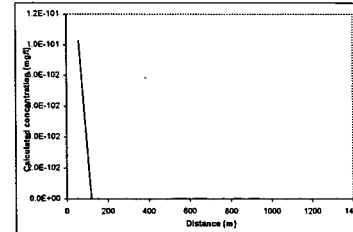
Soil water partition coefficient	K <sub>d</sub>	1.15E+02	l/kg
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Dispersivity

Calculate dispersivity on distance to compliance point (D)		2	
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	α <sub>x</sub>	1.25E+01	m
Transverse dispersivity	α <sub>z</sub>	1.25E+00	m
Vertical dispersivity	α <sub>y</sub>	1.25E-01	m

For calculated value, assumes α<sub>x</sub> = 0.1 \* z, α<sub>z</sub> = 0.01 \* x, α<sub>y</sub> = 0.001 \* x  
Xu & Eckstein (1995) report α<sub>x</sub> = 0.83(log<sub>10</sub>ρ)<sup>0.43</sup>; α<sub>z</sub> = α<sub>x</sub>/10, α<sub>y</sub> = α<sub>x</sub>/100 are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks Distance to Compliance

	mg/l
80.0	1.0E-101
120.0	1.0E-104
180.0	1.0E-107
240.0	1.0E-110
300.0	1.0E-113
360.0	8.8E-117
420.0	9.6E-120
480.0	9.4E-123
540.0	9.3E-126
600.0	8.1E-129
660.0	9.0E-132
720.0	8.9E-135
780.0	8.8E-138
840.0	8.7E-141
900.0	8.7E-144
960.0	8.6E-147

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 6.0E+09.

Site being assessed	Biss Area 4 Downshire well K20
Completed by	AJ
Date	24.11.2005
Version	12



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 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)

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+02	days	
Calculated decay rate $\lambda$	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	2.00E+01	m	
Plume thickness at source $Sy$	2.10E+01	m	
Saturated aquifer thickness $ds$	2.17E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.33E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	1.20E+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	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient $Kd$	9.12E+02	l/kg	see options
Longitudinal dispersivity $ax$	12.536	m	see options
Transverse dispersivity $az$	1.254	m	see options
Vertical dispersivity $ay$	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.46E+00	m/d
Retardation factor $Rf$	8.52E+03	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.72E-04	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{eq}$	2.61E-298	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{eq}$	1.54E-298	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{eq}$ ) $AF$	3.79E+198	
Attenuation factor (two way vertical dispersion, $C_0/C_{eq}$ ) $AF$	6.44E+189	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target	LTC3 2.72E+198	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	1200	m	
Concentration of contaminant at compliance point	$C_{eq}/C_0$ 2.61E-298	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)

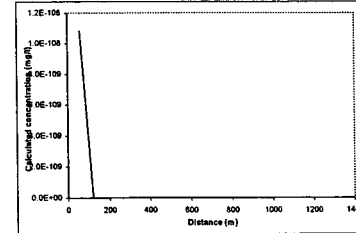
Calculate for non-polar organic chemicals

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

Dispersivity	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity $ax$		1.25E+01 m
Transverse dispersivity $az$		1.25E+00 m
Vertical dispersivity $ay$		1.25E-01 m

For calculated value, assumes  $ax = 0.1 \times z$ ,  $az = 0.01 \times z$ ,  $ay = 0.001 \times z$ . Xu & Eckstein (1995) report  $ax = 0.63(\log_{10} K_{oc})^{0.75}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
60.0	1.1E+03
120.0	1.2E-118
180.0	1.2E-128
240.0	1.3E-138
300.0	1.3E-148
360.0	1.4E-158
420.0	1.4E-168
480.0	1.5E-178
540.0	1.5E-188
600.0	1.6E-198
660.0	1.7E-208
720.0	1.7E-218
780.0	1.8E-228
840.0	1.9E-238
900.0	2.0E-248
960.0	2.1E-258
1020.0	2.2E-268
1080.0	2.3E-278
1140.0	2.4E-288
1200.0	2.6E-298

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+09.

Site being assessed: Bless Area 4 Devonshire wall 420  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

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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): 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 $t_{1/2}$	1.23E+03	days	
Calculated decay rate $\lambda$	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sx$	8.50E+01	m	
Plume thickness at source $Sy$	2.10E+01	m	
Saturated aquifer thickness $da$	2.17E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.33E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	1.20E+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	time variant options only
Partition coefficient $K_d$	1.82E+04	l/kg	see options
Longitudinal dispersivity $ax$	12.536	m	see options
Transverse dispersivity $ay$	1.254	m	see options
Vertical dispersivity $az$	0.125	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.46E+00	m/d
Retardation factor $Rf$	1.70E+05	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	8.60E-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, $C_0/C_{1D}$ ) $AF$	#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	1200	m		
Concentration of contaminant at compliance point after	$C_{1D}/C_0$	#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

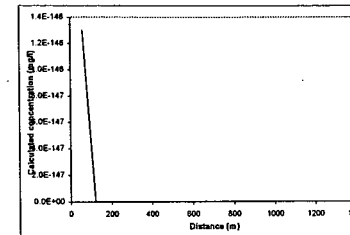
Entry if specify partition coefficient (option)  
 Soil water partition coefficient  $K_d$ : 1.82E+04 l/kg  
 Entry for non-polar organic chemicals (option)  
 Fraction of organic carbon in aquifer  $f_{oc}$ : 1.00E+00 fraction  
 Organic carbon partition coefficient  $K_{oc}$ : 1.82E+04 l/kg  
 Entry for ionic organic chemicals (option)  
 Sorption coefficient for related species  $K_{ow}$ : #NUM! l/kg  
 Sorption coefficient for ionised species  $K_{ow}$ : #NUM! l/kg  
 pH value  
 acid dissociation constant  $pK_a$ : #NUM!

Soil water partition coefficient  $K_d$ : 1.82E+04 l/kg

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

Longitudinal dispersivity  $ax$ : 12.536 m  
 Transverse dispersivity  $ay$ : 1.254 m  
 Vertical dispersivity  $az$ : 0.125 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

Distance	Concentration (mg/l)
60.0	1.3E-146
120.0	1.7E-194
180.0	2.1E-242
240.0	2.7E-290
300.0	0.0E+00
360.0	0.0E+00
420.0	#NUM!
480.0	#NUM!
540.0	#NUM!
600.0	#NUM!
660.0	#NUM!
720.0	#NUM!
780.0	#NUM!
840.0	#NUM!
900.0	#NUM!
960.0	#NUM!
1020.0	#NUM!
1080.0	#NUM!
1140.0	#NUM!
1200.0	#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+09.

Site being assessed: Bess Area 4 Downship well K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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 C<sub>r</sub> 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<sub>0</sub> 9.90E-09 mg/l  
Half life for degradation of contaminant in water t<sub>1/2</sub> 3.85E+03 days  
Calculated decay rate λ 1.90E-04 days<sup>-1</sup>  
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<sup>3</sup>  
Effective porosity of aquifer n 1.82E-01 fraction  
Hydraulic gradient i 1.33E-02 fraction  
Hydraulic conductivity of aquifer K 2.00E+01 m/d  
Distance (lateral) to compliance point perpendicular to flow direction x 1.20E+03 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 2.29E+06 l/kg  
Longitudinal dispersivity ax 12.536 m  
Transverse dispersivity az 1.254 m  
Vertical dispersivity ay 0.125 m

Calculated Parameters Variable

Groundwater flow velocity v 1.46E+00 m/d  
Retardation factor Rf 2.14E+07 fraction  
Decay rate used λ 1.90E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation u 6.83E-08 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion C<sub>1D</sub> #NUM! mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion C<sub>2D</sub> #NUM! mg/l  
Attenuation factor (one way vertical dispersion, C<sub>1D</sub>/C<sub>0</sub>) AF #NUM!  
Attenuation factor (two way vertical dispersion, C<sub>2D</sub>/C<sub>0</sub>) AF #NUM!

Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1200	m		
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	#NUM!	mg/l	Ogata Banks
after	t	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 apically partition coefficient (option) Kd #NUM! l/kg  
Soil water partition coefficient Kd 2.29E+06 l/kg  
Entry for non-polar organic chemicals (option) foc 1.00E+00 fraction  
Fraction of organic carbon in aquifer Koc 2.29E+06 l/kg  
Organic carbon partition coefficient K<sub>ow</sub> #NUM! l/kg  
Entry for ionic organic chemicals (option) K<sub>ow</sub> #NUM! l/kg  
Sorption coefficient for related species K<sub>ow1</sub> #NUM! l/kg  
Sorption coefficient for ionised species pH #NUM!  
pH value pKa #NUM!  
acid dissociation constant

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

Dispersivity

Calculate dependant on distance to compliance point (1) 2

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

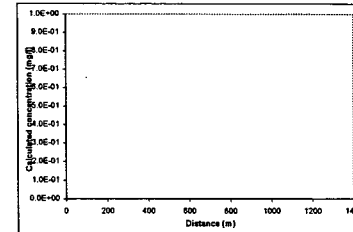
Longitudinal dispersivity ax 1.25E+01 m

Transverse dispersivity az 1.25E+00 m

Vertical dispersivity ay 1.25E-01 m

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* z, ay = 0.001 \* x, y & Eckstein (1995) report ax = 0.83(log<sub>10</sub>μ)<sup>0.14</sup>; az = ax/10, ay = ax/100 are assumed

time variant options only



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
60.0	#NUM!
120.0	#NUM!
180.0	#NUM!
240.0	#NUM!
300.0	#NUM!
360.0	#NUM!
420.0	#NUM!
480.0	#NUM!
540.0	#NUM!
600.0	#NUM!
650.0	#NUM!
720.0	#NUM!
780.0	#NUM!
840.0	#NUM!
900.0	#NUM!
960.0	#NUM!
1020.0	#NUM!
1080.0	#NUM!
1140.0	#NUM!
1200.0	#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+09.

Site being assessed: Bess Area 4 Downshute well K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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 Cr 1.14E-04 mg/l

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

Organic Banks

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 Cg 1.90E-99 mg/l

Half life for degradation of contaminant in water t1/2 3.66E-03 days

Calculated decay rate λ 1.90E-04 days<sup>-1</sup>

Width of plume in aquifer at source (perpendicular to flow) Sz 8.00E-01 m

Plume thickness at source Sy 2.10E-01 m

Submerged aquifer thickness da 1.20E-00 m

Bulk density of aquifer materials ρ 2.15E+01 gm/cm<sup>3</sup>

Effective porosity of aquifer n 1.32E-01 fraction

Hydraulic gradient i 1.33E-02 fraction

Hydraulic conductivity of aquifer K 2.00E+01 m/d

Distance (later) to compliance point perpendicular to flow direction X 1.20E+00 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 point entered groundwater t 9.90E+99 days

Parameters derived from options

Porosity coefficient Kd 2.29E+06 1/kg

Longitudinal dispersivity αx 1.25E m

Transverse dispersivity αz 1.25E m

Vertical dispersivity αy 0.125 m

Calculated Parameters Variable Value Unit Source

Groundwater flow velocity v 1.46E+00 m/d

Retardation factor Rf 2.14E+07 fraction

Decay rate used λ 1.90E-04 days<sup>-1</sup>

Rate of contaminant flow due to retardation u 6.83E-08 m/d

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

Contaminant concentration at distance x, assuming two-way vertical dispersion Ccs #NUM! mg/l

Attenuation factor (one way vertical dispersion, C/Cco) AF #NUM!

Remedial Targets Variable Value Unit Source

Distance to compliance point 1200 m

Concentration of contaminant at compliance point 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 Coefficient (using pull down menu)

Calculate for non-polar organic chemicals

Enter H species partition coefficient (option) Kd 1.00E+00 fraction

Soil water partition coefficient Koc 2.29E+06 fraction

Organic carbon partition coefficient Koc 2.29E+06 fraction

Entropy for ionic organic chemicals (option) Koc 2.29E+06 fraction

Sorption coefficient for limited species Koc 2.29E+06 fraction

pKa value pKa 1.00E+00

acid dissociation constant pKa 1.00E+00

Soil water partition coefficient Kd 1.00E+00 fraction

Dispersivity

Calculate dispersivity (1), or call after Xu & Eckstein (2) ?

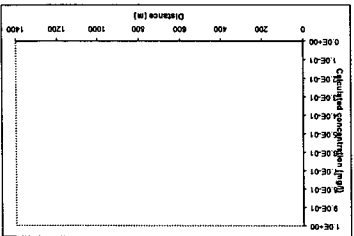
Enter value Calc value Xu & Eckstein

Vertical dispersivity αz 1.25E+00 m

Longitudinal dispersivity αx 1.25E+00 m

For calculated value, assumes αx = 0.1 \* αz = 0.01 \* αy = 0.001 \* αy = αx/100 are assumed

Xu & Eckstein (1992) report αx = 0.83(logKd)<sup>0.5</sup>; αz = αx/10; αy = αx/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 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 that to 9.0E+99.

Site being assessed: Bess Area 4 Downhole Well Z0  
Completed by: SJ  
Date: 24 11 2005  
Version: 12

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R&D Publication20 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)

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 <sub>0</sub>	9.90E+99	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.65E+03	days	
Calculated decay rate	λ	1.90E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	6.00E+01	m	
Plume thickness at source	Sy	2.10E+01	m	
Saturated aquifer thickness	da	2.17E+01	m	
Bulk density of aquifer materials	p	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.02E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	1.70E+03	m	
Distance (lateral) to compliance point perpendicular to flow direction	z	3.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	3.00E+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	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	1.12E+00	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	5.24E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	#NUM!	

Remedial Targets

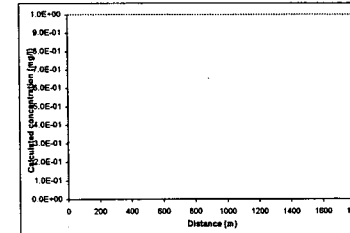
Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	#NUM!	mg/l	Ogata Banks
		9.9E+99	days	

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		l/kg
Soil water partition coefficient	Kd	2.29E+06	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	2.29E+06	l/kg
Organic carbon partition coefficient	K <sub>ow</sub>		l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species	pH		
pH value	pKa		
acid dissociation constant	Kd	2.29E+06	l/kg
Soil water partition coefficient	ax	1.41E+01	m
Longitudinal dispersivity	az	1.41E+00	m
Vertical dispersivity	ay	1.41E-01	m



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

mg/l	
85.0	#NUM!
170.0	#NUM!
256.0	#NUM!
340.0	#NUM!
426.0	#NUM!
610.0	#NUM!
896.0	#NUM!
950.0	#NUM!
765.0	#NUM!
850.0	#NUM!
930.0	#NUM!
1020.0	#NUM!
1100.0	#NUM!
1190.0	#NUM!
1276.0	#NUM!
1360.0	#NUM!
1446.0	#NUM!
1530.0	#NUM!
1616.0	#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: Biss Arca 4 Res K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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Tier 3 - Groundwater

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

Contaminant Target Concentration  $C_T$

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
Initial contaminant concentration in groundwater at plume core $C_0$	9.90E+99	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.65E+03	days	
Calculated decay rate $\lambda$	1.90E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.02E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (lateral) 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 $Kd$	2.29E+06	l/kg	see options
Longitudinal dispersivity $\alpha_x$	14.075	m	see options
Transverse dispersivity $\alpha_z$	1.407	m	see options
Vertical dispersivity $\alpha_y$	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.12E+00	m/d
Retardation factor $Rf$	2.14E+07	fraction
Decay rate used $\lambda$	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	5.24E-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	LC50	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1700		m	
Concentration of contaminant at compliance point after $C_{2D}/C_0$	#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  $f_{oc}$   fraction

Organic carbon partition coefficient  $K_{oc}$   l/kg

Entry for ionic organic chemicals (option) Sorption coefficient for related species  $K_{ow}$   l/kg

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

pH value  $pH$   pH

acid dissociation constant  $pKa$   pH

Soil water partition coefficient  $Kd$   l/kg

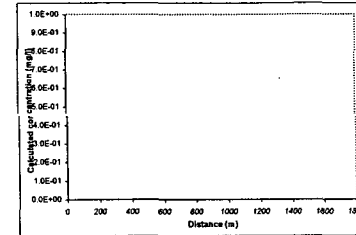
Dispersivity Calculate dependant on distance to compliance point (0)  specify dispersivity (1), or calc after Xu & Eckstein (2) ?

Longitudinal dispersivity  $\alpha_x$   m

Transverse dispersivity  $\alpha_z$   m

Vertical dispersivity  $\alpha_y$   m

For calculated value, assumes  $\alpha_x = 0.1 * z$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$ . Xu & Eckstein (1985) report  $\alpha_x = 0.63/(kg/m^3)^{0.2}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration	Unit
86.0	#NUM!	mg/l
170.0	#NUM!	mg/l
266.0	#NUM!	mg/l
340.0	#NUM!	mg/l
425.0	#NUM!	mg/l
510.0	#NUM!	mg/l
685.0	#NUM!	mg/l
860.0	#NUM!	mg/l
1020.0	#NUM!	mg/l
1105.0	#NUM!	mg/l
1190.0	#NUM!	mg/l
1275.0	#NUM!	mg/l
1360.0	#NUM!	mg/l
1445.0	#NUM!	mg/l
1530.0	#NUM!	mg/l
1615.0	#NUM!	mg/l
1700.0	#NUM!	mg/l

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.

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 Date: 24 11 2005  
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Tier 3 -Groundwater



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

Contaminant: Aromatic 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	$C_0$	9.90E-99	mg/l	see options
Half life for degradation of contaminant in water	$t_{1/2}$	7.35E+03	days	see options
Calculated decay rate	$\lambda$	1.90E-04	days <sup>-1</sup>	see options
Width of plume in aquifer at source (perpendicular to flow)	$S_z$	8.00E+01	m	see options
Plume thickness at source	$S_y$	2.10E+01	m	see options
Saturated aquifer thickness	$d_a$	2.17E+01	m	see options
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>	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	$K$	2.00E+01	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	$K_d$	4.57E+02	l/kg	see options
Longitudinal dispersivity	$\alpha_x$	14.075	m	see options
Transverse dispersivity	$\alpha_z$	1.407	m	see options
Vertical dispersivity	$\alpha_y$	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.12E+00	m/d
Retardation factor	$R_f$	4.27E+03	fraction
Decay rate used	$\lambda$	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.63E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{e0}$	1.83E-242	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{e2}$	1.02E-242	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{e0}$ )	$AF$	5.40E+143	
Attenuation factor (two way vertical dispersion, $C_0/C_{e2}$ )	$AF$	9.70E+143	

Remedial Targets

Remedial Target	LYC3	3.95E+140	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	$C_{e0}/C_0$	1.83E-242	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 cull down menu)

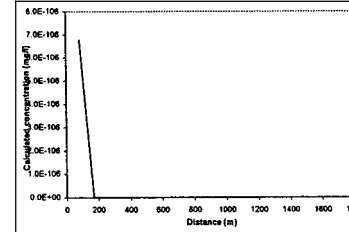
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	$K_d$		l/kg
Soil water partition coefficient	$K_{oc}$	1.00E+00	fraction
Entry for non-polar organic chemicals (option)	$f_{oc}$	4.57E-02	fraction
Fraction of organic carbon in aquifer	$K_{oc}$		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 ionized species	$pK_a$		
pH value	$K_d$	4.57E+02	l/kg
acid dissociation constant			

Soil water partition coefficient  $K_d$  4.57E+02 l/kg

Dispersivity			
Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	$\alpha_x$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	$\alpha_z$		1.41E+01 m
Vertical dispersivity	$\alpha_y$		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  $\alpha_x = 0.63(\log_{10} t)^{0.41}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

DistanceBanking sheet

Distance	Concentration	mg/l
85.0	6.8E-106	
170.0	4.4E-113	
255.0	2.8E-120	
340.0	1.8E-127	
425.0	1.1E-134	
510.0	7.1E-142	
595.0	4.5E-149	
680.0	2.9E-156	
765.0	1.9E-163	
850.0	1.3E-170	
935.0	8.1E-178	
1020.0	5.1E-185	
1105.0	3.4E-192	
1190.0	2.2E-199	
1275.0	1.4E-206	
1360.0	9.5E-214	
1445.0	6.3E-221	
1530.0	4.2E-228	
1615.0	2.8E-235	
1700.0	1.9E-242	

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

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Date: 24/11/2005  
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Tier 3 -Groundwater

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

Contaminant	Ammoniacal Nitrogen as		
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
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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	$5.50E+01$	mg/l	
Half life for degradation of contaminant in water	$2.19E+03$	days	
Calculated decay rate	$3.17E-04$	day <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	$8.00E+01$	m	
Plume thickness at source	$2.10E+01$	m	
Saturated aquifer thickness	$2.17E+01$	m	
Bulk density of aquifer materials	$1.70E+00$	g/cm <sup>3</sup>	
Effective porosity of aquifer	$1.82E-01$	fraction	
Hydraulic gradient	$1.02E-02$	fraction	
Hydraulic conductivity of aquifer	$2.00E+01$	m/d	
Distance to compliance point	$1.70E+03$	m	
Distance (laterally) 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	$8.90E+99$	days	time variant options only
Partition coefficient	$5.00E-01$	l/kg	see options
Longitudinal dispersivity	14.075	m	see options
Transverse dispersivity	1.407	m	see options
Vertical dispersivity	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.12E+00	m/d
Retardation factor	Rf	5.67E+00	fraction
Decay rate used	$\lambda$	3.17E-04	day <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.98E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	1.11E+00	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	8.18E-01	mg/l
Attenuation factor (one way vertical dispersion, $C_{1D}/C_{10}$ )	AF	4.95E+01	
Attenuation factor (two way vertical dispersion, $C_{2D}/C_{10}$ )	AF	8.90E+01	

Remedial Targets

Remedial Target	LTC3	$6.94E+00$	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.11E+00	mg/l	Ogata Banks
after		9.8E+99	days	

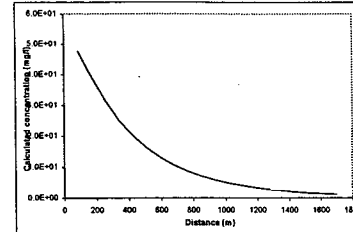
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.8E+99.

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	$K_{ow}$ l/kg
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			
Calculates dependent on distance to compliance point (0, 1, 2)			
specify dispersivity (1), or calc after Xu & Eckstein (2)?			
Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	az		1.41E+01 m
Vertical dispersivity	ay		1.41E-01 m

For calculated value, assumes  $ax = 0.1 \times z$ ,  $az = 0.01 \times x$ ,  $ay = 0.001 \times x$ . 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

Distance	Concentration
85.0	4.8E+01
170.0	3.9E+01
266.0	3.1E+01
340.0	2.6E+01
426.0	2.0E+01
610.0	1.6E+01
695.0	1.3E+01
880.0	1.1E+01
765.0	8.8E+00
856.0	7.0E+00
936.0	6.8E+00
1020.0	4.8E+00
1105.0	3.9E+00
1190.0	3.3E+00
1275.0	2.7E+00
1360.0	2.3E+00
1445.0	1.9E+00
1530.0	1.6E+00
1615.0	1.3E+00
1700.0	1.1E+00

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 K20
Completed by	AJ
Date	24 11 2005
Version	12

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) 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	Source of parameter value
Half life for degradation of contaminant in water	$t_{1/2}$	1.83E+03	days	
Calculated decay rate	$\lambda$	3.80E-04	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.02E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	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	$K_d$	5.75E+00	l/kg	see options
Longitudinal dispersivity	$\alpha_x$	14.075	m	see options
Transverse dispersivity	$\alpha_z$	1.407	m	see options
Vertical dispersivity	$\alpha_y$	0.141	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.12E+00	m/d
Retardation factor	$R_f$	5.47E+01	fraction
Decay rate used	$\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	2.05E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	1.53E-110	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	8.52E-111	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	AF	6.46E+11	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	AF	1.18E+12	

Remedial Targets

Remedial Target	LTC3	4.51E+08	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.53E-110	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 apolly partition coefficient (option)  $K_d$  5.75E+00 l/kg  
Soil water partition coefficient  $K_d$  5.75E+00 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+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  $K_{ow}$  l/kg  
pH value  $pH$   
acid dissociation constant  $pK_a$

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

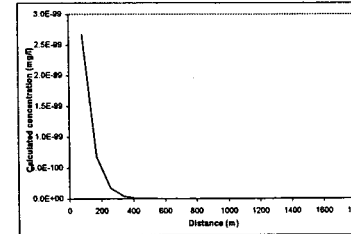
Dispersivity  $\alpha_x$  14.075 m

Calculate dispersivity dependent on distance to compliance point (0)  $\alpha_x$  14.075 m

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

Longitudinal dispersivity	$\alpha_x$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	$\alpha_z$	1.41E+01	m
Vertical dispersivity	$\alpha_y$	1.41E+00	m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} t)^{0.4}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

mg/l	
85.0	2.7E-99
260.0	6.9E-100
340.0	4.3E-101
425.0	1.1E-101
810.0	2.7E-102
835.0	6.8E-103
850.0	1.7E-103
865.0	4.1E-104
935.0	2.8E-105
1020.0	7.3E-106
1106.0	1.9E-106
1190.0	4.9E-107
1275.0	1.3E-107
1360.0	3.3E-108
1445.0	8.6E-109
1635.0	8.8E-109
1100.0	1.5E-110

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.

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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 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 <sub>0</sub>	9.90E-09	mg/l	1.44E-09
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days	1.33E+03
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>	3.80E-04
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	8.00E+01
Plume thickness at source	Sy	2.10E+01	m	2.10E+01
Saturated aquifer thickness	da	2.17E+01	m	2.17E+01
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	1.70E+00
Effective porosity of aquifer	n	1.82E-01	fraction	1.82E-01
Hydraulic gradient	i	1.02E-02	fraction	1.02E-02
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	2.00E+01
Distance to compliance point	x	1.70E+03	m	1.70E+03
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	0.00E+00
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	0.00E+00
Time since pollutant entered groundwater	t	9.90E+09	days	9.90E+09
Parameters values determined from options				
Partition coefficient	Kd	9.12E+00	Wt/g	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	1.12E+00	m/d	
Retardation factor	Rf	8.82E+01	fraction	
Decay rate used	λ	3.80E-04	d <sup>-1</sup>	
Rate of contaminant flow due to retardation	u	1.30E-02	m/d	
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.09E-115	mg/l	
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	8.08E-116	mg/l	
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	9.06E+16		
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	1.83E+17		

Remedial Targets

Remedial Target	LTC3	8.47E+13	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.09E-115	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)

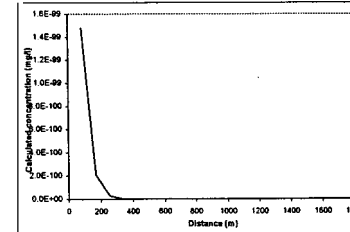
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	9.12E+00	Wt/g
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	9.12E+00	Wt/g
Organic carbon partition coefficient	K <sub>ow</sub>		Wt/g
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		Wt/g
Sorption coefficient for related species	pH		
Sorption coefficient for ionised species	pKa		
pH value			
acid dissociation constant			
Soil water partition coefficient	Kd	9.12E+00	Wt/g

Dispersivity

Calculate dependent 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<sub>10</sub>d)<sup>0.433</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks Distance-Concentration

	mg/l
95.0	2.95E-09
20.0	2.9E-101
340.0	4.0E-102
428.0	6.6E-103
698.0	1.7E-104
980.0	1.6E-105
7 M J	2.1E-104
988.0	4.2E-108
1006.0	6.6E-109
1190.0	1.2E-110
1276.0	1.7E-111
1100.0	2.6E-112
1448.0	3.6E-118
1816.0	7.6E-116
1700.0	1.1E-116

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

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Compiled by: AJ  
Date: 24 11 2005  
Version: 12





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)

Initial contaminant concentration in groundwater at plume core	$C_0$	9.90E-09	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E-09	days
Calculated decay rate	$\lambda$	7.00E-101	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	$Sz$	8.90E+01	m
Plume thickness at source	$Sy$	2.10E+01	m
Saturated aquifer thickness	$da$	2.17E+01	m
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction
Hydraulic gradient	$i$	1.02E-02	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	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
Parameters values determined from options			
Partition coefficient	$Kd$	1.17E+02	l/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	$v$	1.12E+00	m/d
Retardation factor	$Rf$	1.10E+03	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.02E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	2.87E-09	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.59E-09	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 3.45E-02 mg/l For comparison with measured groundwater concentration.

Distance to compliance point	1700	m
Concentration of contaminant at compliance point	$C_{1D}/C_0$	2.87E-09 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)

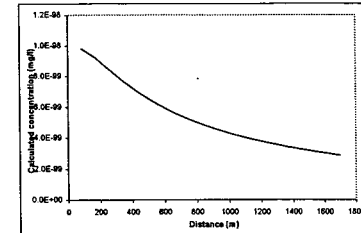
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)  
Soil water partition coefficient  $Kd$  1.17E+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  $Koc$  1.17E+02 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{oc}$  l/kg  
pH value  $pH$   
acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  1.17E+02 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, assumes  $ax = 0.1 * x$ ,  $az = 0.01 * x$ ,  $ay = 0.001 * x$   
Xu & Eckstein (1995) report  $ax = 0.03(\log_{10} t)^{0.14}$ ,  $az = ax/10$ ,  $ay = ax/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration	mg/l
85.0	9.8E-09	
170.0	9.2E-09	
255.0	8.4E-09	
340.0	7.7E-09	
425.0	7.0E-09	
510.0	6.5E-09	
595.0	6.0E-09	
680.0	5.5E-09	
765.0	5.1E-09	
850.0	4.8E-09	
935.0	4.5E-09	
1020.0	4.2E-09	
1105.0	4.0E-09	
1190.0	3.8E-09	
1275.0	3.6E-09	
1360.0	3.4E-09	
1445.0	3.3E-09	
1530.0	3.1E-09	
1615.0	3.0E-09	
1700.0	2.9E-09	

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 A104 4 Res K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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Tier 3 - Groundwater



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

Contaminant Fluoride  
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	$C_0$	1.70E+00	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days
Calculated decay rate	$\lambda$	7.00E-101	days <sup>-1</sup>
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	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction
Hydraulic gradient	$i$	1.02E-02	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	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
Parameters values determined from options			
Partition coefficient	$K_d$	0.00E+00	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	$v$	1.12E+00	m/d
Retardation factor	$Rf$	1.00E+00	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.12E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{eq}$	4.92E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{eq}$	2.74E-01	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{eq}$ )	$AF$	3.45E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{eq}$ )	$AF$	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	$C_{eq}/C_0$	4.92E-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  $K_d$  V/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer  $f_{oc}$  fraction  
Organic carbon partition coefficient  $K_{oc}$  V/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  V/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  V/kg  
pH value  
acid dissociation constant  $pK_a$

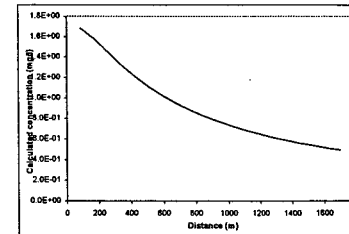
Soil water partition coefficient  $K_d$  0.00E+00 V/kg

Dispersivity

Calculate dispersivity 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  $ax = 0.1 \cdot x$ ,  $az = 0.01 \cdot x$ ,  $ay = 0.001 \cdot x$   
Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} x)^{0.75}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

mg/l	
86.0	1.7E+00
170.0	1.6E+00
266.0	1.5E+00
488.0	1.2E+00
810.0	1.1E+00
896.0	1.0E+00
880.0	9.5E-01
765.0	8.8E-01
660.0	8.2E-01
555.0	7.7E-01
1020.0	7.3E-01
1106.0	6.9E-01
1190.0	6.6E-01
1276.0	1.2E-01
1360.0	6.9E-01
1448.0	6.6E-01
1630.0	6.4E-01
1116.0	6.1E-01
1700.0	4.9E-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: Biss Arca 4 Res K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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 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	$C_0$	6.00E-03	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days	
Calculated decay rate	$\lambda$	7.00E-101	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.02E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	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	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	1.12E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.12E+00	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	$C_{2D}$	9.67E-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.
Ogata Banks				
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

Entry if specify partition coefficient (option)

Soil water partition coefficient

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 retained 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

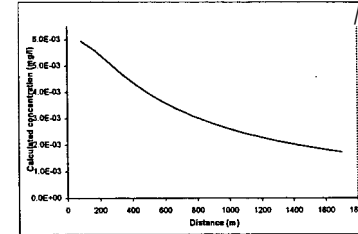
Transverse dispersivity

Vertical dispersivity

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

Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} x)^{1.44}$ ,  $az = ax/10$ ,  $ay = ax/100$  are assumed

Kd		l/kg
foc	1.00E+00	fraction
Koc	0.00E+00	l/kg
$K_{ow}$		l/kg
$K_{ow,i}$		l/kg
pH		
pKa		
Kd	0.00E+00	l/kg
ax	Enter value	1.41E+01 m
az		1.41E+00 m
ay		1.41E-01 m



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

mg/l	
85.0	6.9E-03
170.0	6.6E-03
255.0	6.1E-03
340.0	4.7E-03
425.0	4.3E-03
510.0	3.9E-03
595.0	3.6E-03
680.0	3.3E-03
765.0	3.1E-03
850.0	2.9E-03
935.0	2.7E-03
1020.0	2.6E-03
1105.0	2.3E-03
1190.0	2.3E-03
1275.0	2.0E-03
1360.0	1.9E-03
1445.0	
1530.0	
1615.0	1.1E-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	Bloss Arec 4 Rec K20
Completed by	AJ
Date	24/11/2005
Version	12

Tier 3 - Groundwater

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

Contaminant Phenol  
Target Concentration  $C_T$  8.00E-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

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	$\lambda$	6.93E-02	days <sup>-1</sup>
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	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction
Hydraulic gradient	$i$	1.02E-02	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	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+09	days
Parameters values determined from options			
Partition coefficient	$Kd$	1.05E-01	l/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	$v$	1.12E+00	m/d
Retardation factor	$Rf$	1.88E+00	fraction
Decay rate used	$\lambda$	6.93E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	5.67E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{E0}$	1.07E-146	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{E0}$	5.97E-147	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ )	$AF$	9.22E+47	
Attenuation factor (two way vertical dispersion, $C_0/C_{E0}$ )	$AF$	1.88E+48	

Remedial Targets Remedial Target LTC3 4.81E+44 mg/l

Ogata Banks			
Distance to compliance point	1700	m	
Concentration of contaminant at compliance point	$C_{E0}/C_0$	1.07E-146	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)

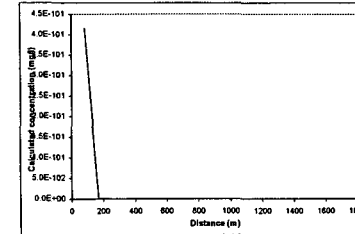
Calculate for non-polar organic chemicals

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

Dispersivity

Calculate dependant 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, assumes  $ax = 0.1 \cdot x$ ,  $az = 0.01 \cdot x$ ,  $ay = 0.001 \cdot x$   
 Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} t^{0.11})$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

mg/l	
85.0	4.2E-101
170.0	1.7E-103
266.0	6.6E-106
340.0	2.6E-108
426.0	9.8E-111
610.0	3.8E-113
695.0	1.6E-116
850.0	6.9E-118
706.0	2.3E-120
850.0	9.3E-123
935.0	3.7E-125
1020.0	1.6E-127
1106.0	5.8E-130
1190.0	2.4E-132
1275.0	9.7E-135
1360.0	3.9E-137
1445.0	1.6E-139
1530.0	6.6E-142
1916.0	2.6E-144
1700.0	1.1E-146

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 K20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

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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)

Initial contaminant concentration in groundwater at plume core	$C_0$	5.70E-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	$\lambda$	7.00E-101	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	1.02E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	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	$Kd$	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	$v$	1.12E+00	m/d
Retardation factor	$Rf$	1.00E+00	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.12E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{ep}$	1.65E-01	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{ep}$	9.18E-02	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{ep}$ )	$AF$	3.45E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{ep}$ )	$AF$	8.21E+00	

Remedial Targets

Remedial Target	LYC3	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	$C_{ep}/C_0$	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)  $Kd$  0.00E+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  $Koc$  0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  $K_{ow}$  l/kg  
Sorption coefficient for related species  
Sorption coefficient for ionized species  $K_{ow}$  l/kg  
pH value  
acid dissociation constant  $pKa$

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

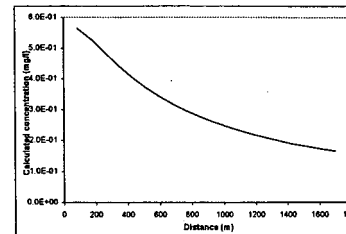
Dispersivity

Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity	$ax$	Enter value	Calc value Xu & Eckstein	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  $az = 0.83(\log_{10} K_{ow})^{0.5}$ ;  $ax = az/10$ ,  $ay = az/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

mg/l	
85.0	6.6E-01
170.0	6.3E-01
255.0	4.9E-01
340.0	4.4E-01
425.0	4.1E-01
510.0	3.7E-01
595.0	3.4E-01
680.0	3.2E-01
765.0	3.0E-01
850.0	2.8E-01
935.0	2.6E-01
1020.0	2.4E-01
1105.0	2.3E-01
1190.0	2.2E-01
1275.0	2.1E-01
1360.0	2.0E-01
1445.0	1.9E-01
1530.0	1.8E-01
1615.0	1.7E-01
1700.0	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: Bliss Area 4 Res K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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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 Sulphide  
Target Concentration C<sub>T</sub> 2.50E-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 <sub>0</sub>	2.00E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.02E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance (latera) to compliance point perpendicular to flow direction	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
<b>Parameters values determined from options</b>				
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	1.12E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.12E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	5.79E-02	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	3.22E-02	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	3.45E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	6.21E+00	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks			
Distance to compliance point	1700	m	
Concentration of contaminant at compliance point	5.79E-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

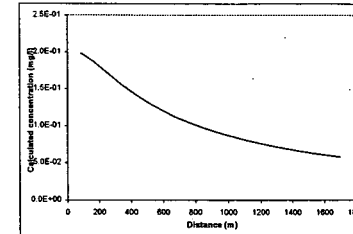
Entry if specify partition coefficient (option) Kd  
Soil water partition coefficient Kd 0.00E+00 l/kg  
Entry for non-polar organic chemicals (option) f<sub>oc</sub> 1.00E+00 fraction  
Fraction of organic carbon in aquifer f<sub>oc</sub> 0.00E+00 l/kg  
Organic carbon partition coefficient K<sub>oc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

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

Dispersivity

Calculate dependent on distance to compliance point (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<sub>10</sub>d)<sup>0.5</sup>, 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	2.0E-01
170.0	1.9E-01
266.0	1.7E-01
340.0	1.6E-01
426.0	1.4E-01
610.0	1.3E-01
896.0	1.2E-01
880.0	1.1E-01
766.0	1.0E-01
850.0	9.7E-02
U6.0	9.1E-02
1020.0	8.6E-02
1106.0	8.1E-02
1190.0	7.6E-02
1276.0	7.3E-02
1360.0	6.9E-02
1446.0	6.6E-02
1630.0	6.3E-02
1616.0	6.0E-02
1700.0	6.6E-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: Bess Area 4 Res. K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater

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

Contaminant: Total Cyanide  
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) **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  $9.90E-99$  mg/l  
Half life for degradation of contaminant in water  $2.92E-01$  days  
Calculated decay rate  $2.38E-02$  days<sup>-1</sup>

Width of plume in aquifer at source (perpendicular to flow)  $8.00E-01$  m  
Plume thickness at source  $2.10E+01$  m  
Saturated aquifer thickness  $2.17E+01$  m  
Bulk density of aquifer materials  $1.70E+00$  g/cm<sup>3</sup>  
Effective porosity of aquifer  $1.82E-01$  fraction  
Hydraulic gradient  $1.02E-02$  fraction  
Hydraulic conductivity of aquifer  $2.00E+01$  m/d

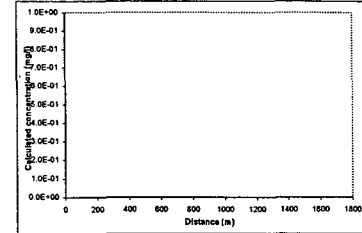
Distance to compliance point  $1.70E+03$  m  
Distance (latera) to compliance point perpendicular to flow direction  $0.00E+00$  m  
Distance (depth) to compliance point perpendicular to flow direction  $0.00E+00$  m  
Time since pollutant entered groundwater  $9.90E+99$  days

Parameters values determined from options  
Partition coefficient  $7.94E+09$  l/kg  
Longitudinal dispersivity  $14.075$  m  
Transverse dispersivity  $1.407$  m  
Vertical dispersivity  $0.141$  m

Calculated Parameters Variable  
Groundwater flow velocity  $1.12E+00$  m/d  
Retardation factor  $7.42E+10$  fraction  
Decay rate used  $2.38E-02$  d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $1.51E-11$  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,  $C_p/C_{p0}$ ) #NUM!  
Attenuation factor (two way vertical dispersion,  $C_p/C_{p0}$ ) #NUM!

Source of parameter value  
Soil water partition coefficient  $7.94E+09$  l/kg  
Dispersivity  
Calculate dependent on distance to compliance point (0), specify dispersivity (1), or calc after Xu & Eckstein (2) ? **2**  
Longitudinal dispersivity  $1.41E+01$  m  
Transverse dispersivity  $1.41E+00$  m  
Vertical dispersivity  $1.41E-01$  m  
For calculated value, assumes  $ax = 0.1 \cdot x$ ,  $az = 0.01 \cdot x$ ,  $ay = 0.001 \cdot x$   
Xu & Eckstein (1995) report  $ax = 0.63(\log_{10} x)^{0.4}$ ,  $az = ax/10$ ,  $ay = ax/100$  are assumed

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  $7.94E+09$  l/kg  
Entry for non-polar organic chemicals (option) foc  $1.00E+00$  fraction  
Fraction of organic carbon in aquifer  $7.94E+09$  l/kg  
Organic carbon partition coefficient Koc  
Entry for ionic organic chemicals (option)  $K_{ow}$   
Sorption coefficient for related species  $K_{ow}$   
Sorption coefficient for ionised species  $K_{ow}$   
pH value  
acid dissociation constant pKa



Calculated concentrations for distance-concentration graph

From Remediation sheet

Distance	Concentration
880.0	#NUM!
340.0	#NUM!
820.0	#NUM!
595.0	#NUM!
650.0	#NUM!
715.0	#NUM!
895.0	#NUM!
1020.0	#NUM!
1100.0	#NUM!
1275.0	#NUM!
1360.0	#NUM!
1480.0	#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: Bias Area 4 Res. K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Remedial Targets

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

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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 Allphatic 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) 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  
Half life for degradation of contaminant in water  $t_{1/2}$  1.83E+03 days  
Calculated decay rate  $\lambda$  3.80E-04 days<sup>-1</sup>  
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  $\rho$  1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer n 1.82E-01 fraction  
Hydraulic gradient i 1.02E-02 fraction  
Hydraulic conductivity of aquifer K 2.00E+01 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

Parameters values determined from odours  
Partition coefficient Kd 1.15E+02 V/kg  
Longitudinal dispersivity  $\alpha_x$  14.075 m  
Transverse dispersivity  $\alpha_z$  1.407 m  
Vertical dispersivity  $\alpha_y$  0.141 m

Calculated Parameters Variable

Groundwater flow velocity v 1.12E+00 m/d  
Retardation factor Rf 1.07E+03 fraction  
Decay rate used  $\lambda$  3.80E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation u 1.04E-03 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion  $C_{1D}$  1.39E-194 mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion  $C_{2D}$  7.75E-195 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ ) AF 7.10E+95  
Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ ) AF 1.28E+98

Remedial Targets

Remedial Target LTC3 6.07E+92 mg/l For comparison with measured groundwater concentration.  
Ogata Banks  
Distance to compliance point 1780 m  
Concentration of contaminant at compliance point  $C_{2D}/C_0$  1.39E-194 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  
Entry for non-polar organic chemicals (option) foc 1.00E+00 fraction  
Fraction of organic carbon in aquifer foc 1.15E+02 V/kg  
Organic carbon partition coefficient Koc  
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 1.15E+02 V/kg

Dispersivity

Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?  
Longitudinal dispersivity  $\alpha_x$  1.41E+01 m  
Transverse dispersivity  $\alpha_z$  1.41E+00 m  
Vertical dispersivity  $\alpha_y$  1.41E-01 m

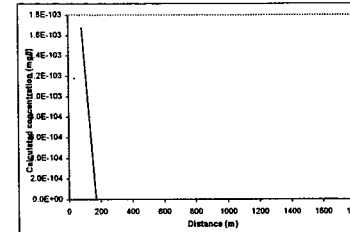
For calculated value, assumes  $\alpha_x = 0.1 \lambda$ ,  $\alpha_z = 0.01 \lambda$ ,  $\alpha_y = 0.001 \lambda$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} K_{ow})^{0.41}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

Source of parameter value

Soil water partition coefficient Kd 1.15E+02 V/kg  
Dispersivity  
Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?  
Longitudinal dispersivity  $\alpha_x$  1.41E+01 m  
Transverse dispersivity  $\alpha_z$  1.41E+00 m  
Vertical dispersivity  $\alpha_y$  1.41E-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  $\alpha_x = 0.83(\log_{10} K_{ow})^{0.41}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

time variant options only

Partition coefficient Kd see options  
Longitudinal dispersivity  $\alpha_x$  see options  
Transverse dispersivity  $\alpha_z$  see options  
Vertical dispersivity  $\alpha_y$  see options



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration (mg/l)
6500	2.7E-108
285.0	4.3E-113
340.0	6.7E-118
620.0	1.9E-122
895.0	2.6E-132
680.0	4.1E-137
706.0	8.8E-142
850.0	1.1E-146
935.0	1.7E-151
1020.0	2.7E-156
1105.0	4.4E-161
1190.0	7.2E-169
1275.0	1.2E-170
1360.0	1.9E-175
1445.0	3.1E-180
1530.0	6.2E-185
1615.0	8.8E-190
1700.0	1.4E-194

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 4 Res K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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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: Aliphatic C10-C12  
Target Concentration C<sub>T</sub>: 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	C <sub>0</sub>	9.90E-99	mg/l	see options
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days	see options
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>	see options
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.90E+017	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 <sup>3</sup>	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	2.00E+01	m/d	see options
Distance to compliance point	x	1.70E+03	m	see options
Distance (laterally) 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	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	1.12E+00	m/d
Retardation factor	Rf	8.52E+03	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.32E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	#NUM!	

Remedial Targets

Remedial Target	LYC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		1700	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	#NUM!	mg/l	Ogata Banks
		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 Kd 9.12E+02 l/kg  
Entry for non-polar organic chemicals (option) f<sub>oc</sub> 1.00E+00 fraction  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 9.12E+02 l/kg  
Entry for ionic organic chemicals (option) K<sub>ow</sub> #NUM! l/kg  
Sorption coefficient for related species K<sub>ow</sub> #NUM! l/kg  
Sorption coefficient for ionised species K<sub>ow</sub> #NUM! l/kg  
pH value pH #NUM!  
acid dissociation constant pKa #NUM!

Source of parameter value

Soil water partition coefficient Kd 9.12E+02 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0, 1, 2) 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, assumes ax = 0.1 \* x, az = 0.01 \* x, ay = 0.001 \* x

Xu & Eckstein (1995) report az = 0.83(log<sub>10</sub>ax)<sup>0.425</sup>; az = ax/10, ay = ax/100 are assumed

time variant options only

see options

see options

see options

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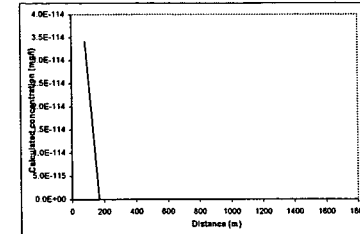
see options

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see options



Calculated concentrations for distance-concentration graph

Ogata Banks sheet

Distance Concentration

85.0	3.4E-114
170.0	1.1E-129
255.0	3.6E-145
340.0	1.1E-160
620.0	3.8E-196
695.0	3.8E-207
880.0	1.2E-222
765.0	3.9E-238
880.0	4.2E-269
101.0	1.4E-284
1105.0	4.6E-300
1190.0	0.0E+00
1275.0	0.0E+00
1150.0	0.0E+00
1445.0	0.0E+00
1630.0	#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: Bress Arca 4 Res K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

R&D Publication20 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<sub>T</sub> 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<sub>0</sub> 9.90E-09 mg/l  
Half life for degradation of contaminant in water t<sub>1/2</sub> 1.83E+03 days  
Calculated decay rate λ 3.80E-04 days<sup>-1</sup>  
Width of plume in aquifer at source (perpendicular to flow) Sz 8.05E+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<sup>3</sup>  
Effective porosity of aquifer n 1.82E-01 fraction  
Hydraulic gradient i 1.02E-02 fraction  
Hydraulic conductivity of aquifer K 2.00E+01 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+09 days

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 1.12E+00 m/d  
Retardation factor Rf 1.70E+05 fraction  
Decay rate used λ 3.80E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation u 8.60E-06 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion C<sub>1D</sub> #NUM! mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion C<sub>2D</sub> #NUM! mg/l  
Attenuation factor (one way vertical dispersion, C<sub>1D</sub>/C<sub>T</sub>) AF #NUM!  
Attenuation factor (two way vertical dispersion, C<sub>2D</sub>/C<sub>T</sub>) AF #NUM!

Remedial Targets

Remedial Target	LTCS	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	1700	m		
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>T</sub>	#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

Entry if specify partition coefficient (option) Kd #NUM! l/kg  
Soil water partition coefficient Kd #NUM! l/kg  
Entry for non-polar organic chemicals (option) f<sub>oc</sub> 1.00E+00 fraction  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.82E+04 l/kg  
Organic carbon partition coefficient K<sub>oc</sub> 1.82E+04 l/kg  
Entry for ionic organic chemicals (option) K<sub>ow</sub> #NUM! l/kg  
Sorption coefficient for related species K<sub>ow</sub> #NUM! l/kg  
Sorption coefficient for ionised species K<sub>ow</sub> #NUM! l/kg  
pH value pH #NUM!  
acid dissociation constant pKa #NUM!

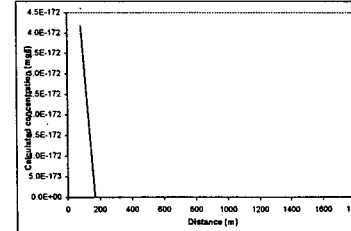
Soil water partition coefficient Kd 1.82E+04 l/kg

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 1.41E+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<sub>10</sub>x)<sup>0.45</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

85.0	4.2E-172
170.0	1.7E-245
266.0	0.0E+00
340.0	0.0E+00
426.0	#NUM!
610.0	#NUM!
696.0	#NUM!
880.0	#NUM!
785.0	#NUM!
850.0	#NUM!
936.0	#NUM!
1020.0	#NUM!
1106.0	#NUM!
1190.0	#NUM!
1276.0	#NUM!
1360.0	#NUM!
1446.0	#NUM!
1530.0	#NUM!
1616.0	#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 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 4 Res K20  
Completed by AJ  
Date 24 11 2005  
Version 12

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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 Target Concentration  $C_T$  Ammoniacal Nitrogen as N  $1.20E-01$  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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core $C_0$	4.40E+00	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	2.19E+03	days	
Calculated decay rate $\lambda$	3.17E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+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	time variant options only
Parameters values determined from options			
Partition coefficient $K_d$	5.00E-01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	10.623	m	see options
Transverse dispersivity $\alpha_z$	1.062	m	see options
Vertical dispersivity $\alpha_y$	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	5.87E+00	fraction
Decay rate used $\lambda$	3.17E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	2.42E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	1.14E+00	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	1.11E+00	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	3.85E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	3.95E+00	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	1.20E-01	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	750	m	
Concentration of contaminant at compliance point	1.14E+00	mg/l	Ogata Banks
after	9.9E+99	days	

Caution 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  $K_{oc}$  l/kg  
 Sorption coefficient for ionised species  $K_{oc}$  l/kg  
 pH value  
 acid dissociation constant  $pK_a$

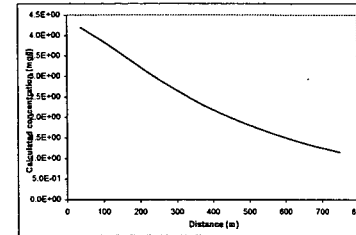
Soil water partition coefficient  $K_d$  5.00E-01 l/kg

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

Longitudinal dispersivity  $\alpha_x$  10.623 m  
 Transverse dispersivity  $\alpha_z$  1.062 m  
 Vertical dispersivity  $\alpha_y$  0.106 m

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

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Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
37.5	4.2E+00
76.0	4.0E+00
112.5	3.8E+00
160.0	3.5E+00
167.6	3.3E+00
226.0	3.1E+00
202.6	2.9E+00
300.0	2.7E+00
	2.3E+00
338.6	2.1E+00
412.6	2.0E+00
487.6	1.8E+00
626.0	1.7E+00
662.6	1.6E+00
800.0	1.5E+00
837.6	1.4E+00
876.0	1.3E+00
711.6	1.2E+00
760.0	1.1E+00

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

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 Area 5 Deepbank A, K20  
 Completed by AJ  
 Date 24 11 2005  
 Version 17



Tier 3 - Groundwater



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

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

Select analytical solution (click on brown call 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: 2.12E-02 mg/l  
Half life for degradation of contaminant in water: 1.83E+03 days  
Calculated decay rate: 3.80E-04 days<sup>-1</sup>  
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<sup>3</sup>  
Effective porosity of aquifer: n = 1.82E-01 fraction  
Hydraulic gradient: i = 1.25E-02 fraction  
Hydraulic conductivity of aquifer: K = 2.00E+01 m/d  
Distance to compliance point: x = 7.50E+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

Parameters values determined from options  
Partition coefficient: Kd = 5.75E+00 l/kg  
Longitudinal dispersivity: ax = 10.623 m  
Transverse dispersivity: az = 1.062 m  
Vertical dispersivity: ay = 0.106 m

Calculated Parameters Variable

Groundwater flow velocity: v = 1.37E+00 m/d  
Retardation factor: Rf = 5.47E+01 fraction  
Decay rate used: λ = 3.80E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation: u = 2.51E-02 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion: C<sub>ep</sub> = 6.92E-07 mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion: C<sub>eb</sub> = 6.74E-07 mg/l  
Attenuation factor (one way vertical dispersion, C<sub>o</sub>/C<sub>ep</sub>): AF = 3.06E+04  
Attenuation factor (two way vertical dispersion, C<sub>o</sub>/C<sub>eb</sub>): AF = 3.15E+04

Remedial Targets

Remedial Target: LYS 2.19E+01 mg/l  
Ogata Banks  
Distance to compliance point: 750 m  
Concentration of contaminant at compliance point after: C<sub>ep</sub>/C<sub>0</sub> = 6.92E-07 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

Soil water partition coefficient: Kd = 5.75E+00 l/kg  
Fraction of organic carbon in aquifer: f<sub>oc</sub> = 1.00E+00 fraction  
Organic carbon partition coefficient: K<sub>oc</sub> = 5.75E+00 l/kg  
Sorption coefficient for related species: K<sub>ow</sub>, K<sub>ow</sub> = l/kg  
Sorption coefficient for ionized species: K<sub>ow</sub>, K<sub>ow</sub> = l/kg  
pH value: pH =  
acid dissociation constant: pKa =

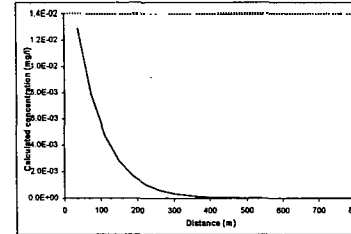
Soil water partition coefficient: Kd = 5.75E+00 l/kg

Dispersivity: Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity: ax = 10.623 m  
Transverse dispersivity: az = 1.062 m  
Vertical dispersivity: ay = 0.106 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<sub>10</sub> x)<sup>0.433</sup>; az = az/10, ay = ay/100 are assumed



Calculated concentrations for distance-concentration graph

Point calculation sheet

Distance Concentration

Distance (m)	Concentration (mg/l)
37.5	1.3E-02
75.0	7.8E-03
112.6	4.7E-03
169.8	2.1E-03
258.0	6.0E-04
300.0	3.6E-04
337.5	2.1E-04
376.0	1.2E-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

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: Area 6 Deep Park A K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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Tier 3 - Groundwater



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

Contaminant 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
Initial contaminant concentration in groundwater at plume core $C_0$	9.90E-09	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	2.28E+02	days	
Calculated decay rate $\lambda$	3.04E-03	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.28E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.80E+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-09	days	time variant options only
Parameters values determined from options			
Partition coefficient $Kd$	1.32E+00	l/kg	see options
Longitudinal dispersivity $ax$	10.623	m	see options
Transverse dispersivity $az$	1.062	m	see options
Vertical dispersivity $ay$	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.33E+01	fraction
Decay rate used $\lambda$	3.04E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.03E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{es}$	1.43E-106	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{eb}$	1.39E-106	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{es}$ ) $AF$	8.92E+07	
Attenuation factor (two way vertical dispersion, $C_0/C_{eb}$ ) $AF$	7.11E+07	

Remedial Targets

Remedial Target	LTC3	6.92E+05	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of oontaminant at compliance point	$C_{es}/C_0$	1.43E-106	mg/l	Ogata Banks
after		8.9E+08	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)  $Kd$  1.32E+00 l/kg  
 Soil water partition coefficient  $Kd$  1.32E+00 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  $Koc$  1.32E+00 l/kg  
 Entry for laotic organic chemicals (option)  $K_{ow}$  1.32E+00 l/kg  
 Sorption coefficient for related species  $K_{ow}$  1.32E+00 l/kg  
 Sorption coefficient for ionised species  $K_{ow}$  1.32E+00 l/kg  
 pH value  $pH$  1.32E+00 l/kg  
 acid dissociation constant  $pKa$  1.32E+00 l/kg

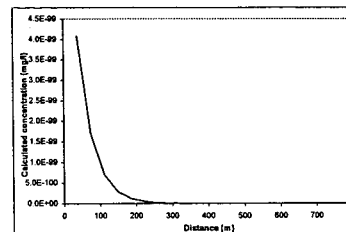
Soil water partition coefficient  $Kd$  1.32E+00 l/kg

Dispersivity Calculate dependant 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 $ax$		1.06E+01 m
Transverse dispersivity $az$		1.06E+00 m
Vertical dispersivity $ay$		1.06E-01 m

For calculated value, assumes  $ax = 0.1 * x$ ,  $az = 0.01 * x$ ,  $ay = 0.001 * x$ . Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} \mu)^{0.41}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
37.5	4.1E-09
76.0	1.7E-09
112.5	8.9E-100
160.0	2.8E-100
187.5	1.1E-100
226.0	4.6E-101
292.5	1.9E-101
300.0	7.6E-102
337.5	3.0E-102
376.0	1.2E-102
412.5	4.9E-103
460.0	2.0E-103
487.5	8.0E-104
626.0	3.2E-104
662.5	1.3E-104
600.0	6.3E-105
637.5	2.1E-105
676.0	8.7E-106
712.5	3.6E-106
750.0	1.4E-106

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+09.

Site being assessed: Bressa B Decapark K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12





Tier 3 - Groundwater



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

Contaminant	Aromatic C12-C16		
Target Concentration	C <sub>T</sub>	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 <sub>0</sub>	2.12E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E-04	days
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	7.80E+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
Parameters values determined from options			
Partition coefficient	Kd	1.82E+01	l/kg see options
Longitudinal dispersivity	ax	10.623	m see options
Transverse dispersivity	ay	1.062	m see options
Vertical dispersivity	az	0.106	m see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.71E+02	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	8.04E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	7.96E-14	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	7.75E-14	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	2.66E+11	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	2.74E+11	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	1.7CS	4.90E+08	mg/l
Distance to compliance point	760	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	7.96E-14	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

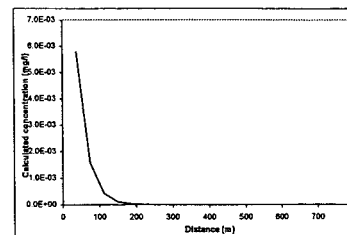
Entry if specify partition coefficient (option)	Kd	1.82E+01	l/kg
Soil water partition coefficient	Kd	1.82E+01	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	1.82E+01	l/kg
Entry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

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

Dispersivity Calculate dependant on distance to compliance point (0) 2

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity	ax	1.06E+01	m
Transverse dispersivity	ay	1.06E+00	m
Vertical dispersivity	az	1.06E-01	m

For calculated value, assumes ax = 0.1 \* x, ax = 0.01 \* x, ay = 0.001 \* x  
Xu & Eckstein (1995) report ax = 0.63(log<sub>10</sub>C<sub>0</sub>)<sup>0.43</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
87.6	5.8E-03
76.0	1.6E-03
112.5	4.3E-04
160.0	1.2E-04
187.5	3.1E-05
225.0	8.3E-06
282.5	2.2E-06
300.0	6.9E-07
337.5	1.6E-07
375.0	4.2E-08
412.5	1.1E-08
450.0	3.0E-09
487.5	8.0E-10
625.0	2.1E-10
662.5	5.7E-11
600.0	1.6E-11
637.5	4.1E-12
675.0	1.1E-12
712.5	3.0E-13
760.0	8.0E-14

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	Area 6 Deep Park A G20
Compiled by	AJ
Date	24/11/2005
Version	12

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 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
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 $\lambda$	1.90E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	3.80E+01	m	
Plume thickness at source $Sy$	5.60E+01	m	
Saturated aquifer thickness $da$	5.71E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+02	m	
Distance (laterally) to compliance point perpendicular to flow direction $z$	2.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction $y$	2.00E+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 $ax$	10.623	m	see options
Transverse dispersivity $ay$	1.062	m	see options
Vertical dispersivity $az$	0.106	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	5.38E+02	fraction
Decay rate used $\lambda$	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	2.55E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{ep}$	1.63E-18	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{ep}$	1.59E-18	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{ep}$ ) $AF$	1.30E+16	
Attenuation factor (two way vertical dispersion, $C_0/C_{ep}$ ) $AF$	1.34E+16	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	1.7CS 8.28E+12	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	750	m	
Concentration of contaminant at compliance point after	$C_{ep}/C_0$ 1.63E-18	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)  $Kd$  5.75E+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  
Entry for ionic organic chemicals (option)  $Koc$  5.75E+01 l/kg  
Organic carbon partition coefficient  
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  $Kd$  5.75E+01 l/kg

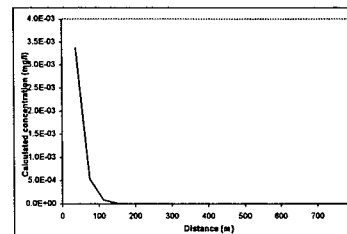
Dispersivity

Calculate dependant on distance to compliance point (0)

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

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity $ax$		1.06E+01	m
Transverse dispersivity $ay$		1.06E+00	m
Vertical dispersivity $az$		1.06E-01	m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration	mg/l
37.6	3.4E-03	
75.0	6.4E-04	
112.6	8.6E-05	
160.0	1.3E-05	
167.6	2.1E-06	
226.0	3.2E-07	
282.6	6.0E-08	
300.0	7.8E-09	
117.6	1.2E-09	
376.0	1.9E-10	
412.6	3.0E-11	
450.0	4.6E-12	
487.6	7.2E-13	
626.0	1.1E-13	
662.6	1.7E-14	
600.0	2.7E-15	
837.6	4.3E-16	
676.0	6.7E-17	
782.6	1.0E-18	

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: Area 6 Deerpark A K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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: C<sub>T</sub> 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 <sub>0</sub>	2.12E-02	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.85E+07	days	
Calculated decay rate	λ	1.90E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	3.00E+01	m	
Saturated aquifer thickness	da	2.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	7.50E+02	m	
Distance (latera) to compliance point perpendicular to flow direction	z	10.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	10.00E+00	m	
Time since pollutant entered groundwater	t	9.90E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	4.57E+02	l/kg	see options
Longitudinal dispersivity	ax	10.623	m	see options
Transverse dispersivity	ay	1.062	m	see options
Vertical dispersivity	az	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	4.27E+03	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	3.22E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.57E-65	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.53E-65	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.35E+83	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.38E+83	

Remedial Targets

Remedial Target	LTC3	6.88E+68	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.67E-66	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)

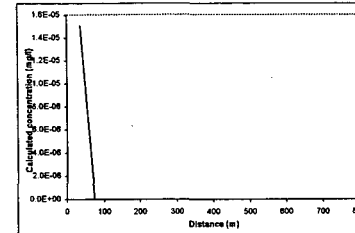
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	4.57E+02	l/kg
Organic carbon partition coefficient	K <sub>ow</sub>		l/kg
Entry for ionic organic chemicals (option)	K <sub>oc,ion</sub>		l/kg
Sorption coefficient for related species	K <sub>oc,ion</sub>		l/kg
Sorption coefficient for ionised species	pH		
pH value	pKa		
acid dissociation constant	Kd	4.57E+02	l/kg
Soil water partition coefficient			

Dispersivity

Calculate dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?		2	
Longitudinal dispersivity	ax		m
Transverse dispersivity	ay		m
Vertical dispersivity	az		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<sub>10</sub>ρ<sup>0.41</sup>); az = az/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
37.6	1.5E-08
75.0	1.1E-08
112.6	7.5E-12
160.0	6.3E-16
187.6	3.7E-18
226.0	2.6E-21
262.5	1.8E-24
300.0	1.2E-27
376.0	6.9E-34
412.6	4.1E-37
460.0	2.8E-40
487.6	2.0E-43
626.0	1.4E-46
662.6	9.6E-50
690.0	6.6E-53
957.6	4.8E-56
976.0	3.2E-59
712.6	2.2E-62
160.0	1.6E-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 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: Area 6 Deerpark A K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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Tier 3 - Groundwater

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

Contaminant 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 RAD 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+99	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E+01	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E+01	fraction	
Hydraulic gradient $i$	1.25E+02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	37.50E+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
Partition coefficient $Kd$	1.17E+02	l/kg	see options
Longitudinal dispersivity $ax$	10.623	m	see options
Transverse dispersivity $az$	1.062	m	see options
Vertical dispersivity $ay$	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.10E+03	fraction
Decay rate used $\lambda$	7.00E+01	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.25E+03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	6.77E+99	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	8.59E+99	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.48E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	1.50E+00	

Remedial Targets

Remedial Target	LTC3	1.48E+02	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		750	m	
Concentration of contaminant at compliance point after	$C_{1D}/C_0$	6.77E+99	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)  $Kd$  1.17E+02 l/kg  
 Soil water partition coefficient  $Kd$  1.17E+02 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  $Koc$  1.17E+02 l/kg  
 Entry for ionic organic chemicals (option)  $K_{ow}$  1.17E+02 l/kg  
 Sorption coefficient for related species  $K_{ow}$  1.17E+02 l/kg  
 Sorption coefficient for ionised species  $K_{ow}$  1.17E+02 l/kg  
 pH value  $pH$  7.00  
 acid dissociation constant  $pKa$  7.00

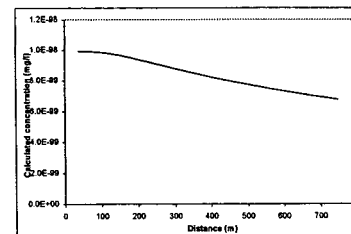
Soil water partition coefficient  $Kd$  1.17E+02 l/kg

Dispersivity  $\alpha$  2

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

Longitudinal dispersivity  $ax$  10.623 m  
 Transverse dispersivity  $az$  1.062 m  
 Vertical dispersivity  $ay$  0.106 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

37.6	9.9E+99
76.0	9.9E+99
112.5	9.9E+99
160.0	9.9E+99
167.6	9.9E+99
225.0	9.9E+99
282.5	9.0E+99
306.0	8.5E+99
337.6	8.6E+99
376.0	8.4E+99
412.6	8.2E+99
450.0	8.0E+99
487.6	7.8E+99
626.0	7.6E+99
682.5	7.5E+99
690.0	7.3E+99
637.5	7.2E+99
976.0	7.0E+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 Area 6 Doerpaik A 620  
 Completed by AJ  
 Date: 24 11 2005  
 Version 12

Tier 3 - Groundwater

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

Contaminant	Benzene		
Target Concentration	C <sub>T</sub>	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)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C <sub>0</sub>	9.90E-99	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	17.20E+02	days
Calculated decay rate	λ	9.63E-04	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	8.00E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+01	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	7.50E+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	2.14E-01	l/kg
Longitudinal dispersivity	ax	10.623	m
Transverse dispersivity	az	1.062	m
Vertical dispersivity	ay	0.106	m

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.37E+00 m/d
Retardation factor	Rf	3.00E+00
Decay rate used	λ	9.63E-04 d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.58E-01 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.45E-99 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.41E-99 mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	6.83E+00
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	7.02E+00

Remedial Targets

Remedial Target	LTC3	6.83E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.45E-99	mg/l	Ogata Banks
after		0.9E+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)

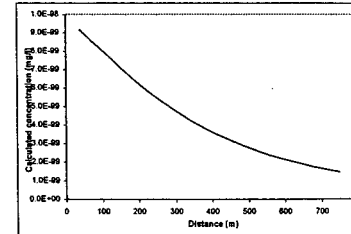
Calculate for non-polar organic chemicals

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<sub>oc</sub>  fraction  
Organic carbon partition coefficient K<sub>oc</sub>  l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>oc, i</sub>  l/kg  
Sorption coefficient for ionised species K<sub>oc, i</sub>  l/kg  
pH value pH    
acid dissociation constant pKa    
Soil water partition coefficient Kd  l/kg

Dispersivity

Calculate dependant 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 (1995) report ax = 0.83(log<sub>10</sub> t)<sup>0.41</sup>, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration	mg/l
37.6	8.2E-99	
76.0	8.6E-99	
112.5	7.8E-99	
182.0	8.4E-99	
225.0	5.8E-99	
282.5	6.3E-99	
300.0	4.7E-99	
337.5	4.3E-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.

476.0	3.2E-99	
487.5	2.9E-99	
525.0	2.6E-99	
662.5	2.3E-99	
600.0	2.1E-99	

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.

837.0	1.8E-99	
712.6	1.8E-99	
760.0	1.4E-W	

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: Area 5 Dearpark A, K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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<sub>T</sub> 1.00E+00 mg/l Boreon  
 Equations in RAD Pub. 20  
 Oganix Banks  
 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) 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 mg/l 1.00E+01  
 Half life for degradation of contaminant in water days 2.00E+01  
 Calculated decay rate 1/2 2.00E-01 days  
 Width of plume in aquifer at source (perpendicular to flow) m 2.00E+01  
 Saturated aquifer thickness da 5.71E+01 m  
 Bulk density of aquifer materials p 1.70E+01 g/cm<sup>3</sup>  
 Effective porosity of aquifer n 1.25E-02 fraction  
 Hydraulic conductivity of aquifer K 2.00E+01 m/d  
 Distance to compliance point x 2.00E+00 m  
 Distance (later) to compliance point perpendicular to flow direction z 2.00E+00 m  
 Time since plume entered groundwater days 9.90E+99  
 Parameters values defined from options  
 Partition coefficient Kd 0.00E+00 mg see options  
 Longitudinal dispersivity α<sub>L</sub> 10.00 m see options  
 Transverse dispersivity α<sub>T</sub> 1.00 m see options  
 Vertical dispersivity α<sub>V</sub> 0.100 m see options

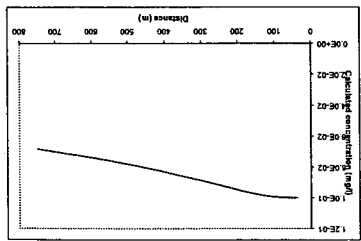
Remedial Targets

Remedial Target	LT3	1.00E+00	mg/l
Concentration of contaminant at compliance point	C <sub>CP</sub>	6.84E-02	mg/l
Distance to compliance point		750	m
Concentration of contaminant at compliance point after	C <sub>CP</sub>	9.9E+99	days
Groundwater flow velocity	v	1.37E+00	m/d
Retention factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-01	d <sup>-1</sup>
Rate of contaminant flow due to retention	C <sub>0</sub>	6.84E-02	mg/l
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>0</sub>	6.86E-02	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>x</sub> )	AF	1.46E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>x</sub> )	AF	1.50E+00	

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)  
 Calculators for non-polar organic chemicals  
 Calculators for deriving Partition Co-efficient (using pull down menu)  
 Enter '1' if apathy partition coefficient (option) Kd 1.00E+00 fraction  
 Enter '2' for non-polar organic chemicals (option) Koc 1.00E+00 fraction  
 Enter '3' for non-polar organic chemicals (option) Koc 0.00E+00 fraction  
 Organic carbon partition coefficient Koc 0.00E+00 fraction  
 Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
 Sorption coefficient for related species K<sub>oc</sub> 1.00E+00 mg/kg  
 Sorption coefficient for ionized species K<sub>oc</sub> 1.00E+00 mg/kg  
 pH value pH 1.00E+00 mg/kg  
 acid dissociation constant pKa 1.00E+00 mg/kg  
 Soil water partition coefficient Kd 0.00E+00 mg/kg  
 Dispersivity  
 Calculate dispersivity dependent on distance to compliance point (0) 1  
 Specify dispersivity (1), or calc after Xu & Eckstein (2) 2  
 Enter value Calc value Xu & Eckstein  
 Longitudinal dispersivity α<sub>L</sub> 1.00E+01 m  
 Transverse dispersivity α<sub>T</sub> 1.00E+01 m  
 Vertical dispersivity α<sub>V</sub> 1.00E-01 m  
 Xu & Eckstein (1985) report α<sub>L</sub> = 0.1 \* α<sub>T</sub>, α<sub>V</sub> = 0.01 \* α<sub>T</sub>, α<sub>L</sub> = 0.01 \* α<sub>T</sub>, α<sub>V</sub> = 0.001 \* α<sub>T</sub>  
 Parameters values defined from options  
 Time since plume entered groundwater days 9.90E+99  
 Distance (later) to compliance point perpendicular to flow direction z 2.00E+00 m  
 Distance to compliance point x 2.00E+00 m  
 Hydraulic conductivity of aquifer K 2.00E+01 m/d  
 Hydraulic gradient 1.25E-02 fraction  
 Saturated aquifer thickness da 5.71E+01 m  
 Bulk density of aquifer materials p 1.70E+01 g/cm<sup>3</sup>  
 Effective porosity of aquifer n 1.25E-02 fraction  
 Width of plume in aquifer at source (perpendicular to flow) m 2.00E+01  
 Saturated aquifer thickness da 5.71E+01 m  
 Bulk density of aquifer materials p 1.70E+01 g/cm<sup>3</sup>  
 Effective porosity of aquifer n 1.25E-02 fraction  
 Hydraulic conductivity of aquifer K 2.00E+01 m/d  
 Distance to compliance point x 2.00E+00 m  
 Distance (later) to compliance point perpendicular to flow direction z 2.00E+00 m  
 Time since plume entered groundwater days 9.90E+99  
 Parameters values defined from options  
 Partition coefficient Kd 0.00E+00 mg see options  
 Longitudinal dispersivity α<sub>L</sub> 10.00 m see options  
 Transverse dispersivity α<sub>T</sub> 1.00 m see options  
 Vertical dispersivity α<sub>V</sub> 0.100 m see options



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 Tier 3 remedial target for groundwater, based on the distances to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is C<sub>CP</sub>. 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	0	100	200	300	400	500	600	700	750
Concentration	1.00E+01	1.00E-01	1.00E-02	1.00E-03	1.00E-04	1.00E-05	1.00E-06	1.00E-07	1.00E-08



Site being assessed: A16 6 Deciper A K20  
 Completed by: RJ  
 Date: 24 11 2005  
 Version: 12

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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	Chlorobenzene		
Target Concentration	C <sub>T</sub>	1.00E-03	mg/l

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

Ogata Banks	Equations in RAD 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) **0**

Initial contaminant concentration in groundwater at plume core	C <sub>0</sub>	9.90E-09	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.00E+02	days	
Calculated decay rate	λ	2.31E-03	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	3.60E+01	m	
Saturated aquifer thickness	Sa	6.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+02	m/d	
Distance to compliance point	x	7.50E+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+09	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	7.94E-01	l/kg	see options
Longitudinal dispersivity	ax	10.623	m	see options
Transverse dispersivity	az	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	8.42E+00	fraction
Decay rate used	λ	2.31E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.63E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	5.74E-103	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	5.59E-103	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.72E+04	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.77E+04	

Remedial Targets

Remedial Target	LTCS	1.72E+01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	5.74E-103	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)

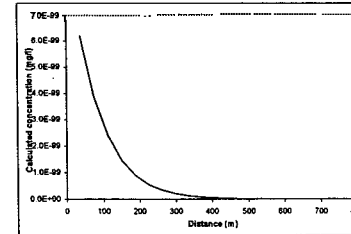
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	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	7.94E-01	l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	7.94E-01	l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	10.623	m
Transverse dispersivity	az	1.062	m
Vertical dispersivity	ay	0.106	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<sub>10</sub>x)<sup>0.41</sup>, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet

Distance	Concentration
31.6	6.2E-09
762.0	1.8E-09
11.0	1.5E-09
222.0	6.6E-100
362.5	3.4E-100
300.0	2.1E-100
337.6	1.1E-100
476.0	3.7E-101
460.0	2.9E-101
482.0	1.8E-101
562.5	6.8E-102
600.0	4.0E-102
637.5	2.5E-102
975.0	1.8E-102
112.6	9.3E-103
750.0	5.7E-103

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	Bloss 6 B Deepak K20
Completed by	AJ
Date	24 11 2005
Version	12

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Tier 3 - Groundwater

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

Contaminant Chloroethane  
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

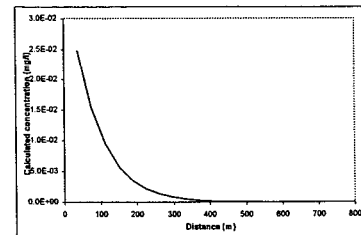
Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core $C_0$	4.00E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.80E+01	days	
Calculated decay rate $\lambda$	1.24E-02	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	1.00E+01	m	
Plume thickness at source $Sy$	5.00E+01	m	
Saturated aquifer thickness $da$	6.71E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+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 $Kd$	6.46E-02	l/kg	see options
Longitudinal dispersivity $ax$	10.623	m	see options
Transverse dispersivity $az$	1.062	m	see options
Vertical dispersivity $ay$	0.106	m	see options

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

Parameter	Value	Unit
Soil water partition coefficient $Kd$	6.46E-02	l/kg
Entry if specific 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 $foc$		fraction
Entry for non-polar organic chemicals (option) $Koc$	6.46E-02	l/kg
Organic carbon partition coefficient $Koc$		l/kg
Entry for ionic organic chemicals (option) $Koc_{i}$		l/kg
Sorption coefficient for related species $Koc_{i}$		l/kg
Sorption coefficient for ionised species $Koc_{i}$		l/kg
pH value $pKa$		l/kg
acid dissociation constant $pKa$		l/kg
Soil water partition coefficient $Kd$	6.46E-02	l/kg

Dispersivity	Value	Unit
Calculate dispersivity dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2	
Longitudinal dispersivity $ax$	1.06E+01	m
Transverse dispersivity $az$	1.06E+00	m
Vertical dispersivity $ay$	1.06E-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 (m)	Concentration (mg/l)
0	2.5E-02
100	1.5E-02
200	1.0E-02
300	7.5E-03
400	6.0E-03
500	5.0E-03
600	4.5E-03
700	4.2E-03
800	4.1E-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

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	1.80E+00	fraction
Decay rate used	$\lambda$	1.24E-02	days <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	8.57E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	1.95E-08	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.90E-08	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	2.05E+04	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	2.10E+04	

Remedial Targets	Value	Unit	Notes
Remedial Target	1.00E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	750	m	
Concentration of contaminant at compliance point	1.95E-08	mg/l	Ogata Banks
after	9.9E+99	days	

Caution 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.

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Site being assessed: Blislington Appeal  
Completed by: Anna Jeffcoat  
Date: \*\*\*\*\*  
Version: 11

Tier 3 - Groundwater

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

Contaminant	Isopropylbenzene		
Target Concentration	C <sub>T</sub>	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 <sub>0</sub>	9.90E-09	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	7.20E-02	days	
Calculated decay rate	λ	9.63E-04	days <sup>-1</sup>	
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	8.71E-01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E-01	m/d	
Distance to compliance point	x	7.50E+02	m	
Distance (laterals) to compliance point perpendicular to flow direction	z	1.00E+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	10.623	m	see options
Transverse dispersivity	az	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.63E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.45E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.41E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	8.83E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	7.02E+00	

Remedial Targets

Remedial Target	LTC3	8.93E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		760	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.45E-09	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)

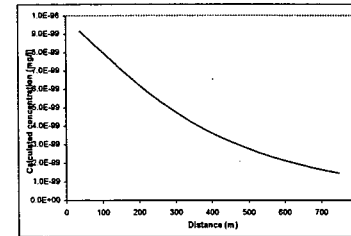
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	2.14E-01	l/kg
Entry for non-polar organic chemicals (option)	Koc	2.14E-01	l/kg
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)	Kow		l/kg
Sorption coefficient for related species	Kow		l/kg
Sorption coefficient for ionised species	Kow		l/kg
pH value	pH		
acid dissociation constant	pKa		

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?		2
Longitudinal dispersivity	ax	10.623
Transverse dispersivity	az	1.062
Vertical dispersivity	ay	0.106

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* z, ay = 0.001 \* y. Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>ax)<sup>0.42</sup>, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks Distance to Compliance point

376	8.2E-09
76.0	8.5E-09
112.6	7.6E-09
160.0	7.1E-09
187.5	6.4E-09
225.0	5.8E-09
262.5	5.3E-09
300.0	4.7E-09
337.6	4.3E-09
376.0	3.9E-09
412.6	3.6E-09
460.0	3.2E-09
487.6	2.9E-09
626.0	2.6E-09
602.6	2.3E-09
600.0	2.1E-09
637.6	1.9E-09
976.0	1.8E-09
712.6	1.6E-09
760.0	1.4E-09

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	Stress & B Deerpark K20
Completed by	AJ
Date	24/11/2005
Version	12

e)

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  $C_T$  n-butylbenzene 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

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 $t_{1/2}$	9.90E-09	days	
Calculated decay rate $\lambda$	6.94E-101	days <sup>-1</sup>	
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 $\rho$	1.70E+01	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+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 $K_d$	8.91E+00	V/kg	see options
Longitudinal dispersivity $\alpha_x$	10.623	m	see options
Transverse dispersivity $\alpha_z$	1.062	m	see options
Vertical dispersivity $\alpha_y$	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	8.42E+01	fraction
Decay rate used $\lambda$	6.94E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.63E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	6.77E-09	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	6.59E-09	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.46E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	1.50E+00	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	1.46E-03	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	750	m	
Concentration of contaminant at compliance point after	6.77E-09	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 $K_d$	8.91E+00	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 $K_{oc}$	8.91E+00	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 $pK_a$		

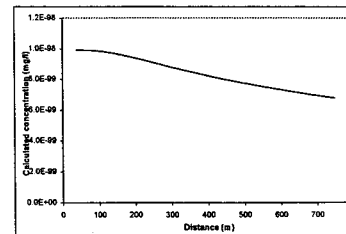
Soil water partition coefficient  $K_d$  8.91E+00 V/kg

Dispersivity

Calculate dependent on distance to compliance point (0) 2

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity $\alpha_x$		1.06E+01	m
Transverse dispersivity $\alpha_z$		1.06E+00	m
Vertical dispersivity $\alpha_y$		1.06E-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  $\alpha_x = 0.63(\log_e \rho)^{0.4}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  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.

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 From calculation sheet

Distance	Concentration	mg/l
37.5	9.9E-09	
75.0	9.9E-09	
112.5	9.8E-09	
150.0	9.7E-09	
187.5	9.6E-09	
225.0	9.2E-09	
262.5	9.0E-09	
300.0	8.8E-09	
337.5	8.6E-09	
375.0	8.4E-09	
412.5	8.2E-09	
450.0	8.0E-09	
487.5	7.8E-09	
525.0	7.6E-09	
562.5	7.3E-09	
600.0	7.2E-09	
637.5	7.0E-09	
675.0	6.8E-09	
712.5	6.3E-09	
750.0	6.8E-09	

Site being assessed: Blosa 6 B Decrepark K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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 <sub>T</sub>	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)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C <sub>0</sub>	9.90E+99	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	2.55E+23	days
Calculated decay rate	λ	2.69E-03	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	e	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	7.50E+02	m
Distance (laterals) to compliance point perpendicular to flow direction	z	0.05E+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	10.623	m
Transverse dispersivity	az	1.062	m
Vertical dispersivity	ay	0.106	m

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.37E+00 m/d
Retardation factor	Rf	8.87E+01
Decay rate used	λ	2.69E-03 d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.00E-02 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	2.89E-123 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.81E-123 mg/l
Attenuation factor (one way vertical dispersion, C <sub>1</sub> /C <sub>0</sub> )	AF	3.42E+24
Attenuation factor (two way vertical dispersion, C <sub>2</sub> /C <sub>0</sub> )	AF	3.52E+24

Remedial Targets

Remedial Target	LYC3	3.42E+24	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	2.89E-123	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

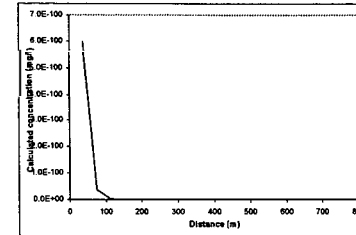
Soil water partition coefficient	Kd	7.24E+00	l/kg
Soil water partition coefficient (option)	Kd		l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	7.24E+00	l/kg
Organic carbon partition coefficient	K <sub>ow</sub>		l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species	K <sub>oc</sub>		l/kg
Sorption coefficient for ionised species	pH		
pH value	pKa		
acid dissociation constant			

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

Dispersivity

Calculate dependant on distance to compliance point (0)	ax	Enter value	Calc value Xu & Eckstein
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	ax		1.06E+01 m
Longitudinal dispersivity	az		1.06E+00 m
Transverse dispersivity	ay		1.06E-01 m
Vertical dispersivity			

For calculated value, assume ax = 0.1 \* x, az = 0.01 \* z, ay = 0.001 \* y. Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>ax)<sup>0.75</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
37.5	8.0E-100
75.0	3.6E-101
112.5	2.2E-102
150.0	1.3E-103
187.5	7.8E-105
225.0	4.6E-106
262.5	2.7E-107
300.0	1.6E-108
337.5	9.3E-110
375.0	5.6E-111
412.5	3.2E-112
450.0	1.9E-113
487.5	1.1E-114
525.0	6.7E-116
562.5	3.9E-117
600.0	2.3E-118
637.5	1.4E-119
675.0	8.2E-121
712.5	4.9E-122
750.0	2.9E-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. 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 6 B Decipark 420  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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Tier 3 - Groundwater



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

Contaminant Phenol  
Target Concentration  $C_T$  8.00E-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)

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	$C_0$	9.80E-09	mg/l	
Half life for degradation of contaminant in water	$t_{1/2}$	1.00E+01	days	
Calculated decay rate	$\lambda$	6.93E-02	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	7.50E+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	1.05E-01	l/kg	see options
Longitudinal dispersivity	ax	10.623	m	see options
Transverse dispersivity	az	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.98E+00	fraction
Decay rate used	$\lambda$	6.93E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	8.94E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	1.18E-118	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	1.13E-118	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	AF	8.55E+19	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	AF	8.78E+19	

Remedial Targets

Remedial Target	LTC3	4.29E+18	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.18E-118	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 1.05E-01 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient K<sub>oc</sub> 1.05E-01 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow</sub> l/kg

Sorption coefficient for ionised species K<sub>ow</sub> l/kg

pH value pH

acid dissociation constant pKa

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

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

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

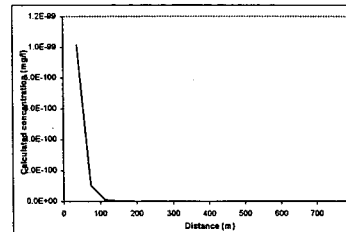
Longitudinal dispersivity ax 1.06E+01 m

Transverse dispersivity az 1.06E+00 m

Vertical dispersivity ay 1.06E-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<sub>10</sub>Q)<sup>0.44</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

17.6	1.0E-100
76.0	1.0E-100
111.6	1.1E-101
160.0	1.1E-102
187.6	1.1E-103
226.0	1.1E-104
262.6	1.1E-105
300.0	1.1E-106
337.6	1.1E-107
376.0	1.1E-108
412.6	1.1E-109
450.0	1.1E-110
487.6	1.1E-111
526.0	1.1E-112
562.6	1.1E-113
600.0	1.1E-114
637.6	1.1E-115
676.0	1.1E-116
712.6	1.1E-117
760.0	1.2E-118

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 & B Oberpark K20  
Compiled by: AJ  
Date: 24/11/2005  
Version: 12

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 <sub>T</sub> 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 <sub>0</sub>	9.90E-09	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.20E+02	days
Calculated decay rate	λ	9.83E-04	d <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance (lateral) to compliance point	x	7.50E+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+09	days

Partition coefficient	Kd	2.14E-01	l/kg	see options
Longitudinal dispersivity	ax	10.823	m	see options
Transverse dispersivity	ay	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.83E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.45E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.41E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	6.83E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	7.92E+00	

Remedial Targets

Remedial Target	LYC3	4.95E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		760	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	1.45E-09	mg/l	Ogata Banks
		9.8E+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	Kd 2.14E-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 2.14E-01 l/kg
Entry for ionic organic chemicals (option)	
Sorption coefficient for related species	K <sub>oc,r</sub> l/kg
Sorption coefficient for ionised species	K <sub>oc,i</sub> l/kg
pH value	pH
acid dissociation constant	pKa

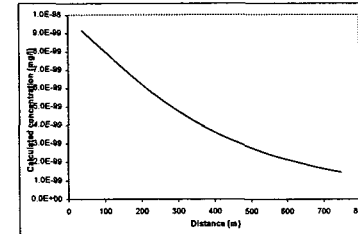
Soil water partition coefficient Kd 2.14E-01 l/kg

Dispersivity Calculate dependant on distance to compliance point (0)

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

Longitudinal dispersivity	ax	1.06E+01	m
Transverse dispersivity	az	1.06E+00	m
Vertical dispersivity	ay	1.06E-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<sub>10</sub>d)<sup>0.414</sup>, az = ax/10, ay = az/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+09.

Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

	mg/l
37.6	9.2E-09
76.0	8.5E-09
112.6	7.8E-09
160.0	7.1E-09

285.0	6.4E-09
292.6	6.3E-09
300.0	4.7E-09
47.6	4.3E-09
37.0	3.5E-09
412.6	3.8E-09
460.0	3.2E-09
487.6	2.9E-09
626.0	2.8E-09
582.6	2.3E-09
600.0	2.1E-09
617.6	1.9E-09
576.0	1.8E-09
712.6	1.5E-09
760.0	1.4E-09

Site being assessed	Bless B B Deep Park A20
Completed by	AJ
Date	24/11/2005
Version	12



Tier 3 -Groundwater



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

Contaminant	see butylbenzene		
Target Concentration	C <sub>T</sub>	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
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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 <sub>0</sub>	9.90E-09	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	7.20E+02	days	
Calculated decay rate	λ	9.63E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	9.90E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+01	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	7.50E+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	2.14E-01	l/kg	see options
Longitudinal dispersivity	ax	10.623	m	see options
Transverse dispersivity	az	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.63E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>ep</sub>	1.45E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>tp</sub>	1.41E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>ep</sub> )	AF	8.63E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>tp</sub> )	AF	7.02E+00	

Remedial Targets

Remedial Target	LYC3	6.93E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>ep</sub> /C <sub>0</sub>	1.45E-09	mg/l	Ogata Banks
after		9.9E+99	days	

Caution 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	Koc	2.14E-01	l/kg
Organic carbon partition coefficient	K <sub>ow</sub>		l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	pH		
pH value	pKa		
acid dissociation constant			

Soil water partition coefficient Kd 2.14E-01 l/kg

Dispersivity

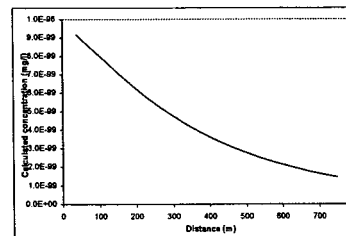
Calculator dependant on distance to compliance point (0)

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

Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein	1.06E+01	m
Transverse dispersivity	az			1.06E+00	m
Vertical dispersivity	ay			1.06E-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<sub>10</sub>x)<sup>0.75</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
37.6	9.2E-09
76.0	8.6E-09
112.5	7.8E-09
160.0	7.1E-09
187.6	6.4E-09
226.0	5.8E-09
292.0	4.3E-09
337.5	4.3E-09
376.0	3.9E-09
412.6	3.6E-09
460.0	3.2E-09
487.6	2.9E-09
626.0	2.6E-09
662.5	2.3E-09
600.0	2.1E-09
037.6	1.9E-09
675.0	1.8E-09
712.6	1.6E-09
750.0	1.4E-09

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 6 B Dierpark 420  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater

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

Contaminant Target Concentration	$C_T$	1.00E-02	mg/l
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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
Initial contaminant concentration in groundwater at plume core	$C_0$	3.00E+00	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days
Calculated decay rate	$\lambda$	7.00E-101	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	da	5.00E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	7.50E+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
Parameters values determined from options			
Partition coefficient	Kd	9.55E+00	l/kg
Longitudinal dispersivity	ax	10.623	m
Transverse dispersivity	az	1.062	m
Vertical dispersivity	ay	0.106	m

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.37E+00 m/d
Retardation factor	Rf	9.02E+01 fraction
Decay rate used	$\lambda$	7.00E-101 d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.52E-02 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	2.05E+00 mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	2.05E+00 mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	AF	1.48E+00
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	AF	1.50E+00

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	LTC3	1.44E-02	mg/l
Distance to compliance point	750	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	2.05E+00	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)		
Soil water partition coefficient	Kd	9.55E+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	9.55E+00 l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	$K_{ow}$	
Sorption coefficient for ionised species	$K_{oc,i}$	
pH value	pH	
acid dissociation constant	pKa	
Soil water partition coefficient	Kd	9.55E+00 l/kg

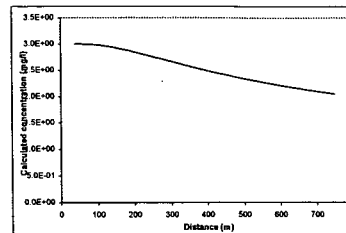
Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

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

Variable	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity	ax	1.06E+01 m
Transverse dispersivity	az	1.06E+00 m
Vertical dispersivity	ay	1.06E-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
Ogata Banks	
From calculation sheet	
17.6	3.0E+00
76.0	3.0E+00
168.0	3.0E+00
187.5	2.9E+00
228.0	2.8E+00
282.0	2.7E+00
300.0	2.7E+00
375.0	2.6E+00
412.5	2.5E+00
460.0	2.4E+00
487.5	2.4E+00
626.0	2.3E+00
682.5	2.3E+00
690.0	2.2E+00
637.5	2.2E+00
076.0	2.1E+00
711.6	2.1E+00
760.0	2.1E+00

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

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	Area 6 Deerpark A 420
Compiled by	AJ
Date	24 11 2005
Version	12

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 <sub>T</sub>	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
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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 <sub>0</sub>	2.30E+01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+07	m/d	
Distance to compliance point	x	7.90E+02	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
<b>Parameters values determined from options</b>				
Partition coefficient	Kd	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	10.623	m	see options
Transverse dispersivity	az	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.37E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>60</sub>	1.57E+01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>100</sub>	1.53E+01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>60</sub> /C <sub>0</sub> )	AF	1.46E+00	
Attenuation factor (two way vertical dispersion, C <sub>100</sub> /C <sub>0</sub> )	AF	1.50E+00	

Remedial Targets

Remedial Target	LTC3	1.46E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		760	m	
Concentration of contaminant at compliance point	C <sub>100</sub> /C <sub>0</sub>	1.67E+01	mg/l	Ogata Banks
after		9.9E+99	days	

Caution 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

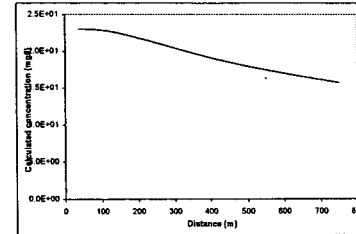
Entry if specify partition coefficient (option)  
 Soil water partition coefficient Kd 0.00E+00 l/kg  
 Entry for non-polar organic chemicals (option)  
 Fraction of organic carbon in aquifer foc 1.00E+00 fraction  
 Organic carbon partition coefficient Koc 0.00E+00 l/kg  
 Entry for ionic organic chemicals (option)  
 Sorption coefficient for related species K<sub>ow</sub> 1.00E+00 l/kg  
 Sorption coefficient for ionised species K<sub>ow</sub> 1.00E+00 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	Enter value	Calc value Xu & Eckstein	1.06E+01	m
Transverse dispersivity	az			1.06E+00	m
Vertical dispersivity	ay			1.06E-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<sub>10</sub>μ)<sup>0.75</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

mg/l	
37.6	2.3E+01
76.0	2.3E+01
112.5	2.3E+01
160.0	2.2E+01
187.6	2.2E+01
228.0	2.1E+01
232.6	2.1E+01
300.0	2.0E+01
337.5	2.0E+01
376.0	1.9E+01
412.6	1.9E+01
460.0	1.8E+01
487.6	1.8E+01
626.0	1.7E+01
662.6	1.7E+01
976.0	1.6E+01
712.5	1.6E+01
71.0	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:	Area B Deepak A K20
Completed by:	AJ
Date:	24 11 2005
Version:	12

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

Tier 3 - Groundwater



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

Contaminant Styrene  
Target Concentration  $C_T$  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)

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-093 mg/l

Half life for degradation of contaminant in water  $t_{1/2}$  2.10E+02 days

Calculated decay rate  $\lambda$  3.30E-03 days<sup>-1</sup>

Width of plume in aquifer at source (perpendicular to flow)  $Sz$  8.00E+010 m

Plume thickness at source  $Sy$  5.00E+011 m

Saturated aquifer thickness  $da$  5.71E+011 m

Bulk density of aquifer materials  $\rho$  1.70E+001 g/cm<sup>3</sup>

Effective porosity of aquifer  $n$  1.92E-011 fraction

Hydraulic gradient  $i$  1.25E-02 fraction

Hydraulic conductivity of aquifer  $K$  2.00E+010 m/d

Distance to compliance point  $x$  7.50E+023 m

Distance (latera) to compliance point perpendicular to flow direction  $z$  0.00E+000 m

Distance (depth) to compliance point perpendicular to flow direction  $y$  0.00E+000 m

Time since pollutant entered groundwater  $t$  9.90E+99 days

Parameters values determined from options

Partition coefficient  $Kd$  4.64E+000 l/kg

Longitudinal dispersivity  $ax$  10.623 m

Transverse dispersivity  $ay$  1.062 m

Vertical dispersivity  $az$  0.106 m

Calculated Parameters Variable

Groundwater flow velocity  $v$  1.37E+00 m/d

Retardation factor  $Rf$  4.43E+01 fraction

Decay rate used  $\lambda$  3.30E-03 d<sup>-1</sup>

Rate of contaminant flow due to retardation  $u$  3.10E-02 m/d

Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{1D}$  1.32E-119 mg/l

Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{2D}$  1.28E-119 mg/l

Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ )  $AF$  7.53E+20

Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  7.73E+20

Remedial Targets

Remedial Target LYCS 3.76E+10 mg/l For comparison with measured groundwater concentration.

Ogata Banks

Distance to compliance point 750 m

Concentration of contaminant at compliance point  $C_{1D}/C_0$  1.32E-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)

Calculates for non-polar organic chemicals

Entry if specify partition coefficient (option)

$Kd$  4.64E+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  $Koc$  4.64E+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  $pKa$  pKa

Soil water partition coefficient  $Kd$  4.64E+00 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

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

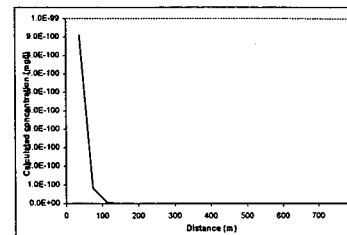
Longitudinal dispersivity  $ax$  Enter value Calc value Xu & Eckstein

Transverse dispersivity  $ay$  1.06E+00 m

Vertical dispersivity  $az$  1.06E-01 m

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

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



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

Distance (m)	Concentration (mg/l)
37.6	9.1E-100
76.0	8.4E-101
112.5	7.7E-102
160.0	7.0E-103
117.6	6.3E-104
226.0	6.0E-105
282.5	5.1E-106
300.0	1.0E-107
17.6	4.1E-108
376.0	3.7E-109
412.5	3.8E-110
450.0	3.0E-111
487.6	2.7E-112
626.0	2.4E-113
662.5	2.2E-114
600.0	2.0E-115
637.5	1.8E-116
676.0	1.6E-117
712.6	1.5E-118
760.0	1.3E-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: Glass B B Deerpark K20  
Compiled by: AJ  
Date: 24.11.2005  
Version: 12

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

Tier 3 - Groundwater



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

Contaminant Sulphide  
Target Concentration  $C_T$  2.50E-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 $C_0$	6.20E-013	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_z$	8.00E+01	m	
Plume thickness at source $S_y$	5.80E+01	m	
Saturated aquifer thickness $d_a$	5.71E-01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $I$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	1.20E+01	m/d	
Distance to compliance point $x$	7.50E+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 $K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	10.623	m	see options
Transverse dispersivity $\alpha_z$	1.062	m	see options
Vertical dispersivity $\alpha_y$	0.108	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $R_f$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.37E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	4.24E-01	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	4.13E-01	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.46E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	1.50E+00	

Remedial Targets

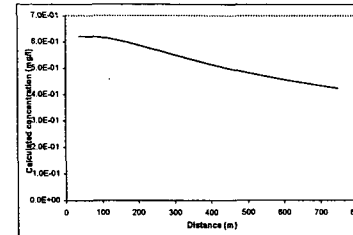
Remedial Target	LYCS 3.84E-04	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	750	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$ 4.24E-01	mg/l	Ogata Banks
after	9.9E+99	days	

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) $K_d$		l/kg
Soil water partition coefficient $K_{ow}$		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 $K_{oc}$		l/kg
Entry for ionic organic chemicals (option) $K_{ow}$		l/kg
Sorption coefficient for related species $K_{ow}$		l/kg
Sorption coefficient for ionized species $pH$		
pH value $pK_a$		
acid dissociation constant $K_d$	0.00E+00	l/kg
Soil water partition coefficient $K_d$	0.00E+00	l/kg
Dispersivity		
Calculate dispersivity dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2)?		
Longitudinal dispersivity $\alpha_x$	Enter value	Calc value Xu & Eckstein 1.06E+01 m
Transverse dispersivity $\alpha_z$		1.06E+00 m
Vertical dispersivity $\alpha_y$		1.06E-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 $\alpha_x = 0.83(\log_{10} t)^{0.43}$ ; $\alpha_z = \alpha_x/10$ , $\alpha_y = \alpha_x/100$ are assumed		



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
37.6	6.2E-01
76.0	6.2E-01
112.6	6.1E-01
160.0	6.0E-01
167.6	5.9E-01
226.0	5.8E-01
300.0	5.6E-01
337.6	5.4E-01
376.0	5.2E-01
412.6	5.1E-01
460.0	5.0E-01
487.6	4.9E-01
526.0	4.8E-01
602.6	4.7E-01
89.0	4.6E-01
837.6	4.5E-01
876.0	4.4E-01
922.6	4.3E-01
760.0	4.2E-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: Area 6 Deep Park A K20  
Completed by: R.J.  
Date: 24/11/2005  
Version: 12

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

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 $t_{1/2}$	9.99E+99	days	
Calculated decay rate $\lambda$	6.94E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	6.90E+01	m	
Plume thickness at source $Sy$	6.90E+01	m	
Saturated aquifer thickness $da$	6.71E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+001	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+02	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
Partition coefficient $Kd$	2.14E-01	l/kg	see options
Longitudinal dispersivity $ax$	10.623	m	see options
Transverse dispersivity $az$	1.062	m	see options
Vertical dispersivity $ay$	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	3.00E+00	fraction
Decay rate used $\lambda$	6.94E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.58E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	6.77E-99	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	8.59E-99	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.48E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	1.50E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	1.00E-03	mg/l	
Distance to compliance point	750	m	
Concentration of contaminant at compliance point after	6.77E-99	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

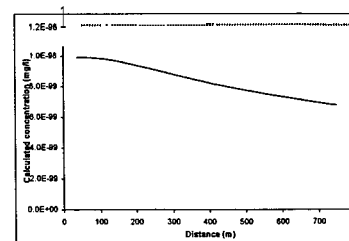
Entry if specify partition coefficient (option)  
 Soil water partition coefficient  $Kd$  2.14E-01 l/kg  
 Entry for non-polar organic chemicals (option)  
 Fraction of organic carbon in aquifer  $foc$  1.00E+00 fraction  
 Organic carbon partition coefficient  $Koc$  2.14E-01 l/kg  
 Entry for ionic 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  $Kd$  2.14E-01 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	Unit
Transverse dispersivity $az$		1.06E+00	m
Vertical dispersivity $ay$		1.06E-01	m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

37.6	9.9E-99
76.0	9.9E-99
112.6	9.9E-99
160.0	9.9E-99
187.6	9.9E-99
225.0	9.9E-99
282.5	9.9E-99
300.0	8.8E-99
337.6	1.0E-99
376.0	8.4E-99
412.6	8.2E-99
450.0	8.0E-99
487.5	7.8E-99
525.0	7.6E-99
562.5	7.6E-99
600.0	7.3E-99
637.5	7.2E-99
675.0	7.0E-99
712.6	6.9E-99
760.0	6.8E-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 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: Blots & B Depotpark K20  
 Compiled by: AJ  
 Date: 24 11 2005  
 Version: 12

Tier 3 - Groundwater



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

Contaminant	Total Cyanide		
Target Concentration	C <sub>T</sub>	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
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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	6.40E+01	mg/l	
Half life for degradation of contaminant in water	2.92E+01	days	
Calculated decay rate	2.38E-02	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	8.00E+01	m	
Plume thickness at source	5.60E+01	m	
Saturated aquifer thickness	5.71E+01	m	
Bulk density of aquifer materials	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	1.82E-01	fraction	
Hydraulic gradient	1.25E-02	fraction	
Hydraulic conductivity of aquifer	2.00E+01	m/d	
Distance to compliance point	7.50E+02	m	
Distance (laterally) 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	time variant options only
Partition coefficient	9.90E+00	l/kg	see options
Longitudinal dispersivity	10.623	m	see options
Transverse dispersivity	1.062	m	see options
Vertical dispersivity	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	9.35E+01	fraction
Decay rate used	λ	2.38E-02	days <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.47E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	9.17E+112	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	8.93E+112	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>T</sub> )	AF	8.98E+112	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>T</sub> )	AF	7.17E+112	

Remedial Targets

Remedial Target	LTC5	6.99E+110	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		760	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	9.17E+112	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)

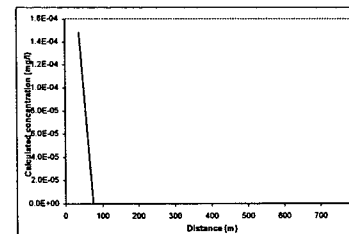
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	9.90E+00	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	9.90E+00	l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		

Dispersivity

Calculate dispersivity on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	1.06E+01	m
Transverse dispersivity	ay	1.06E+00	m
Vertical dispersivity	az	1.06E-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<sub>10</sub>ax)<sup>0.5</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
17.6	1.6E-04
76.0	3.4E-10
112.6	7.9E-16
160.0	1.8E-21
187.6	4.1E-27
226.0	9.4E-33
282.6	2.1E-38
300.0	4.3E-44
347.6	1.1E-49
376.0	2.5E-54
412.6	5.6E-61
450.0	1.3E-66
467.6	2.9E-72
526.0	6.6E-78
562.6	1.6E-83
600.0	3.4E-89
637.6	7.7E-94
676.0	1.8E-100
712.6	4.0E-106
760.0	9.2E-112

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	Area 8 Doornik A K20
Compiled by	AJ
Date	24 11 2005
Version	12



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

Tier 3 - Groundwater



Input Parameter. (using pull down menu) Variable Value Unit Source

Contaminant	Zinc
Target Concentration	C <sub>T</sub> 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 of parameter value
Initial contaminant concentration in groundwater at plume core	C <sub>0</sub> 1.47E-01	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub> 9.90E+99	days	
Calculated decay rate	λ 7.00E-101	days <sup>-1</sup>	
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 3.170E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 1.25E-02	fraction	
Hydraulic conductivity of aquifer	K 2.00E+01	m/d	
Distance to compliance point	x 7.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction	z 1.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y 1.00E+00	m	
Time since pollutant entered groundwater	t 9.90E+99	days	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient	Kd 0.00E+00	l/kg	see options
Longitudinal dispersivity	ax 10.623	m	see options
Transverse dispersivity	az 1.062	m	see options
Vertical dispersivity	ay 0.106	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.37E+00	m/d
Retardation factor	Rf 1.00E+00	fraction
Decay rate used	λ 7.00E-101	days <sup>-1</sup>
Rate of contaminant flow due to retardation	u 1.37E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>20</sub> 1.90E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2a</sub> 9.78E-02	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>20</sub> )	AF 1.46E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2a</sub> )	AF 1.50E+00	

Remedial Targets

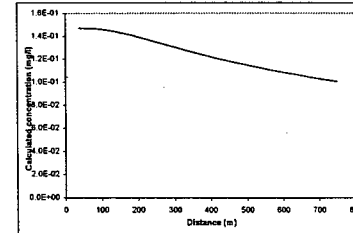
Remedial Target	LTC3	1.46E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>20</sub> /C <sub>0</sub>	1.00E-01	mg/l	Ogata Banks
after		9.9E+99	days	

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 <sub>ow</sub> 0.00E+00 l/kg
Sorption coefficient for ionised species	K <sub>oc1</sub> 0.00E+00 l/kg
pH value	pH 0.00E+00
acid dissociation constant	pKa 0.00E+00
Soil water partition coefficient	Kd 0.00E+00 l/kg
<b>Dispersivity</b>	
Calculate dependent on distance to compliance point (0)	0
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2
Longitudinal dispersivity	ax 1.06E+01 m
Transverse dispersivity	az 1.06E+00 m
Vertical dispersivity	ay 1.06E-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 <sub>10</sub> μ) <sup>0.11</sup> ; az = ax/10, ay = ax/100 are assumed	



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
37.5	1.5E-01
76.0	1.5E-01
112.6	1.5E-01
160.0	1.4E-01
187.5	1.4E-01
225.0	1.4E-01
282.5	1.3E-01
300.0	1.3E-01
337.5	1.3E-01
375.0	1.2E-01
412.6	1.2E-01
450.0	1.2E-01
487.5	1.2E-01
626.0	1.1E-01
682.5	1.1E-01
690.0	1.1E-01
817.5	1.1E-01
876.0	1.0E-01
712.6	1.0E-01
760.0	1.0E-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	Area B Deep Park A K20
Completed by	AJ
Date	24/11/2005
Version	12

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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 Target Concentration  $C_T$  1.24 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) 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 $C_0$	3.00E-03	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.80E+02	days	
Calculated decay rate $\lambda$	1.93E-03	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_z$	8.00E+02	m	
Plume thickness at source $S_y$	5.60E+01	m	
Saturated aquifer thickness $d_s$	5.71E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+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	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient $K_d$	2.95E+01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	10.623	m	see options
Transverse dispersivity $\alpha_z$	1.062	m	see options
Vertical dispersivity $\alpha_y$	0.106	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	2.77E+02	fraction
Decay rate used $\lambda$	1.93E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.97E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	3.58E-52	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	3.49E-52	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	8.37E+48	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	8.60E+48	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	LYC3 6.37E+48	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	750	m	
Concentration of contaminant at compliance point	3.58E-52	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

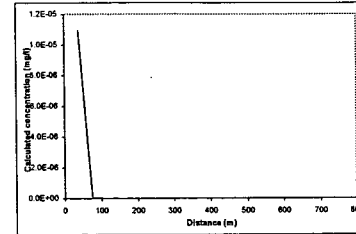
Soil water partition coefficient $K_d$	2.95E+01	l/kg
Entry for non-polar organic chemicals (option) Fraction of organic carbon in aquifer $f_{oc}$	1.00E+00	fraction
Organic carbon partition coefficient $K_{oc}$	2.95E+01	l/kg
Entry for ionic organic chemicals (option) Sorption coefficient for related species $K_{ow}$		l/kg
Sorption coefficient for ionised species $K_{ow,i}$		l/kg
pH value		
acid dissociation constant $pK_a$		
Soil water partition coefficient $K_d$	2.95E+01	l/kg

Dispersivity Calculate dependent on distance to compliance point (0) 2

Dispersivity	Enter value	Calc value Xu & Eckstein	Unit
Longitudinal dispersivity $\alpha_x$		1.06E+01	m
Transverse dispersivity $\alpha_z$		1.06E+00	m
Vertical dispersivity $\alpha_y$		1.06E-01	m

For calculated value, assumes  $\alpha_x = 0.1 \times \alpha_z = 0.01 \times \alpha_y = 0.001 \times \alpha_z$  Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} t)^{0.43}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet

Distance	Concentration
31.6	1.1E-06
75.0	4.0E-08
112.6	1.4E-10
158.0	5.9E-18
225.0	6.6E-18
282.6	2.3E-20
316.0	1.1E-27
412.6	3.8E-30
480.0	1.3E-32
487.5	4.8E-36
626.0	1.7E-37
682.6	8.1E-40
690.0	2.2E-42
637.5	7.8E-46
016.0	2.8E-47
712.6	1.0E-49
750.0	3.6E-52

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 6 B Doozpark #20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

R&D Publication20 RemedialTargets Worksheet, Release 2.2a

Tier 3 - Groundwater



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

Contaminant 1,3,5-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) 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 $C_0$	1.00E-03	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.60E+02	days	
Calculated decay rate $\lambda$	1.93E-03	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	3.00E+01	m	
Plume thickness at source $Sy$	5.00E+01	m	
Saturated aquifer thickness $da$	5.21E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.29E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+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 $Kd$	2.95E+01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	10.623	m	see options
Transverse dispersivity $\alpha_z$	1.062	m	see options
Vertical dispersivity $\alpha_y$	0.108	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	2.77E+02	fraction
Decay rate used $\lambda$	1.93E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.97E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	1.19E-52	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	1.16E-52	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	8.37E+48	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	8.80E+48	

Remedial Targets

Remedial Target	Value	unit	Source
Ogata Banks	1.19E-52	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	760	m	
Concentration of contaminant at compliance point after $C_{EQ}/C_0$	1.19E-52	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  $Kd$  2.95E+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  $K_{oc}$  2.95E+01 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  $pKa$

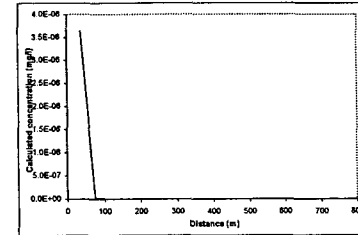
Soil water partition coefficient  $Kd$  2.95E+01 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0) 2  
specify dispersivity (1), or calc after Xu & Eckstein (2) 7

Longitudinal dispersivity  $\alpha_x$  10.623 m  
Transverse dispersivity  $\alpha_z$  1.062 m  
Vertical dispersivity  $\alpha_y$  0.108 m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * x$ ,  $\alpha_y = 0.001 * x$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} C_0)^{0.41}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  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  
From calculation sheet  
Distance Concentration

Distance	Concentration
116.0	3.8E-06
162.0	1.3E-08
112.6	4.8E-11
160.0	1.7E-13
187.5	6.2E-16
225.0	2.2E-18
262.5	7.8E-21
300.0	2.8E-23
337.5	9.8E-26
375.0	3.6E-28
412.6	1.3E-30
450.0	4.6E-33
487.5	1.6E-35
525.0	5.9E-38
562.5	2.1E-40
600.0	7.3E-43
637.5	2.6E-45
675.0	9.3E-48
712.5	3.3E-50
750.0	1.2E-52

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: Bess 6 B Doerpark K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater

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

Contaminant 1,4-Dichlorobenzene  
Target Concentration  $C_T$  1.90E-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 $C_0$	19.90E+99	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.00E+02	days	
Calculated decay rate $\lambda$	1.93E-03	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (lateral) to compliance point perpendicular to flow direction $x$	7.95E+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 $t$	19.90E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient $K_d$	7.78E+00	l/kg	see options
Longitudinal dispersivity $ax$	10.823	m	see options
Transverse dispersivity $az$	1.062	m	see options
Vertical dispersivity $ay$	0.108	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	7.35E+01	fraction
Decay rate used $\lambda$	1.93E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation $U$	1.87E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	4.08E+119	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	3.97E+119	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	2.43E+20	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	2.49E+20	

Remedial Targets

Remedial Target L1C3 2.43E+19 mg/l For comparison with measured groundwater concentration.

Distance to compliance point	750	m	Ogata Banks
Concentration of contaminant at compliance point after $C_{1D}/C_0$	4.08E+119	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

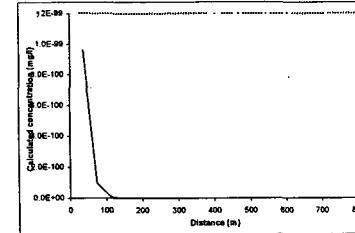
Entry if specify partition coefficient (option)  
Soil water partition coefficient  $K_d$  7.78E+00 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer  $f_{oc}$  1.00E+00 fraction  
Organic carbon partition coefficient  $K_{oc}$  7.78E+00 l/kg  
Entry for ionic 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  
acid dissociation constant  $pK_a$

Soil water partition coefficient  $K_d$  7.78E+00 l/kg

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

Longitudinal dispersivity  $ax$  10.823 m  
Transverse dispersivity  $az$  1.062 m  
Vertical dispersivity  $ay$  0.108 m

For calculated value, assumes  $ax = 0.1 \cdot x$ ,  $az = 0.01 \cdot z$ ,  $ay = 0.001 \cdot x$ .  
Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} x)^{0.411}$ ,  $az = ax/10$ ,  $ay = ax/100$  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

Distance	Concentration
Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
37.6	9.7E-100
76.0	9.4E-101
112.6	9.1E-102
160.0	8.7E-103
187.5	8.3E-104
225.0	7.9E-105
262.5	7.5E-106
300.0	7.2E-107
337.5	6.8E-108
376.0	6.5E-109
412.5	6.2E-110
460.0	5.9E-111
467.6	5.8E-112
525.0	5.3E-113
562.5	5.1E-114
600.0	4.9E-115
637.6	4.7E-116
676.0	4.4E-117
712.6	4.3E-118
760.0	4.1E-119

Site being assessed: Bless 6 B Deorpark K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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: 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 <sub>0</sub>	2.12E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.93E+03	days	
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	3.800E+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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	7.50E+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	time variant options only
Partition coefficient	Kd	1.15E+02	l/kg	see options
Longitudinal dispersivity	ax	10.623	m	see options
Transverse dispersivity	az	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.07E+03	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.28E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>0D</sub>	8.60E-44	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>0D</sub>	8.37E-44	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>0D</sub> )	AF	2.47E+41	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>0D</sub> )	AF	2.53E+41	

Remedial Targets

Remedial Target	LTC3	1.76E+03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>0D</sub> /C <sub>0</sub>	8.60E-44	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.

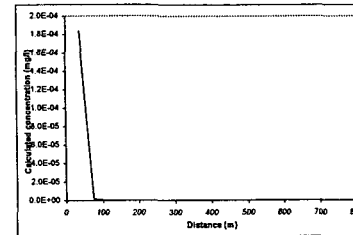
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals		
Entry if specify partition coefficient (option)	Kd	1.15E+02 l/kg
Soil water partition coefficient	Kd	1.15E+02 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	1.15E+02 l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>	1.15E+02 l/kg
Sorption coefficient for related species	K <sub>ow</sub>	1.15E+02 l/kg
Sorption coefficient for ionised species	K <sub>ow</sub>	1.15E+02 l/kg
pH value	pH	
acid dissociation constant	pKa	

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

Longitudinal dispersivity	ax	10.623 m
Transverse dispersivity	az	1.062 m
Vertical dispersivity	ay	0.106 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<sub>10</sub> t)<sup>0.43</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks		
From calculation sheet		
Distance	Concentration	mg/l
37.5	1.8E-04	
76.0	1.6E-06	
112.5	1.4E-08	
150.0	1.2E-10	
187.5	1.0E-12	
225.0	8.9E-15	
262.5	7.2E-17	
300.0	6.1E-19	
337.5	5.1E-21	
375.0	4.4E-23	
412.5	3.7E-25	
450.0	3.1E-27	
487.5	2.7E-29	
525.0	2.3E-31	
562.5	1.9E-33	
600.0	1.6E-35	
637.5	1.4E-37	
675.0	1.2E-39	
712.5	1.0E-41	
750.0	8.6E-44	

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: Area 6 Deepark A K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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 <sub>1</sub>	7.14E-04	mg/l

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

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 <sub>0</sub>	2.12E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance (lateral) to compliance point perpendicular to flow direction	x	7.50E+02	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	9.12E+02	l/kg
Longitudinal dispersivity	αx	10.623	m
Transverse dispersivity	αz	1.062	m
Vertical dispersivity	αy	0.106	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	8.52E+03	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.81E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	2.27E-141	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.21E-141	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	9.32E+138	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	8.57E+138	

Remedial Targets

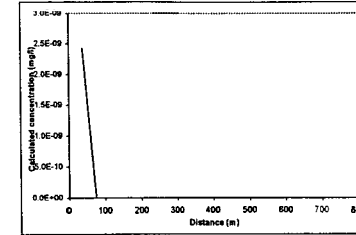
Remedial Target	LTCS	6.85E+138	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	2.27E-141	mg/l	Ogata Banks
after		9.9E+99	days	

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 0.12E+02 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 <sub>oc,1</sub> l/kg
Entry for ionic organic chemicals (option)	K <sub>oc,2</sub> l/kg
Sorption coefficient for related species	pH
Sorption coefficient for ionised species	pKa
pH value	
acid dissociation constant	

Soil water partition coefficient	Kd	0.12E+02	l/kg
<i>Dispersivity</i>			
Calculate dependent on distance to compliance point (0, 1, 2)		2	
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	αx	10.623	m
Transverse dispersivity	αz	1.062	m
Vertical dispersivity	αy	0.106	m
For calculated value, assumes αx = 0.1 * x, αz = 0.01 * z, αy = 0.001 * y, αx & Eckstein (1995) report αx = 0.83(log <sub>10</sub> t) <sup>0.41</sup> ; αz = αz/10, αy = αy/100 are assumed			
<i>time variant options only</i>			



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

Distance	Concentration
17.6	2.4E-09
76.0	2.8E-16
112.6	3.2E-23
186.0	3.6E-30
187.6	4.0E-37
226.0	4.6E-44
282.6	5.1E-51
306.0	6.7E-58
337.6	8.3E-65
375.0	7.1E-72
412.6	7.9E-79
460.0	8.9E-86
487.6	1.0E-92
626.0	1.1E-99
662.6	1.3E-106
600.0	1.4E-113
637.6	1.6E-120
676.0	1.8E-127
712.6	2.0E-134
760.0	2.3E-141

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:	Area 6 Decipark A K20
Completed by:	AJ
Date:	24/11/2005
Version:	12

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)

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 $\lambda$	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $Sz$	3.90E+01	m	
Plume thickness at source $Sy$	2.50E+01	m	
Saturated aquifer thickness $da$	5.71E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	7.50E+02	m	
Distance (lateral) to compliance point perpendicular to flow direction $z$	0.90E+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+04	l/kg	see options
Longitudinal dispersivity $\alpha_x$	10.623	m	see options
Transverse dispersivity $\alpha_z$	1.082	m	see options
Vertical dispersivity $\alpha_y$	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.70E+05	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	8.08E-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, $C_0/C_{1D}$ ) $AF$	#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	750		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

Entry if specify partition coefficient (option)  
Soil water partition coefficient  $Kd$  1.82E+04 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  $K_{oc}$  1.82E+04 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{oc}$  l/kg  
pH value  
acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  1.82E+04 l/kg

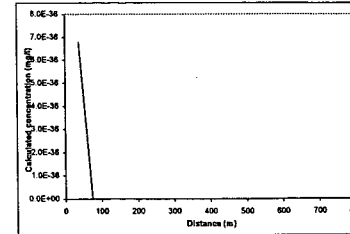
Dispersivity

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 $\alpha_x$		1.06E+01		m
Transverse dispersivity $\alpha_z$		1.06E+00		m
Vertical dispersivity $\alpha_y$		1.06E-01		m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * z$ ,  $\alpha_y = 0.001 * y$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} \rho)^{0.75}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

Distance (m)	Concentration (mg/l)
17.6	6.8E-36
76.0	2.2E-69
112.6	6.9E-103

188.9	8.8E-138
226.0	2.1E-203
282.6	6.7E-237
300.0	2.1E-270
337.6	#NUM!
376.0	#NUM!
412.6	#NUM!
460.0	#NUM!
487.6	#NUM!
626.0	#NUM!
642.6	#NUM!
650.0	#NUM!
637.6	#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: Area 6 Decipark A K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12



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 C<sub>T</sub> 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 <sub>0</sub>	2.12E-02	mg/l	2.12E-02
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.95E+03	days	3.95E+03
Calculated decay rate	λ	1.90E-04	days <sup>-1</sup>	1.90E-04
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	8.00E+01
Plume thickness at source	Sy	5.00E+01	m	5.00E+01
Saturated aquifer thickness	da	5.71E+01	m	5.71E+01
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	1.70E+00
Effective porosity of aquifer	n	1.82E-01	fraction	1.82E-01
Hydraulic gradient	i	1.25E-02	fraction	1.25E-02
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	2.00E+01
Distance to compliance point	x	7.50E+02	m	7.50E+02
Distance (laterally) to compliance point perpendicular to flow direction	z	0.00E+00	m	0.00E+00
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	0.00E+00
Time since pollutant entered groundwater	t	9.90E+99	days	9.90E+99
Parameters values determined from options				
Partition coefficient	Kd	2.29E+06	l/kg	see options
Longitudinal dispersivity	ax	10.623	m	see options
Transverse dispersivity	az	1.062	m	see options
Vertical dispersivity	ay	0.106	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	6.42E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	#NUM!	

Remedial Targets

Remedial Target	LTCS	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		750	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	#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 [redacted] l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 2.29E+06 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub> [redacted] l/kg  
Sorption coefficient for ionised species K<sub>ow</sub> [redacted] l/kg  
pH value pH [redacted]  
acid dissociation constant pKa [redacted]

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

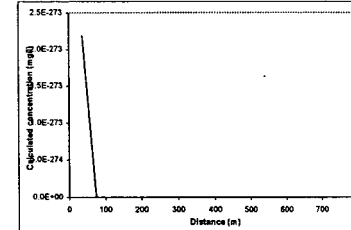
Dispersivity

Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity ax Enter value Calc value Xu & Eckstein 1.06E+01 m  
Transverse dispersivity az 1.06E+00 m  
Vertical dispersivity ay 1.06E-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<sub>10</sub>d<sup>0.41</sup>); az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

37.6	2.2E-273
76.0	#NUM!
112.6	#NUM!
150.0	#NUM!
117.6	#NUM!
226.0	#NUM!
282.6	#NUM!
330.0	#NUM!
337.6	#NUM!
176.0	#NUM!
412.6	#NUM!
487.6	#NUM!
626.0	#NUM!
682.6	#NUM!
600.0	#NUM!
017.6	#NUM!
176.0	#NUM!
712.6	#NUM!
760.0	#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: Area 6 Dberpark A K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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
Half life for degradation of contaminant in water	$t_{1/2}$	7.30E+02	days
Calculated decay rate	$\lambda$	9.50E-04	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	$Sz$	8.00E+01	m
Plume thickness at source	$Sy$	5.50E+01	m
Saturated aquifer thickness	$da$	5.71E+01	m
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction
Hydraulic gradient	$i$	1.25E-02	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d
Distance to compliance point	$x$	7.50E+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
Parameters values determined from options			
Partition coefficient	$Kd$	1.45E+01	l/kg
Longitudinal dispersivity	$ax$	10.823	m
Transverse dispersivity	$az$	1.062	m
Vertical dispersivity	$ay$	0.106	m

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	1.35E+02	fraction
Decay rate used	$\lambda$	9.50E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.01E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	1.70E-21	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.06E-21	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	1.25E+19	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	1.28E+19	

Remedial Targets

Remedial Target	LYC3	8.90E+16	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		760	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.70E-21	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)

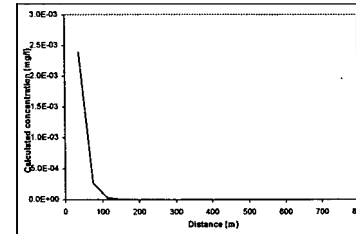
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	$Kd$	1.45E+01	l/kg
Soil water partition coefficient	$Kd$	1.45E+01	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	$Koc$	1.45E+01	l/kg
Entry for ionic organic chemicals (option)	$Kow$		l/kg
Sorption coefficient for related species	$Kow$		l/kg
Sorption coefficient for ionised species	$Kow$		l/kg
pH value	$pKa$		
acid dissociation constant	$pKa$		
Soil water partition coefficient	$Kd$	1.45E+01	l/kg

Dispersivity

Calculate dispersivity on distance to compliance point (0), specify dispersivity (1), or calc after Xu & Eckstein (2) ?		2
Longitudinal dispersivity	$ax$	10.823
Transverse dispersivity	$az$	1.062
Vertical dispersivity	$ay$	0.106

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



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

mg/l	
76.6	2.2E-04
112.6	3.0E-05
160.0	3.4E-06
187.5	3.7E-07
225.0	4.1E-08
262.5	4.6E-09
300.0	5.0E-10
317.6	5.6E-11
176.0	9.1E-12
412.5	6.8E-13
450.0	7.5E-14
487.5	8.3E-15
626.0	9.1E-16
662.6	1.0E-16
600.0	1.1E-17
817.6	1.2E-18
875.0	1.4E-19
712.6	1.6E-20
760.0	1.7E-21

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: Area 6 Deerpark A, K20  
Compiled by: AJ  
Date: 24 11 2005  
Version: 12

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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**

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	2.12E-02	mg/l	
Half life for degradation of contaminant in water	3.65E+03	days	
Calculated decay rate	1.90E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	8.00E+01	m	
Plume thickness at source	5.90E+01	m	
Saturated aquifer thickness	5.71E+01	m	
Bulk density of aquifer materials	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	1.82E-01	fraction	
Hydraulic gradient	7.00E-03	fraction	
Hydraulic conductivity of aquifer	2.00E+01	m/d	
Distance to compliance point	8.50E+02	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	time variant options only
<i>Parameters values determined from options</i>			
Partition coefficient	2.29E+06	l/kg	see options
Longitudinal dispersivity	11.114	m	see options
Transverse dispersivity	1.111	m	see options
Vertical dispersivity	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	7.69E-01	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	3.80E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	#NUM!	

Remedial Targets

Remedial Target	LYCS	#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 <sub>1D</sub> /C <sub>0</sub>	#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.

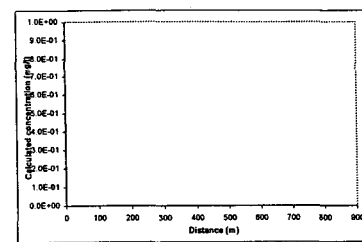
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00 fraction
Fraction of organic carbon in aquifer	Koc	2.29E+06 l/kg
Organic carbon partition coefficient	K <sub>ow</sub>	l/kg
Entry for ionic organic chemicals (option)	K <sub>oc1</sub>	l/kg
Sorption coefficient for related species	pH	
pH value	pKa	
acid dissociation constant		

Soil water partition coefficient	Kd	2.29E+06	l/kg
<i>Dispersivity</i>			
Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
<i>Longitudinal dispersivity</i>			
ax	Enter value	Calc value Xu & Eckstein	1.11E+01 m
<i>Transverse dispersivity</i>			
ay			1.11E-01 m
<i>Vertical dispersivity</i>			
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(log<sub>10</sub>)<sup>0.411</sup>; 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.

Site being assessed: Bless 6 Res #20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

Calculated concentrations for distance-concentration graph

Ogata Banks

Distance (m)	Concentration (mg/l)
42.5	#NUM!
85.0	#NUM!
127.6	#NUM!
170.0	#NUM!
212.5	#NUM!
255.0	#NUM!
297.6	#NUM!
340.0	#NUM!
382.6	#NUM!
425.0	#NUM!
467.5	#NUM!
510.0	#NUM!
552.5	#NUM!
595.0	#NUM!
637.5	#NUM!
680.0	#NUM!
722.5	#NUM!
765.0	#NUM!
807.5	#NUM!
850.0	#NUM!

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<sub>T</sub> 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<sub>0</sub> 2.12E-02 mg/l  
Half life for degradation of contaminant in water t<sub>1/2</sub> 7.30E+02 days  
Calculated decay rate λ 9.50E-04 days<sup>-1</sup>  
Width of plume in aquifer at source (perpendicular to flow) S<sub>z</sub> 8.00E+01 m  
Plume thickness at source S<sub>y</sub> 5.00E+01 m  
Saturated aquifer thickness d<sub>a</sub> 5.71E+01 m  
Bulk density of aquifer materials ρ 1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer n 1.82E-01 fraction  
Hydraulic gradient I 7.00E-03 fraction  
Hydraulic conductivity of aquifer K 2.00E+01 m/d  
Distance (laterals) 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

Parameters values determined from options  
Partition coefficient K<sub>d</sub> 1.45E+01 l/kg see options  
Longitudinal dispersivity α<sub>x</sub> 11.114 m see options  
Transverse dispersivity α<sub>z</sub> 1.111 m see options  
Vertical dispersivity α<sub>y</sub> 0.111 m see options

Calculated Parameters Variable

Groundwater flow velocity v 7.69E-01 m/d  
Retardation factor R<sub>f</sub> 1.38E+02 fraction  
Decay rate used λ 9.50E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation u 5.68E-03 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion C<sub>1D</sub> 2.69E-34 mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion C<sub>2D</sub> 2.58E-34 mg/l  
Attenuation factor (one way vertical dispersion, C<sub>0</sub>/C<sub>1D</sub>) AF 7.87E+31  
Attenuation factor (two way vertical dispersion, C<sub>0</sub>/C<sub>2D</sub>) AF 8.21E+31

Remedial Targets

Remedial Target LTC3 6.82E+29 mg/l For comparison with measured groundwater concentration.  
Ogata Banks  
Distance to compliance point 860 m  
Concentration of contaminant at compliance point C<sub>60</sub>/C<sub>0</sub> 2.69E-34 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<sub>d</sub> 1.45E+01 l/kg  
Soil water partition coefficient K<sub>d</sub> 1.45E+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 K<sub>oc</sub> 1.45E+01 l/kg  
Entry for ionic organic chemicals (option) Organic carbon partition coefficient K<sub>oc, ionic</sub> 1.45E+01 l/kg  
Sorption coefficient for related species K<sub>oc, related</sub> 1.45E+01 l/kg  
Sorption coefficient for ionised species K<sub>oc, ionised</sub> 1.45E+01 l/kg  
pH value pH  
acid dissociation constant pKa

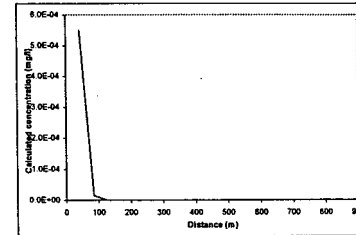
Soil water partition coefficient K<sub>d</sub> 1.45E+01 l/kg

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

Longitudinal dispersivity α<sub>x</sub> 1.11E+01 m  
Transverse dispersivity α<sub>z</sub> 1.11E+00 m  
Vertical dispersivity α<sub>y</sub> 1.11E-01 m

For calculated value, assumes α<sub>x</sub> = 0.1 \* x, α<sub>z</sub> = 0.01 \* z, α<sub>y</sub> = 0.001 \* y  
Xu & Eckstein (1995) report α<sub>x</sub> = 0.83(log<sub>10</sub> t)<sup>0.11</sup>; α<sub>z</sub> = α<sub>z</sub>/10, α<sub>y</sub> = α<sub>y</sub>/100 are assumed

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Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration (mg/l)
42.5	6.5E-04
85.0	1.4E-06
127.5	3.7E-07
170.0	9.3E-09
212.5	2.3E-10
255.0	5.9E-12
297.5	1.6E-13
340.0	3.8E-16
382.5	9.6E-17
425.0	2.4E-18

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: Blass B Res K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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<sub>T</sub> 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<sub>0</sub> 4.40E+00 mg/l  
Half life for degradation of contaminant in water t<sub>1/2</sub> 2.18E+03 days  
Calculated decay rate λ 3.17E-04 days<sup>-1</sup>  
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<sup>3</sup>  
Effective porosity of aquifer n 1.82E-01  
Hydraulic gradient i 7.00E-03  
Hydraulic conductivity of aquifer K 2.00E+01 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 K<sub>d</sub> 5.00E-01 l/kg  
Longitudinal dispersivity α<sub>x</sub> 11.114 m  
Transverse dispersivity α<sub>z</sub> 1.111 m  
Vertical dispersivity α<sub>y</sub> 0.111 m

Calculated Parameters Variable

Groundwater flow velocity v 7.69E-01 m/d  
Retardation factor Rf 5.67E+00  
Decay rate used λ 3.17E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation u 1.36E-01 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion C<sub>1D</sub> 4.09E-01 mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion C<sub>2D</sub> 3.92E-01 mg/l  
Attenuation factor (one way vertical dispersion, C<sub>1D</sub>/C<sub>0</sub>) AF 1.08E+01  
Attenuation factor (two way vertical dispersion, C<sub>2D</sub>/C<sub>0</sub>) AF 1.12E+01

Remedial Targets

Remedial Target	LTC3	1.20E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	850		m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	4.09E-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 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<sub>d</sub> [ ] l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 5.00E-01 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>oc,r</sub> [ ] l/kg  
Sorption coefficient for ionised species K<sub>oc,i</sub> [ ] l/kg  
pH value pH [ ]  
acid dissociation constant pKa [ ]

Soil water partition coefficient K<sub>d</sub> 5.00E-01 l/kg

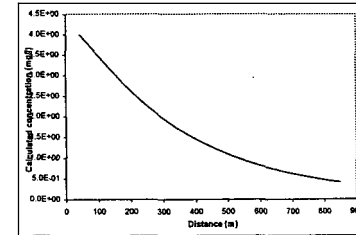
Dispersivity

Calculate dependent on distance to compliance point (0)

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

Longitudinal dispersivity α<sub>x</sub> 1.11E+01 m  
Transverse dispersivity α<sub>z</sub> 1.11E+00 m  
Vertical dispersivity α<sub>y</sub> 1.11E-01 m

For calculated value, assumes α<sub>x</sub> = 0.1 \* λ, α<sub>z</sub> = 0.01 \* λ, α<sub>y</sub> = 0.001 \* λ  
Xu & Eckstein (1995) report α<sub>x</sub> = 0.93(log<sub>10</sub> λ)<sup>0.411</sup>; α<sub>z</sub> = α<sub>x</sub>/10, α<sub>y</sub> = α<sub>z</sub>/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  
Bremsal/Clasificación

mg/l	
42.5	4.0E+00
65.0	3.6E+00
120.0	3.8E+00
212.5	2.6E+00
265.0	2.2E+00
340.0	1.7E+00
382.5	1.6E+00
426.0	1.3E+00
467.5	1.2E+00
610.0	1.1E+00
662.5	9.3E-01
696.0	8.3E-01
711.6	7.3E-01
680.0	6.6E-01
722.5	6.6E-01
765.0	6.2E-01
807.5	4.6E-01
850.0	4.1E-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. 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 6 Res #20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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)

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	$C_0$	7.70E-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	$\lambda$	9.50E-04	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.82E-01	fraction	
Hydraulic gradient	$i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	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	$Kd$	9.12E-01	l/kg	see options
Longitudinal dispersivity	$\alpha_x$	1.111	m	see options
Transverse dispersivity	$\alpha_z$	1.111	m	see options
Vertical dispersivity	$\alpha_y$	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	7.69E-01	m/d
Retardation factor	$Rf$	9.52E+00	fraction
Decay rate used	$\lambda$	9.50E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	8.08E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{E0}$	6.48E-06	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{E0}$	8.21E-06	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ )	$AF$	1.19E+04	
Attenuation factor (two way vertical dispersion, $C_0/C_{E0}$ )	$AF$	1.24E+04	

Remedial Targets

Remedial Target	LTCS	6.49E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	$C_{10}/C_0$	6.48E-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

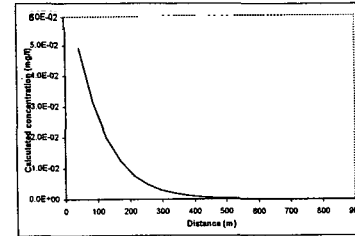
Soil water partition coefficient  $Kd$  9.12E-01 l/kg  
 Fraction of organic carbon in aquifer  $foc$  1.00E+00 fraction  
 Organic carbon partition coefficient  $Koc$  9.12E-01 l/kg  
 Sorption coefficient for related species  $K_{oc}$  l/kg  
 Sorption coefficient for ionized species  $K_{oc+}$  l/kg  
 pH value  $pH$   
 acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  9.12E-01 l/kg

Dispersivity

Calculate dispersivity (1), or calc after Xu & Eckstein (2) ?  
 Longitudinal dispersivity  $\alpha_x$  1.11E+01 m  
 Transverse dispersivity  $\alpha_z$  1.11E+01 m  
 Vertical dispersivity  $\alpha_y$  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  $\alpha_x = 0.83(\log_{10} C)^{0.414}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

	mg/l
42.5	4.9E-02
85.0	3.1E-02
127.5	2.0E-02
170.0	1.2E-02
212.5	7.7E-03
255.0	4.8E-03
297.5	3.0E-03
340.0	1.9E-03
382.5	1.1E-03
425.0	7.1E-04
467.5	4.4E-04
510.0	2.8E-04
552.5	1.7E-04
595.0	1.1E-04
637.5	6.7E-05
680.0	4.2E-05
722.5	2.6E-05
765.0	1.6E-05
807.5	1.0E-05
850.0	6.5E-06

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 9.9E+99.

Site being assessed: Sloss B Res. K20  
 Compiled by: AJ  
 Date: 24/11/2005  
 Version: 12



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) 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 $t_{1/2}$	1.83E+03	days	
Calculated decay rate $\lambda$	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_x$	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 $\rho$	1.70E+01	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance 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 $K_d$	5.75E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.114	m	see options
Transverse dispersivity $\alpha_z$	1.111	m	see options
Vertical dispersivity $\alpha_y$	0.111	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity $v$	7.69E-01	m/d
Retardation factor $R_f$	5.47E+01	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.41E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	1.26E-10	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	1.21E-10	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.68E+08	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	1.76E+08	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	1.20E+05	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	850	m	
Concentration of contaminant at compliance point after $C_{1D}/C_0$	1.26E-10	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.

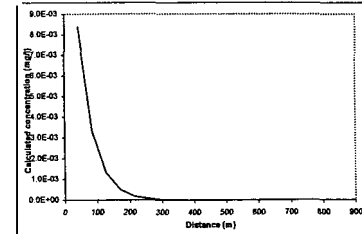
Select Method for deriving Partition Co-efficient (using pull down menu)

Variable	Value	Unit
Soil water partition coefficient $K_d$	5.75E+00	l/kg
Fraction of organic carbon in aquifer $f_{oc}$	1.00E+00	fraction
Organic carbon partition coefficient $K_{oc}$	5.75E+00	l/kg
Soil water partition coefficient $K_d$	5.75E+00	l/kg

Dispersivity

Variable	Value	Unit
Longitudinal dispersivity $\alpha_x$	11.11E+01	m
Transverse dispersivity $\alpha_z$	1.11E+00	m
Vertical dispersivity $\alpha_y$	1.11E-01	m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * z$ ,  $\alpha_y = 0.001 * y$ . Xu & Eckstein (1995) report  $\alpha_x = 0.63(\log_{10} C_0)^{0.4}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed.



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

Distance	Concentration
42.6	8.4E-03
85.0	3.3E-03
127.5	1.3E-03
170.0	5.0E-04
268.0	7.8E-04
297.5	2.9E-05
340.0	1.1E-05
382.5	4.3E-06
426.0	1.6E-06
467.5	6.0E-07
510.0	2.6E-07
552.5	9.6E-08
595.0	3.7E-08
637.5	1.4E-08
680.0	5.0E-09
722.5	1.8E-09
765.0	6.3E-10
807.5	2.3E-10
850.0	8.3E-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: Bless 9 Res. K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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Tier 3 -Groundwater



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

Contaminant Styrene  
Target Concentration C<sub>T</sub> 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 C<sub>0</sub> 9.90E-09 mg/l  
Half life for degradation of contaminant in water t<sub>1/2</sub> 2.10E+02 days  
Calculated decay rate λ 3.30E-03 days<sup>-1</sup>  
Width of plume in aquifer at source (perpendicular to flow) S<sub>Z</sub> 8.00E+01 m  
Plume thickness at source S<sub>y</sub> 5.00E+01 m  
Saturated aquifer thickness d<sub>a</sub> 8.71E+01 m  
Bulk density of aquifer materials ρ 1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer n 1.82E-01 fraction  
Hydraulic gradient i 1.30E-03 fraction  
Hydraulic conductivity of aquifer K 2.00E+01 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

Parameters values determined from options  
Partition coefficient K<sub>d</sub> 4.64E+00 V/kg see options  
Longitudinal dispersivity α<sub>x</sub> 1.1114 m see options  
Transverse dispersivity α<sub>z</sub> 1.111 m see options  
Vertical dispersivity α<sub>y</sub> 0.111 m see options

Calculated Parameters Variable

Groundwater flow velocity v 7.89E-01 m/d  
Retardation factor R<sub>f</sub> 4.43E+01 fraction  
Decay rate used λ 3.30E-03 d<sup>-1</sup>  
Rate of contaminant flow due to retardation u 1.74E-02 m/d  
Contaminant concentration at distance x, assuming one-way vertical dispersion C<sub>1D</sub> 2.18E-133 mg/l  
Contaminant concentration at distance x, assuming two-way vertical dispersion C<sub>2D</sub> 2.09E-133 mg/l  
Attenuation factor (one way vertical dispersion, C<sub>1D</sub>/C<sub>T</sub>) AF 4.54E+34  
Attenuation factor (two way vertical dispersion, C<sub>2D</sub>/C<sub>T</sub>) AF 4.74E+34

Remedial Targets

Remedial Target LTC3 2.27E+35 mg/l For comparison with measured groundwater concentration.  
Ogata Banks  
Distance to compliance point 850 m  
Concentration of contaminant at compliance point C<sub>1D</sub>/C<sub>0</sub> 2.18E-133 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

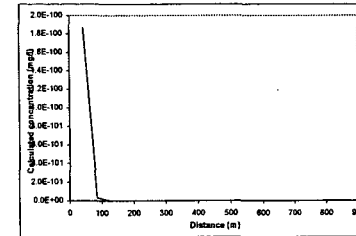
Entry if specify partition coefficient (option)  
Soil water partition coefficient K<sub>d</sub> 4.64E+00 V/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 4.64E+00 V/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow,s</sub> V/kg  
Sorption coefficient for ionised species K<sub>ow,i</sub> V/kg  
pH value pH  
acid dissociation constant pKa

Source of parameter value

Soil water partition coefficient K<sub>d</sub> 4.64E+00 V/kg  
Dispersivity  
Calculate dependent on distance to compliance point (0) 2  
specify dispersivity (1), or calc after Xu & Eckstein (2) ?  
Longitudinal dispersivity α<sub>x</sub> 1.1114 m  
Transverse dispersivity α<sub>z</sub> 1.1114 m  
Vertical dispersivity α<sub>y</sub> 0.111 m

For calculated value, assumes α<sub>x</sub> = 0.1 \* x, α<sub>z</sub> = 0.01 \* x, α<sub>y</sub> = 0.001 \* x  
Xu & Eckstein (1995) report α<sub>x</sub> = 0.83(log<sub>10</sub> x)<sup>0.411</sup>; α<sub>z</sub> = α<sub>x</sub>/10, α<sub>y</sub> = α<sub>x</sub>/100 are assumed

Enter value Calc value Xu & Eckstein  
α<sub>x</sub> 1.1114 m  
α<sub>z</sub> 1.1114 m  
α<sub>y</sub> 0.111 m



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance (m)	Concentration (mg/l)
42.6	1.9E-100
85.0	3.6E-102
127.5	6.6E-104
170.0	1.2E-105
212.5	2.2E-107
255.0	4.1E-109
297.5	7.6E-112
340.0	1.4E-114
382.5	2.6E-116
425.0	4.8E-118
467.5	8.9E-120
510.0	1.6E-121
552.5	2.9E-123
595.0	5.4E-124
637.5	1.0E-124
680.0	1.8E-125
722.5	3.4E-126
765.0	6.3E-127
807.5	1.2E-130
850.0	2.2E-133

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 6 Res 420  
Completed by AJ  
Date 24 11 2005  
Version 12

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

Contaminant 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
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 $\lambda$	3.80E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	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	
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
Partition coefficient $K_d$	8.12E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.114	m	see options
Transverse dispersivity $\alpha_z$	1.111	m	see options
Vertical dispersivity $\alpha_y$	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	7.69E-01	m/d
Retardation factor $Rf$	8.62E+01	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	8.93E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{10}$	3.18E-14	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{20}$	3.04E-14	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{10}$ ) $AF$	6.68E+11	
Attenuation factor (two way vertical dispersion, $C_0/C_{20}$ ) $AF$	6.87E+11	

Remedial Targets

Remedial Target	LECS	4.77E+08	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		860	m	
Concentration of contaminant at compliance point	$C_{EP}/C_0$	3.18E-14	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  $K_d$  8.12E+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  $K_{oc}$  8.12E+00 l/kg

Entry for ionic organic chemicals (option)

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

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

pH value

acid dissociation constant  $pK_a$

Soil water partition coefficient  $K_d$  8.12E+00 l/kg

Dispersivity

Calculate dependant on distance to compliance point (0) 2

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

Longitudinal dispersivity  $\alpha_x$  Enter value Calc value Xu & Eckstein 1.11E+01 m

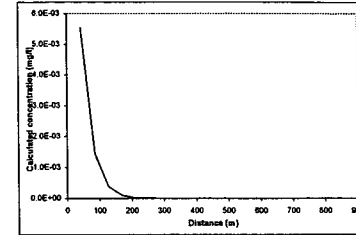
Transverse dispersivity  $\alpha_z$  1.11E+00 m

Vertical dispersivity  $\alpha_y$  1.11E-01 m

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

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

time variant options only



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

426	5.6E-03
860	1.9E-03
1700	8.8E-05
2650	8.2E-06
297.5	1.6E-06
340.0	4.0E-07
382.5	1.0E-07
426.0	2.6E-08
467.5	6.7E-09
610.0	1.7E-09
658.0	4.3E-10
677.5	2.8E-11
680.0	7.3E-12
722.5	1.9E-12
765.0	4.8E-13
807.6	1.2E-13
850.0	3.2E-14

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+09.

Site being assessed: Bless 6 Res K20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

Tier 3 - Groundwater

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

Contaminant 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 $C_0$	2.12E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	1.93E+03	days	
Calculated decay rate $\lambda$	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_z$	8.00E+01	m	
Plume thickness at source $S_y$	5.90E+01	m	
Saturated aquifer thickness $d_a$	5.71E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	8.50E+02	m	
Distance (laterally) 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 $K_d$	1.82E+01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	1.1114	m	see options
Transverse dispersivity $\alpha_z$	1.111	m	see options
Vertical dispersivity $\alpha_y$	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	7.89E-01	m/d
Retardation factor $R_f$	1.71E+02	fraction
Decay rate used $\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.50E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	3.45E-22	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	3.31E-22	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	8.14E+19	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	8.40E+19	

Remedial Targets

Remedial Target	LTC3	4.38E+18	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	3.45E-22	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)

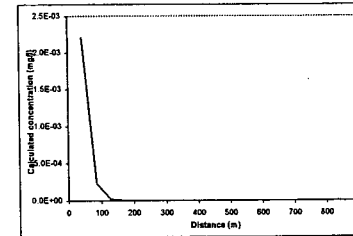
Calculate for non-polar organic chemicals

Entry if specific partition coefficient (option)	$K_d$		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	$f_{oc}$		
Organic carbon partition coefficient	$K_{oc}$	1.82E+01	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+01	l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	$\alpha_x$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	$\alpha_z$		1.11E+01 m
Vertical dispersivity	$\alpha_y$		1.11E-01 m

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

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  
From calculation sheet

Distance	Concentration
	mg/l
42.5	2.2E-03
85.0	2.3E-04
127.5	2.4E-05
170.0	2.5E-06
212.5	2.5E-07
255.0	2.5E-08
297.5	2.5E-09
340.0	2.5E-10
382.5	2.7E-11
425.0	2.7E-12

667.5	2.8E-14
662.5	2.9E-16
698.0	1.0E-16
637.5	3.0E-17

828.6	3.2E-19
795.0	3.3E-20
807.5	3.4E-21
960.0	3.5E-22

Site being assessed: Boss 9 Res 420  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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

Tier 3 - Groundwater

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

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant	Aromatic C16-C21	7.14E-04	mg/l	
Target Concentration	C <sub>T</sub>	7.14E-04	mg/l	

Select analytical solution (click on brown cell below, then on pull-down menu) **Equations in RAD Pub. 20**

**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 **2.17E-02** mg/l

Half life for degradation of contaminant in water **3.66E+03** days

Calculated decay rate **1.90E-04** days<sup>-1</sup>

Width of plume in aquifer at source (perpendicular to flow) **8.00E+01** m

Plume thickness at source **5.00E+01** m

Saturated aquifer thickness **5.17E+01** m

Bulk density of aquifer materials **1.72E+01** g/cm<sup>3</sup>

Hydraulic gradient **1.70E-03**

Hydraulic conductivity of aquifer **2.00E+01** m/d

Distance to compliance point **8.00E+02** m

Distance (later) to compliance point perpendicular to flow direction **1.00E+00** m

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

Parameters values determined from options **1**

Three axes pointing defined from options **1**

Partition coefficient **5.75E+01** see options

Longitudinal dispersivity **1.11E+01** m see options

Transverse dispersivity **1.11E+01** m see options

Vertical dispersivity **0.111** m see options

Groundwater flow velocity **7.89E-01** m/d

Retardation factor **5.38E+02** fraction

Decay rate used **1.80E-04** d<sup>-1</sup>

Rate of contaminant flow due to retardation **1.43E-03** m/d

Contaminant concentration at distance x, assuming one-way vertical dispersion **1.23E-29** mg/l

Admission factor (one way vertical dispersion, C<sub>0</sub>C<sub>0</sub>) **1.73E-27** mg/l

Admission factor (two way vertical dispersion, C<sub>0</sub>C<sub>0</sub>) **1.80E-27** mg/l

Remedial Target **1.23E-29** mg/l

Distance to compliance point **880** m

Concentration of contaminant at compliance point **1.23E-29** mg/l

after **9.8E+99** days

Ogata Banks

Ogata Banks

Remedial Targets

For comparison with measured groundwater concentration.

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

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

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 **2.17E-02** mg/l

Half life for degradation of contaminant in water **3.66E+03** days

Calculated decay rate **1.90E-04** days<sup>-1</sup>

Width of plume in aquifer at source (perpendicular to flow) **8.00E+01** m

Plume thickness at source **5.00E+01** m

Saturated aquifer thickness **5.17E+01** m

Bulk density of aquifer materials **1.72E+01** g/cm<sup>3</sup>

Hydraulic gradient **1.70E-03**

Hydraulic conductivity of aquifer **2.00E+01** m/d

Distance to compliance point **8.00E+02** m

Distance (later) to compliance point perpendicular to flow direction **1.00E+00** m

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

Parameters values determined from options **1**

Three axes pointing defined from options **1**

Partition coefficient **5.75E+01** see options

Longitudinal dispersivity **1.11E+01** m see options

Transverse dispersivity **1.11E+01** m see options

Vertical dispersivity **0.111** m see options

Groundwater flow velocity **7.89E-01** m/d

Retardation factor **5.38E+02** fraction

Decay rate used **1.80E-04** d<sup>-1</sup>

Rate of contaminant flow due to retardation **1.43E-03** m/d

Contaminant concentration at distance x, assuming one-way vertical dispersion **1.23E-29** mg/l

Admission factor (one way vertical dispersion, C<sub>0</sub>C<sub>0</sub>) **1.73E-27** mg/l

Admission factor (two way vertical dispersion, C<sub>0</sub>C<sub>0</sub>) **1.80E-27** mg/l

Remedial Target **1.23E-29** mg/l

Distance to compliance point **880** m

Concentration of contaminant at compliance point **1.23E-29** mg/l

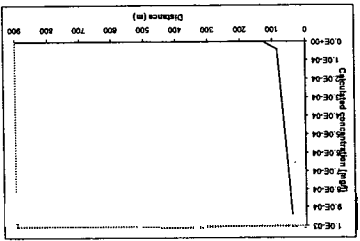
after **9.8E+99** days

Ogata Banks

Ogata Banks

Remedial Targets

For comparison with measured groundwater 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 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 (m)	Concentration (mg/l)
0	0.00E+00
100	0.00E+00
200	0.00E+00
300	0.00E+00
400	0.00E+00
500	0.00E+00
600	0.00E+00
700	0.00E+00
800	0.00E+00
880	9.4E-04
900	9.4E-04

Ogata Banks

From calculation sheet

Distance (m)	Concentration (mg/l)
0	0.00E+00
100	0.00E+00
200	0.00E+00
300	0.00E+00
400	0.00E+00
500	0.00E+00
600	0.00E+00
700	0.00E+00
800	0.00E+00
880	9.4E-04
900	9.4E-04

Site being assessed: **Bices B Res A2D**

Completed by: **AJ**

Date: **24 11 2005**

Version: **12**

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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 C<sub>T</sub> 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 <sub>0</sub>	2.12E-02	mg/l	
Half life for degradation of contaminant in water t <sub>1/2</sub>	3.65E+03	days	
Calculated decay rate λ	1.90E-04	days <sup>-1</sup>	
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+01	g/cm <sup>3</sup>	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	9.700E-03	fraction	
Hydraulic conductivity of aquifer K	2.00E+01	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
Partition coefficient Kd	4.57E+02	l/kg	see options
Longitudinal dispersivity α <sub>x</sub>	11.114	m	see options
Transverse dispersivity α <sub>z</sub>	1.111	m	see options
Vertical dispersivity α <sub>y</sub>	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	7.69E-01	m/d
Retardation factor Rf	4.27E+03	fraction
Decay rate used λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation u	1.80E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C <sub>D</sub>	7.09E-101	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C <sub>D2</sub>	6.80E-101	mg/l
Attenuation factor (one way vertical dispersion, C <sub>D</sub> /C <sub>T</sub> ) AF	2.99E+98	
Attenuation factor (two way vertical dispersion, C <sub>D2</sub> /C <sub>T</sub> ) AF	3.12E+98	

Remedial Targets

Remedial Target LYC3	2.12E+05	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	850	m	
Concentration of contaminant at compliance point after C <sub>D</sub> /C <sub>0</sub>	7.09E-101	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 4.57E+02 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 4.57E+02 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub> l/kg  
Sorption coefficient for ionised species K<sub>ow,i</sub> l/kg  
pH value  
acid dissociation constant pKa

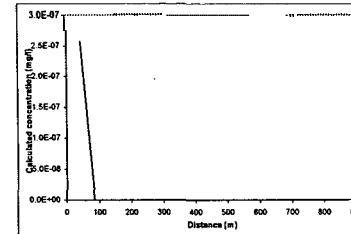
Soil water partition coefficient Kd 4.57E+02 l/kg

Dispersivity

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

Longitudinal dispersivity α<sub>x</sub> 1.11E+01 m  
Transverse dispersivity α<sub>z</sub> 1.11E+00 m  
Vertical dispersivity α<sub>y</sub> 1.11E-01 m

For calculated value, assumes α<sub>x</sub> = 0.1 \* x, α<sub>z</sub> = 0.01 \* z, α<sub>y</sub> = 0.001 \* y  
Xu & Eckstein (1995) report α<sub>x</sub> = 0.83(log<sub>10</sub>α<sub>x</sub>)<sup>0.75</sup>; α<sub>z</sub> = α<sub>x</sub>/10, α<sub>y</sub> = α<sub>x</sub>/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet  
Distance Concentration

	mg/l
42.5	2.6E-07
85.0	3.1E-12
127.5	3.8E-17
170.0	4.6E-22
212.6	6.3E-27
255.0	8.3E-32
W7.5	7.4E-37
342.8	8.9E-44
425.0	1.2E-51
510.0	1.6E-56
552.5	2.1E-60
596.0	2.6E-71
917.6	2.9E-76
850.0	3.5E-81
788.0	4.9E-94
807.6	5.9E-96
850.0	7.1E-101

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 6 Res K20  
Completed by: AJ  
Date: 24.11.2005  
Version: 12

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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	Arsenic		
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, '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	$9.90E-09$	mg/l	
Half life for degradation of contaminant in water	$9.90E-09$	days	
Calculated decay rate	$7.00E-101$	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	$8.00E+03$	m	
Plume thickness at source	$5.80E+01$	m	
Saturated aquifer thickness	$5.71E+01$	m	
Bulk density of aquifer materials	$1.70E+00$	g/cm <sup>3</sup>	
Effective porosity of aquifer	$1.82E-01$	fraction	
Hydraulic gradient	$7.00E-03$	fraction	
Hydraulic conductivity of aquifer	$2.00E+01$	m/d	
Distance to compliance point	$8.50E+02$	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	time variant options only
Parameters values determined from options			
Partition coefficient	$1.17E+02$	l/kg	see options
Longitudinal dispersivity	11.114	m	see options
Transverse dispersivity	1.111	m	see options
Vertical dispersivity	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$7.69E-01$	m/d
Retardation factor	$1.10E+03$	fraction
Decay rate used	$7.00E-101$	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$7.00E-04$	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$6.36E-09$	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$6.10E-09$	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1</sub> /C <sub>0</sub> )	1.56E+00	
Attenuation factor (two way vertical dispersion, C <sub>2</sub> /C <sub>0</sub> )	1.42E+00	

Remedial Targets

Remedial Target	$1.00E-02$	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	850	m	
Concentration of contaminant at compliance point	$6.36E-09$	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

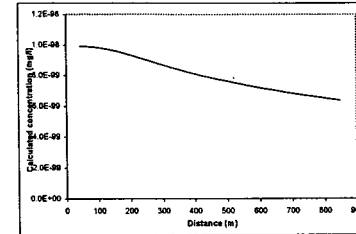
Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	$1.17E+02$ l/kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	$1.00E+00$ fraction
Organic carbon partition coefficient	Koc	$1.17E+02$ l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K <sub>ow</sub>	$1.17E+02$ l/kg
Sorption coefficient for ionised species	K <sub>oc</sub>	$1.17E+02$ l/kg
pH value	pH	
acid dissociation constant	pKa	
Soil water partition coefficient	Kd	$1.17E+02$ l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)		
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 = 0.63(log<sub>10</sub>ax)<sup>0.414</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration
	mg/l
42.5	$9.9E-09$
85.0	$9.9E-09$
127.5	$9.7E-09$
170.0	$9.5E-09$
212.5	$9.2E-09$
255.0	$8.7E-09$
297.5	$8.2E-09$
340.0	$7.8E-09$
382.5	$7.4E-09$
425.0	$7.0E-09$
467.5	$6.6E-09$
510.0	$6.2E-09$
552.5	$5.8E-09$
595.0	$5.4E-09$
637.5	$5.0E-09$
680.0	$4.6E-09$
722.5	$4.2E-09$
765.0	$3.8E-09$
807.5	$3.4E-09$
850.0	$3.0E-09$

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 6 Res #20
Completed by	AJ
Date	24 11 2005
Version	12



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	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)

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 $t_{1/2}$	7.20E+02	days	
Calculated decay rate $\lambda$	9.63E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	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 $t$	9.00E+09	days	time variant options only
<i>Parameters values determined from options</i>			
Partition coefficient $K_d$	2.14E-01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.114	m	see options
Transverse dispersivity $\alpha_z$	1.111	m	see options
Vertical dispersivity $\alpha_y$	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	7.69E-01	m/d
Retardation factor $R_f$	3.00E+00	fraction
Decay rate used $\lambda$	9.83E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	2.57E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion $C_{10}$	2.97E-100	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion $C_{20}$	2.84E-100	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{10}$ ) $AF$	3.34E+01	
Attenuation factor (two way vertical dispersion, $C_0/C_{20}$ ) $AF$	3.48E+01	

Remedial Targets

Remedial Target	TC3	3.34E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point	860	m		
Concentration of contaminant at compliance point	$C_{10}/C_0$	2.97E-100	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.

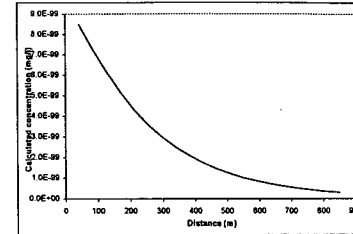
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)  
Soil water partition coefficient  $K_d$  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  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{oc}$  l/kg  
pH value  $pH$   
acid dissociation constant  $pK_a$

Soil water partition coefficient  $K_d$  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  $\alpha_x$  11.11E+01 m  
Transverse dispersivity  $\alpha_z$  1.11E+00 m  
Vertical dispersivity  $\alpha_y$  1.11E-01 m

For calculated value, assumes  $\alpha_x = 0.1 \times z$ ,  $\alpha_z = 0.01 \times z$ ,  $\alpha_y = 0.001 \times z$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} t)^{0.11}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_z/100$  are assumed



Calculated concentrations for distance-concentration graph

Options  
From calculation sheet  
Distance Concentration

Distance	Concentration
42.5	8.6E-09
86.0	7.3E-09
127.5	6.1E-09
170.0	6.2E-09
212.5	4.3E-09
255.0	3.6E-09
297.5	3.0E-09
340.0	2.5E-09
382.5	2.1E-09
425.0	1.7E-09
467.5	1.4E-09
610.0	1.2E-09
662.5	1.0E-09
696.0	8.4E-100
837.5	7.1E-100
880.0	6.9E-100
722.5	6.0E-100
765.0	4.2E-100
807.5	3.6E-100
850.0	3.0E-100

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+09.

Site being assessed: Bless B Res #20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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:  $C_r$  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

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) 1

Initial contaminant concentration in plume core  $C_0$  1.00E-01 mg/l  
Half life for degradation of contaminant in water  $t_{1/2}$  9.90E+99 days  
Calculated decay rate  $\lambda$  7.00E-101 days<sup>-1</sup>  
Width of plume in aquifer at source (perpendicular to flow)  
Plume thickness at source  $S_y$  5.60E+01 m  
Saturated aquifer thickness  $d_a$  5.71E+01 m  
Bulk density of aquifer materials  $\rho$  1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-012  
Hydraulic gradient  $i$  7.00E-033  
Hydraulic conductivity of aquifer  $K$  2.00E+01 m/d  
Distance to compliance point  $x$  8.50E+02 m  
Distance (lateral) to compliance point perpendicular to flow direction  $z$  0.00E+000 m  
Distance (depth) to compliance point perpendicular to flow direction  $y$  0.00E+000 m  
Time since pollutant entered groundwater  $t$  9.90E+99 days

Parameters values determined from options  
Partition coefficient  $K_d$  0.00E+00 l/kg  
Longitudinal dispersivity  $\alpha_x$  11.114 m  
Transverse dispersivity  $\alpha_z$  1.111 m  
Vertical dispersivity  $\alpha_y$  0.111 m

Calculated Parameters Variable

Groundwater flow velocity  $v$  7.69E-01 m/d  
Retardation factor  $Rf$  1.00E+00  
Decay rate used  $\lambda$  7.00E-101 d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $u$  7.69E-01 m/d  
Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{2D}$  6.43E-02 mg/l  
Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{3D}$  8.16E-02 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  1.56E+00  
Attenuation factor (two way vertical dispersion,  $C_0/C_{3D}$ )  $AF$  1.82E+00

Remedial Targets  
Remedial Target: LTC3 1.54E+00 mg/l For comparison with measured groundwater concentration.  
Ogata Banks

Distance to compliance point 850 m  
Concentration of contaminant at compliance point  $C_{2D}/C_0$  6.43E-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  $K_d$  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  $K_{oc}$  0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  l/kg  
pH value  $pH$   
acid dissociation constant  $pK_a$

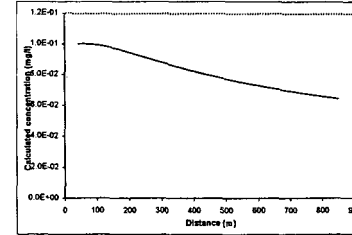
Soil water partition coefficient  $K_d$  0.00E+00 l/kg

Dispersivity

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

Longitudinal dispersivity  $\alpha_x$  1.11E+01 m  
Transverse dispersivity  $\alpha_z$  1.11E+00 m  
Vertical dispersivity  $\alpha_y$  1.11E-01 m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * z$ ,  $\alpha_y = 0.001 * y$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} v)^{0.41}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
42.5	1.0E-01
85.0	1.0E-01
127.6	9.8E-02
170.0	9.6E-02
212.6	9.3E-02
266.0	9.1E-02
297.6	8.8E-02
340.0	8.6E-02
382.6	8.3E-02
426.0	8.1E-02
487.5	7.9E-02
610.0	7.7E-02
662.6	7.6E-02
696.0	7.5E-02
637.6	7.1E-02
680.0	7.0E-02
722.6	6.8E-02
765.0	6.7E-02
808.0	6.6E-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: Bess & Res 420  
Completed by: AJ  
Date: 24.11.2005  
Version: 12

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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

Chlorobenzene C<sub>p</sub> 1.00E-03 mg/l Target Concentration

Equations in RAD Pkg. 20

nr 1 to simulate vertical dispersion in one direction, "Z" for two directions (pull down menu)

Enter "1" if degradation rate is for the substance in water.

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

Initial contaminant concentration in groundwater at plume core

Half life for degradation of contaminant in water

Width of plume in aquifer (perpendicular to flow)

Saline thickness at source

Dike density of aquifer materials

Effective porosity of aquifer

Hydraulic gradient

Distance (later) to compliance point perpendicular to flow direction

Distance (depth) to compliance point perpendicular to flow direction

Three source plumes entered from options

Parameters values determined from options

Partition coefficient

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

Groundwater flow velocity

Retardation factor

Decay rate used

Rate of contaminant flow due to retardation

Contaminant concentration at distance x, assuming one-way vertical dispersion

Contaminant concentration at distance x, assuming two-way vertical dispersion

Attenuation factor (one way vertical dispersion, C<sub>p</sub>/C<sub>0</sub>)

Attenuation factor (two way vertical dispersion, C<sub>p</sub>/C<sub>0</sub>)

Remedial Target LCOS 6.19E+04 mg/l

Distance to compliance point 860 m

Concentration of contaminant at compliance point C<sub>p</sub>/C<sub>0</sub> 1.81E-106 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 Coefficient (using pull down menu)

Calculate for non-polar organic chemicals

Entry for non-polar organic chemicals (option)

Soil water partition coefficient

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer

Organic carbon partition coefficient

Entry for non-polar organic chemicals (option)

Sorption coefficient for related species

Entry for non-polar organic chemicals (option)

Sorption coefficient for related species

acid dissociation constant

pH value

Soil water partition coefficient

Dispersivity

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

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

For calculated value, assumes ac = 0.1 %, ac = 0.01 %, ac = 0.001 %

Xu & Eckstein (1995) report ac = 0.23(log<sub>10</sub> ac = ac - ac(0.99) = ac(100 are assumed

Enter value Calc value Xu & Eckstein

Longitudinal dispersivity 1.11E+01 m

Transverse dispersivity 1.11E+00 m

Vertical dispersivity 1.11E-01 m

Partition coefficient 7.94E-01

Longitudinal dispersivity 1.1114 m see options

Transverse dispersivity 1.1111 m see options

Vertical dispersivity 0.1111 m see options

Variable

Calculated Parameters

Remedial Target LCOS 6.19E+04 mg/l

For comparison with measured groundwater concentration.

Distance to compliance point 860 m

Concentration of contaminant at compliance point C<sub>p</sub>/C<sub>0</sub> 1.81E-106 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.



Calculated concentrations for distance-concentration graph

From calculation sheet

Distance Concentration

42.5 4.1E-99

86.0 1.7E-99

170.0 2.1E-100

212.5 1.2E-100

279.5 1.9E-101

340.0 7.7E-102

425.0 1.3E-102

487.5 6.2E-103

562.5 8.6E-104

622.5 9.6E-104

680.0 6.8E-105

722.5 2.4E-105

768.0 9.8E-106

807.5 3.9E-106

850.0 1.8E-106

Note: graph assumes plume disperses vertically in one direction only. An

asymmetric solution assuming the centre of the plume is located at the mid-

depth of the aquifer is presented in the calculation sheets.

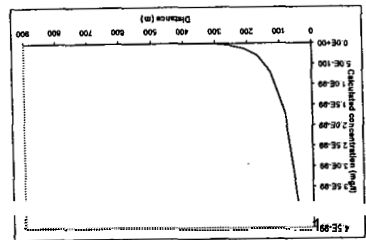
By setting a long travel time it will give the steady state solution, which should

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.



Enter value Calc value Xu & Eckstein

Longitudinal dispersivity 1.11E+01 m

Transverse dispersivity 1.11E+00 m

Vertical dispersivity 1.11E-01 m

Partition coefficient 7.94E-01

Longitudinal dispersivity 1.1114 m see options

Transverse dispersivity 1.1111 m see options

Vertical dispersivity 0.1111 m see options

Variable

Calculated Parameters

Remedial Target LCOS 6.19E+04 mg/l

For comparison with measured groundwater concentration.

Distance to compliance point 860 m

Concentration of contaminant at compliance point C<sub>p</sub>/C<sub>0</sub> 1.81E-106 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.

Completed by: AL

Date: 26 11 2005

Version: 12

Site being assessed: Bivy 5 Res K20

Project: 26 11 2005

Version: 12

Completed by: AL

Date: 26 11 2005

Version: 12

Site being assessed: Bivy 5 Res K20

Project: 26 11 2005

Version: 12

Completed by: AL

Date: 26 11 2005

Version: 12

Site being assessed: Bivy 5 Res K20

Tier 3 -Groundwater



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

Contaminant Chloroethane  
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)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core $C_0$	4.00E-02	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	5.60E+01	days	
Calculated decay rate $\lambda$	1.24E-02	days <sup>-1</sup>	
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 $d_a$	5.21E+01	m	
Bulk density of aquifer materials $\rho$	2.170E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	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 $K_d$	6.46E-02	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.114	m	see options
Transverse dispersivity $\alpha_z$	1.111	m	see options
Vertical dispersivity $\alpha_y$	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	7.89E-01	m/d
Retardation factor $R_f$	1.60E+00	fraction
Decay rate used $\lambda$	1.24E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.80E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{E0}$	4.81E-10	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{E2}$	4.81E-10	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ ) $AF$	8.31E+07	
Attenuation factor (two way vertical dispersion, $C_0/C_{E2}$ ) $AF$	8.87E+07	

Remedial Targets

Remedial Target LYC3	6.39E+04	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	880	m	
Concentration of contaminant at compliance point after	4.81E-10	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)

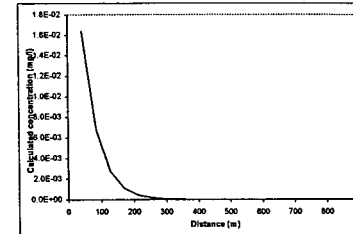
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option) $K_d$		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 $K_{oc}$	6.46E-02	l/kg
Entry for ionic organic chemicals (option) $K_{ow}$		
Sorption coefficient for related species		
Sorption coefficient for ionised species $K_{ow}$		l/kg
pH value		
acid dissociation constant $pK_a$		
Soil water partition coefficient $K_d$	6.46E-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 $\alpha_x$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity $\alpha_z$		1.11E+01 m
Vertical dispersivity $\alpha_y$		1.11E-01 m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * z$ ,  $\alpha_y = 0.001 * y$ . Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} C_0)^{0.41}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

From Banketion sheet

Distance Concentration

	mg/l
42.6	1.6E-02
86.0	4.7E-03
129.6	2.7E-03
212.6	4.4E-04
298.6	1.0E-04
340.0	2.8E-05
382.6	1.1E-05
425.0	4.4E-06
467.5	1.6E-06
610.0	7.1E-07
662.6	2.8E-07
637.6	4.5E-08
688.6	7.8E-09
766.0	3.0E-09
807.6	1.2E-09
850.0	4.8E-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. 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 Appeal  
Completed by: Anna Jeffcock  
Date: #####  
Version: 11

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

Tier 3 - Groundwater

Input Parameters (using pull down menu), Z for two directions (pull down menu)

Contaminant: Ethylbenzene  
 Target Concentration: 1.00E+02 mg/l

Ogata Banks  
 Equations in RAD Pub. 20

1

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

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

Half life for degradation of contaminant in water

Calculation decay rate

Width of plume in aquifer at source (perpendicular to flow)

Pore thickness at source

Saturated aquifer thickness

Bulk density of aquifer materials

Effective porosity of aquifer

Hydraulic gradient

Hydraulic conductivity of aquifer

Distance to compliance point

Distance (depth) to compliance point perpendicular to flow direction

Time since plume entered groundwater

Parameters values determined from options

Partition coefficient

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

Groundwater flow velocity

Retardation factor

Decay rate used

Rate of contaminant flow rate to retardation

Contaminant concentration at distance x, assuming one-way vertical dispersion

Attenuation factor (one way vertical dispersion, C<sub>p</sub>/C<sub>0</sub>)

Attenuation factor (two way vertical dispersion, C<sub>p</sub>/C<sub>0</sub>)

Remedial Target: 1.00E+02 mg/l

Ogata Banks

Distance to compliance point

Concentration of contaminant at compliance point

after

9.9E+99 days

C<sub>p</sub>/C<sub>0</sub> 1.16E-12

mg/l

1.11E-12

8.91E+13

AF

8.98E+13

AF

8.98E+13

8.98E+13

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.

For comparison with measured groundwater concentration.

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

Calculate for non-polar organic chemicals

Entry H specific partition coefficient (option)

Entry for non-polar organic chemicals (option)

Entry for non-polar organic chemicals (option)

Organic carbon partition coefficient

Entry for toxic organic chemicals (option)

Sorption coefficient for related species

Sorption coefficient for related species

pKa

pH value

acid dissociation constant

Soil water partition coefficient

Dispersivity

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

Enter value Calc value Xu & Eckstein

ax 1.11E+01

ay 1.11E+01

Vertical dispersivity

Transverse dispersivity

Longitudinal dispersivity

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

Xu & Eckstein (1995) report ax = 0.1 %, az = 0.01 %, ay = 0.001 %

1.32E+00

1.32E+00

1.32E+00

1.32E+00

1.32E+00

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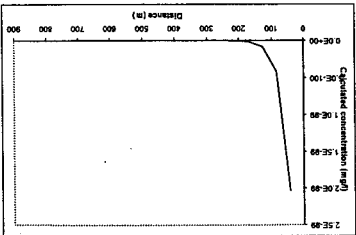
1.32E+00

1.32E+00

1.32E+00

1.32E+00

1.32E+00



ENVIRONMENTAL AGENCY

From calculation sheet

Distance Concentration

42.5

2.0E-99

85.0

4.2E-100

177.5

8.5E-101

170.0

1.7E-101

212.5

3.4E-102

256.0

6.0E-103

297.5

1.4E-103

340.0

2.7E-104

382.5

6.4E-105

425.0

1.1E-105

467.5

2.2E-106

610.0

4.3E-107

652.5

8.7E-108

695.0

1.7E-108

737.5

3.5E-109

780.0

7.0E-110

822.5

1.4E-110

865.0

2.9E-111

907.5

6.3E-112

950.0

1.2E-112

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 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: Shyvs 6 Rec K20  
 Completed by: AU  
 Date: 24 11 2005  
 Version: 12

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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 Isopropylbenzene  
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 $t_{1/2}$	7.20E+02	days	
Calculated decay rate $\lambda$	9.63E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (lateral) 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	time variant options only
Partition coefficient $Kd$	2.14E-01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.114	m	see options
Transverse dispersivity $\alpha_z$	1.111	m	see options
Vertical dispersivity $\alpha_y$	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	7.68E-01	m/d
Retardation factor $Rf$	3.00E+00	fraction
Decay rate used $\lambda$	9.63E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	2.57E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	2.87E-100	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	2.84E-100	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	3.34E+01	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	3.48E+01	

Remedial Targets

Remedial Target	LYCS	3.34E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		860	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	2.87E-100	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  $Kd$  2.14E-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  $Koc$  2.14E-01 l/kg

Entry for ionic organic chemicals (option)

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

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

pH value

acid dissociation constant  $pKa$

Soil water partition coefficient  $Kd$  2.14E-01 l/kg

Dispersivity

Calculate dependant on distance to compliance point (0)

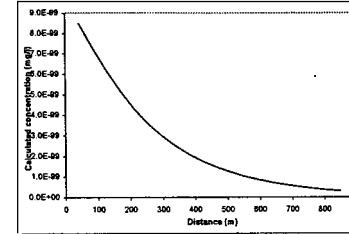
specify dispersivity (1), or calc after Xu & Eckstein (2) ? 2

Longitudinal dispersivity  $\alpha_x$  Enter value Calc value Xu & Eckstein 1.11E+01 m

Transverse dispersivity  $\alpha_z$  1.11E+00 m

Vertical dispersivity  $\alpha_y$  1.11E-01 m

For calculated value, assumes  $\alpha_x = 0.1 * x$ ,  $\alpha_z = 0.01 * z$ ,  $\alpha_y = 0.001 * y$   
Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} t)^{0.11}$ ;  $\alpha_z = \alpha_z10$ ,  $\alpha_y = \alpha_y100$  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-Concentration

Distance (m)	Concentration (mg/l)
42.6	8.6E-99
86.0	7.3E-99
127.6	6.1E-99
170.0	5.2E-99
212.6	4.1E-99
255.0	3.6E-99
297.5	3.0E-99
340.0	2.6E-99

382.0	2.2E-99
425.0	1.7E-99
467.6	1.4E-99
510.0	1.2E-99
562.6	1.0E-99
605.0	8.4E-100
647.6	7.1E-100

689.6	6.0E-100
732.0	4.2E-100
780.6	3.5E-100
807.5	3.0E-100

Site being assessed: Bess 6 Res A20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12



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 <sub>T</sub>	1.00E-03	mg/l	

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)	1	Equations in R&D Pub. 20
---	---	--------------------------

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	9.90E-09	mg/l	
Half life for degradation of contaminant in water	9.99E+99	days	
Calculated decay rate	6.94E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	8.00E+01	m	
Plume thickness at source	5.60E+01	m	
Saturated aquifer thickness	5.71E+00	m	
Bulk density of aquifer materials	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	1.82E-01	fraction	
Hydraulic gradient	7.00E-03	fraction	
Hydraulic conductivity of aquifer	2.00E+01	m/d	
Distance to compliance point	8.50E+02	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	Time variant options only
Partition coefficient	8.91E+00	l/kg	see options
Longitudinal dispersivity	11.114	m	see options
Transverse dispersivity	1.111	m	see options
Vertical dispersivity	0.111	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	7.69E-01	m/d
Retardation factor	8.42E+01	fraction
Decay rate used	8.94E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	9.13E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	6.36E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	6.10E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>T</sub> )	1.56E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>T</sub> )	1.82E+00	

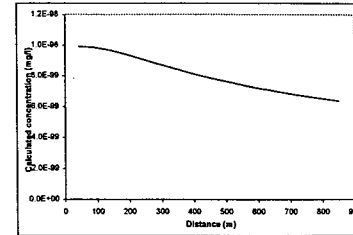
Remedial Targets

Remedial Target	1.00E-03	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	850	m	
Concentration of contaminant at compliance point	6.36E-09	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)

Method	Value	Unit
Calculate for non-polar organic chemicals	8.91E+00	l/kg
Soil water partition coefficient		l/kg
Fraction of organic carbon in aquifer	1.00E+00	fraction
Organic carbon partition coefficient	8.91E+00	l/kg
Soil water partition coefficient	8.91E+00	l/kg
Longitudinal dispersivity	11.114	m
Transverse dispersivity	1.111	m
Vertical dispersivity	0.111	m



Calculated concentrations for distance-concentration graph

Distance-Concentration sheet

Distance	Concentration
42.6	8.5E-09
85.0	9.9E-09
127.6	9.7E-09
170.0	1.5E-09
212.6	9.2E-09
255.0	8.0E-09
217.6	8.7E-09
340.0	8.5E-09
426.0	8.0E-09
487.6	7.8E-09
610.0	7.6E-09
662.6	7.4E-09
696.0	7.2E-09
717.6	7.0E-09
680.0	6.9E-09
722.6	6.7E-09
745.0	6.6E-09
607.6	6.6E-09
850.0	6.4E-09

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 6 Res #20
Completed by	AJ
Date	24 11 2005
Version	17



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-03 mg/l Naphthalene

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 $t_{1/2}$	2.55E+02	days	
Calculated decay rate $\lambda$	2.69E-03	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	7.00E-03	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	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 $K_d$	7.24E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.114	m	see options
Transverse dispersivity $\alpha_z$	1.111	m	see options
Vertical dispersivity $\alpha_y$	0.111	m	see options

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)  $K_d$  7.24E+00 l/kg  
 Soil water partition coefficient  $K_d$  7.24E+00 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  $K_{oc}$  7.24E+00 l/kg  
 Entry for ionic organic chemicals (option)  $K_{oc}$  7.24E+00 l/kg  
 Sorption coefficient for related species  $K_{oc}$  7.24E+00 l/kg  
 Sorption coefficient for ionised species  $K_{oc}$  7.24E+00 l/kg  
 pH value  $pH$   
 acid dissociation constant  $pK_a$

Soil water partition coefficient  $K_d$  7.24E+00 l/kg  
 Dispersivity  
 Calculate dependant on distance to compliance point (0) 2  
 specify dispersivity (1), or calc after Xu & Eckstein (2) ?  
 Longitudinal dispersivity  $\alpha_x$  11.114 m  
 Transverse dispersivity  $\alpha_z$  1.111 m  
 Vertical dispersivity  $\alpha_y$  0.111 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  $\alpha_x = 0.83(\log_{10} t)^{0.411}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

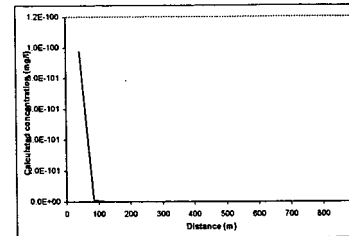
Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity $v$	7.68E-01	m/d
Retardation factor $Rf$	6.87E+01	fraction
Decay rate used $\lambda$	2.69E-03	days <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.12E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	5.04E-139	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	4.83E-139	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	1.96E+40	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	2.05E+40	

Remedial Targets

Remedial Target	LYCS	Value	Unit	Source
Ogata Banks		1.96E+37	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	5.04E-139	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.



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 (mg/l)
42.5	9.8E-101
85.0	9.6E-103
127.6	9.4E-105
170.0	9.1E-107
212.5	8.7E-109
255.0	8.4E-111
297.5	8.0E-113
340.0	7.7E-115
382.5	7.4E-117
425.0	7.1E-119
467.5	6.8E-121
510.0	6.6E-123
552.5	6.4E-125
595.0	6.1E-127
637.5	5.9E-129
680.0	5.6E-131
722.5	5.4E-133
765.0	5.2E-135
807.5	5.0E-137
850.0	4.8E-139

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 6 Res R20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

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<sub>T</sub> 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
Initial contaminant concentration in groundwater at plume core C <sub>0</sub>	9.90E-09	mg/l	
Half life for degradation of contaminant in water t <sub>1/2</sub>	1.00E+01	days	
Calculated decay rate λ	6.93E-02	days <sup>-1</sup>	
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 <sup>3</sup>	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	7.00E-03	fraction	
Hydraulic conductivity of aquifer K	2.00E+01	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	1.05E-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	7.69E-01	m/d
Retardation factor Rf	1.88E+00	fraction
Decay rate used λ	6.93E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation u	3.89E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C <sub>1D</sub>	6.33E-132	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C <sub>2D</sub>	6.07E-132	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> ) AF	1.56E+33	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> ) AF	1.63E+33	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	7.82E+20	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	850	m	
Concentration of contaminant at compliance point after C <sub>1D</sub> /C <sub>0</sub>	6.33E-132	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 1.05E-01 l/kg  
Soil water partition coefficient Kd 1.05E-01 l/kg  
Entry for non-polar organic chemicals (option) f<sub>oc</sub> 1.00E+00 fraction  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 1.05E-01 l/kg  
Entry for ionic organic chemicals (option) K<sub>ow</sub> l/kg  
Sorption coefficient for related species K<sub>ow</sub> l/kg  
Sorption coefficient for ionised species K<sub>ow</sub> l/kg  
pH value pHKa  
acid dissociation constant pHKa

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

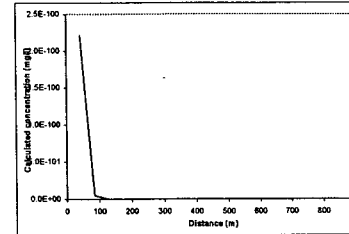
Dispersivity

Calculate dispersivity dependent on distance to compliance point (0) 2

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

Dispersivity	ax	ay	az
Longitudinal dispersivity	11.11E+01		
Transverse dispersivity	1.11E+00		
Vertical dispersivity	1.11E-01		

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* x, ay = 0.001 \* x  
Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>ax)<sup>0.5</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
42.5	2.2E-100
85.0	4.9E-102
127.5	1.1E-103
170.0	1.1E-106
212.5	6.2E-107
255.0	1.1E-108
297.5	2.5E-110
340.0	6.3E-112

422.0 2.8E-115

467.5 6.5E-117

512.5 2.8E-120

557.5

602.5 6.7E-122

647.5 1.2E-123

692.5 2.7E-125

737.5 6.0E-127

782.5 1.3E-128

827.5 2.9E-130

872.5 6.3E-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: Blass 6 Res #20  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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<sub>T</sub> = 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 <sub>0</sub>	9.90E-09	mg/l	See options
Half life for degradation of contaminant in water	t <sub>1/2</sub>	7.20E+02	days	See options
Calculated decay rate	λ	9.63E-04	days <sup>-1</sup>	See options
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	See options
Plume thickness at source	Sy	5.60E+01	m	See options
Saturated aquifer thickness	da	5.71E+01	m	See options
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	See options
Effective porosity of aquifer	n	1.82E-01	fraction	See options
Hydraulic gradient	i	7.00E-03	fraction	See options
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	See options
Distance to compliance point	x	8.50E+02	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+09	days	Time variant options only
Partition coefficient	Kd	2.14E-01	l/kg	See options
Longitudinal dispersivity	α <sub>x</sub>	1.114	m	See options
Transverse dispersivity	α <sub>z</sub>	1.111	m	See options
Vertical dispersivity	α <sub>y</sub>	0.111	m	See options

Calculated Parameters Variable

Groundwater flow velocity	v	7.69E-01	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.63E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.57E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>2D</sub>	2.97E-100	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.84E-100	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	3.34E+01	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	3.48E+01	

Remedial Targets

Remedial Target	LTC3	3.34E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C <sub>2D</sub> /C <sub>0</sub>	2.97E-100	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.

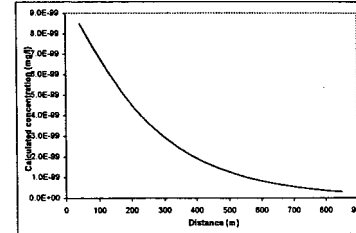
Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	2.14E-01	l/kg
Fraction of organic carbon in aquifer	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	2.14E-01	l/kg
Soil water partition coefficient	Kd	2.14E-01	l/kg
Longitudinal dispersivity	α <sub>x</sub>	1.11E+01	m
Transverse dispersivity	α <sub>z</sub>	1.11E+00	m
Vertical dispersivity	α <sub>y</sub>	1.11E-01	m

Calculate dependent on distance to compliance point (D)		2	
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	α <sub>x</sub>	1.11E+01	m
Transverse dispersivity	α <sub>z</sub>	1.11E+00	m
Vertical dispersivity	α <sub>y</sub>	1.11E-01	m

For calculated value, assumes α<sub>x</sub> = 0.1 \* x, α<sub>z</sub> = 0.01 \* x, α<sub>y</sub> = 0.001 \* x  
Xu & Eckstein (1995) report α<sub>x</sub> = 0.83(log<sub>10</sub>d)<sup>0.83</sup>; α<sub>z</sub> = α<sub>x</sub>/10, α<sub>y</sub> = α<sub>x</sub>/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet.  
Distance Concentration

42.5	8.8E-09
85.0	7.3E-09
127.5	6.1E-09
170.0	6.2E-09
212.5	4.3E-09
255.0	3.6E-09
297.5	3.0E-09
340.0	2.6E-09
382.5	2.1E-09
425.0	1.7E-09
467.5	1.4E-09
610.0	1.2E-09
652.5	1.0E-09
695.0	8.4E-100
637.5	7.1E-100
680.0	6.9E-100
722.5	6.0E-100
765.0	4.2E-100
807.5	3.6E-100
850.0	3.0E-100

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+09

Site being assessed: Blosa 6 Res A20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12



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

Tier 3 - Groundwater



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

Contaminant	Selenium		
Target Concentration	C <sub>T</sub>	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
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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 <sub>0</sub>	3.00E+00	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>	
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+01	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.62E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	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
Partition coefficient	Kd	9.55E+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	7.69E-01	m/d
Retardation factor	Rf	9.02E+01	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	8.53E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.93E+00	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.85E+00	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	1.56E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	1.62E+00	

Remedial Targets

Remedial Target	LTC3	1.56E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C <sub>2D</sub> /C <sub>0</sub>	1.93E+00	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)

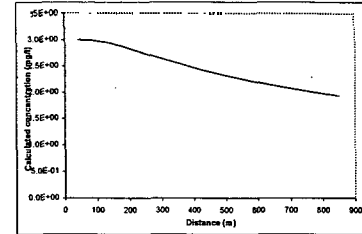
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd		l/kg
Soil water partition coefficient			
Entry for non-polar organic chemicals (option)	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 <sub>oc,1</sub>		l/kg
Sorption coefficient for related species	K <sub>oc,1</sub>		l/kg
Sorption coefficient for ionized species	pH		
pH value	pKa		
acid dissociation constant			
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	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 \* z, αy = 0.001 \* y. Xu & Eckstein (1995) report αx = 0.83(log<sub>10</sub>α)<sup>2</sup>; αz = αx/10, αy = αx/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks		
From calculation sheet		
Distance	Concentration	mg/l
42.5	3.0E+00	
16.0	3.0E+00	
127.5	2.9E+00	
170.0	2.9E+00	
212.5	2.8E+00	
255.0	2.7E+00	
297.5	2.6E+00	
340.0	2.6E+00	
488.5	2.4E+00	
487.5	2.4E+00	
610.0	2.3E+00	
552.5	2.2E+00	
695.0	2.2E+00	
637.5	2.1E+00	
850.0	2.1E+00	
722.5	2.0E+00	
765.0	2.0E+00	
807.5	2.0E+00	
850.0	1.9E+00	

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

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	Slips 6 Res K20
Completed by	AJ
Date	24 11 2005
Version	12

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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 <sub>T</sub> 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 <sub>0</sub>	2.30E+01	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.90E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	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	9.90E+99	days
Time since pollutant entered groundwater	t	9.90E+99	days
Parameters values determined from options			
Partition coefficient	M	0.00E+00	l/kg
Longitudinal dispersivity	α <sub>L</sub>	11114	m
Transverse dispersivity	α <sub>T</sub>		m
Vertical dispersivity	α <sub>V</sub>	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	v	7.69E-01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	7.69E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.48E+01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.42E+01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.56E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.82E+00	

Remedial Targets

Remedial Target	1.00E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	850	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.48E+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

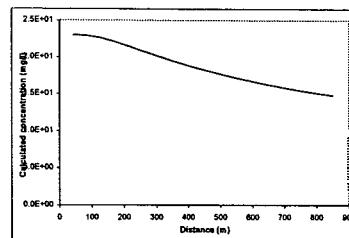
Soil water partition coefficient: K<sub>d</sub> 0.00E+00 l/kg  
 Fraction of organic carbon in aquifer: f<sub>oc</sub> 1.00E+00 fraction  
 Organic carbon partition coefficient: K<sub>oc</sub> 0.00E+00 l/kg  
 Sorption coefficient for related species: K<sub>ow</sub> l/kg  
 Sorption coefficient for ionised species: K<sub>ow</sub> l/kg  
 pH value: pH  
 acid dissociation constant: pKa

Soil water partition coefficient: K<sub>d</sub> 0.00E+00 l/kg

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

Longitudinal dispersivity: α<sub>L</sub> 1.11E+01 m  
 Transverse dispersivity: α<sub>T</sub> 1.11E+00 m  
 Vertical dispersivity: α<sub>V</sub> 1.11E-01 m

For calculated value, assumes α<sub>L</sub> = 0.1 \* x, α<sub>T</sub> = 0.01 \* x, α<sub>V</sub> = 0.001 \* x  
 Xu & Eckstein (1995) report α<sub>L</sub> = 0.83(log<sub>10</sub> t)<sup>0.41</sup>; α<sub>T</sub> = α<sub>L</sub>/10, α<sub>V</sub> = α<sub>L</sub>/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
42.6	2.3E+01
85.0	2.3E+01
127.6	2.3E+01
170.0	2.2E+01
212.6	2.1E+01
256.0	2.1E+01
297.5	2.0E+01
340.0	2.0E+01
382.5	1.9E+01
426.0	1.9E+01
467.5	1.8E+01
510.0	1.8E+01
552.6	1.7E+01
595.0	1.7E+01
637.5	1.6E+01
680.0	1.6E+01
722.6	1.6E+01
765.0	1.6E+01
807.5	1.6E+01
850.0	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 9.9E+99

Site being assessed: Bess 5 Res #20  
 Completed by: AJ  
 Date: 24 11 2005  
 Version: 12

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Tier 3 -Groundwater



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

Contaminant Sulphide  
Target Concentration C<sub>T</sub> 2.50E-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 <sub>0</sub>	6.20E-01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E-01	m	
Plume thickness at source	Sy	5.50E+01	m	
Saturated aquifer thickness	ds	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	I	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	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	0.00E+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

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 <sub>ow</sub>		l/kg
Sorption coefficient for related species	K <sub>oc</sub>		l/kg
Sorption coefficient for ionized species	K <sub>oc</sub>		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 dependant 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 1.11E+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 az = 0.83(log<sub>10</sub> t)<sup>0.5</sup>; az = ax/10, ay = ax/100 are assumed

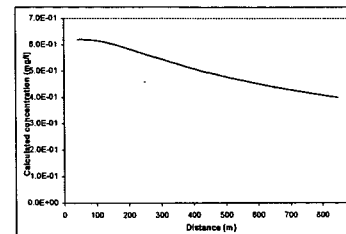
Calculated Parameters Variable

Groundwater flow velocity	v	7.69E-01	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	7.69E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	3.98E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	3.82E-01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.56E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.82E+00	

Remedial Targets

Remedial Target	LTC3	3.98E-04	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	3.98E-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.



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
42.5	6.2E-01
85.0	6.2E-01
127.5	6.1E-01
170.0	6.0E-01
212.5	5.8E-01
255.0	5.6E-01
297.6	5.4E-01
340.0	5.3E-01
482.5	4.9E-01
565.0	4.7E-01
647.5	4.6E-01
730.0	4.5E-01
812.5	4.4E-01
895.0	4.3E-01
977.5	4.2E-01
1060.0	4.1E-01
1142.5	4.1E-01
1225.0	4.0E-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 6 Res A2D  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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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 tert butylbenzene  
Target Concentration C<sub>T</sub> 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

Variable	Value	Unit	Source of parameter value
C <sub>0</sub>	9.90E+99	mg/l	
t <sub>1/2</sub>	9.99E+99	days	
λ	6.94E-101	days <sup>-1</sup>	
S <sub>Z</sub>	8.00E+01	m	
S <sub>Y</sub>	5.80E+01	m	
d <sub>a</sub>	5.71E+01	m	
ρ	1.70E+00	g/cm <sup>3</sup>	
n	1.82E-01	fraction	
i	7.00E-03	fraction	
K	2.00E+01	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 <sub>d</sub>	2.14E-01	1/kg	see options
a <sub>x</sub>	11.114	m	see options
a <sub>z</sub>	1.111	m	see options
a <sub>y</sub>	0.111	m	see options

Calculated Parameters Variable

v	7.69E-01	m/d
Rf	3.00E+00	fraction
λ	6.94E-101	d <sup>-1</sup>
u	2.57E-01	m/d
C <sub>0p</sub>	6.36E-99	mg/l
C <sub>0c</sub>	6.10E-89	mg/l
AF	1.56E+00	
AF	1.82E+00	

Remedial Targets

Remedial Target	LTC3	1.68E-03	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		650	m	
Concentration of contaminant at compliance point	C <sub>0p</sub> /C <sub>0</sub>	6.36E-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

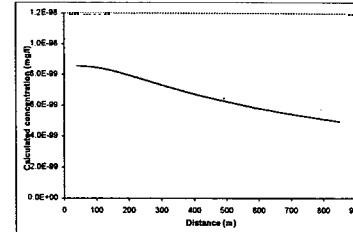
Entry if specify partition coefficient (option)  
Soil water partition coefficient K<sub>d</sub> 2.14E-01 1/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 2.14E-01 1/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub>  
Sorption coefficient for ionised species K<sub>ow</sub>  
pH value  
acid dissociation constant pK<sub>a</sub>

Soil water partition coefficient K<sub>d</sub> 2.14E-01 1/kg

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

Longitudinal dispersivity	a <sub>x</sub>	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	a <sub>z</sub>		1.11E+01 m
Vertical dispersivity	a <sub>y</sub>		1.11E-01 m

For calculated value, assumes a<sub>x</sub> = 0.1 \* z, a<sub>z</sub> = 0.01 \* z, a<sub>y</sub> = 0.001 \* z  
Xu & Eckstein (1995) report a<sub>x</sub> = 0.83(log<sub>10</sub>z)<sup>0.425</sup>, a<sub>z</sub> = a<sub>x</sub>/10, a<sub>y</sub> = a<sub>x</sub>/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

Distance (m)	Concentration (mg/l)
42.6	9.9E-99
85.0	9.9E-99
127.6	9.9E-99
170.0	9.9E-99
212.5	9.9E-99
256.0	9.9E-99
297.5	9.9E-99
340.0	9.9E-99
382.6	9.9E-99
425.0	9.9E-99
467.5	9.9E-99
510.0	9.9E-99
552.5	9.9E-99
595.0	9.9E-99
637.5	9.9E-99
680.0	9.9E-99
722.5	9.9E-99
765.0	9.9E-99
807.5	9.9E-99
850.0	9.9E-99

Site being assessed: Boss & Res 420  
Completed by: AJ  
Date: 24 11 2005  
Version: 12



Tier 3 - Groundwater



Input Parameters (using cull-down menu) Variable Value unit Source

Contaminant Zinc  
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)

Initial contaminant concentration in groundwater at plume core	$C_0$	$1.47E-01$	mg/l	See R&D Pub. 20
Half life for degradation of contaminant in water	$t_{1/2}$	$9.90E+99$	days	See R&D Pub. 20
Calculated decay rate	$\lambda$	$7.00E-101$	days <sup>-1</sup>	See R&D Pub. 20
Width of plume in aquifer at source (perpendicular to flow)	$S_z$	$8.00E+01$	m	See R&D Pub. 20
Plume thickness at source	$S_y$	$5.00E+01$	m	See R&D Pub. 20
Saturated aquifer thickness	$d_a$	$5.71E+015$	m	See R&D Pub. 20
Bulk density of aquifer materials	$\rho$	$1.70E+00$	g/cm <sup>3</sup>	See R&D Pub. 20
Effective porosity of aquifer		$1.82E-01$	fraction	See R&D Pub. 20
Hydraulic gradient		$7.00E-03$	fraction	See R&D Pub. 20
Hydraulic conductivity of aquifer	$K$	$2.00E+01$	m/d	See R&D Pub. 20
Distance to compliance point		$8.50E+02$	m	See R&D Pub. 20
Distance (latera) to compliance point perpendicular to flow direction		$0.00E+00$	m	See R&D Pub. 20
Distance (depth) to compliance point perpendicular to flow direction		$0.00E+00$	m	See R&D Pub. 20
Time since pollutant entered groundwater	$I$	$9.90E+99$	days	time variant options only
Parameters values determined from options				
Partition coefficient	$K_d$	$0.00E+00$	W/g	see options
Longitudinal dispersivity	$\alpha_x$	11.114	m	see options
Transverse dispersivity	$\alpha_z$	1.111	m	see options
Vertical dispersivity	$\alpha_y$	0.111	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	7.89E-01	m/d
Retardation factor	$R_f$	1.00E+00	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	7.89E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{E0}$	9.44E-02	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{E2}$	9.05E-02	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{E0}$ )	$AF$	1.56E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{E2}$ )	$AF$	1.82E+00	

Remedial Targets

Remedial Target	LTC3	$1.56E-01$	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		880	m	
Concentration of contaminant at compliance point	$C_{E0}/C_0$	9.44E-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)

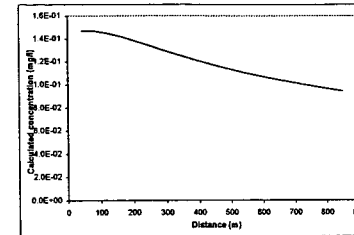
Calculate for non-polar organic chemicals

Soil water partition coefficient	$K_d$		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	$K_{oc}$	$0.00E+00$	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	$K_d$	$0.00E+00$	l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)			
specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	$\alpha_x$	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	$\alpha_z$		$1.11E+01$ m
Vertical dispersivity	$\alpha_y$		$1.11E+00$ 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  $\alpha_x = 0.83(\log_{10} C_0)^{0.11}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_z/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks Biotransformation

	mg/l
42.6	$1.5E-01$
86.0	$1.8E-01$
127.6	$1.4E-01$
170.0	$1.4E-01$
212.6	$1.4E-01$
266.0	$1.3E-01$
297.5	$1.3E-01$
340.0	$1.3E-01$
382.6	$1.2E-01$
426.0	$1.2E-01$
467.6	$1.2E-01$
510.0	$1.1E-01$
552.6	$1.1E-01$
596.0	$1.1E-01$
637.6	$1.0E-01$
680.0	$1.0E-01$

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: Bress 6 Res 420  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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 2 4 trimethylbenzene		
Target Concentration	C <sub>T</sub>	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 <sub>0</sub>	3.00E-03	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.60E+02	days
Calculated decay rate	λ	1.93E-03	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.80E-01	m
Plume thickness at source	Sy	5.90E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd	2.95E+01	l/kg
Longitudinal dispersivity	ax	1.114	m
Transverse dispersivity	az	1.111	m
Vertical dispersivity	ay	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	v	7.69E-01	m/d
Retardation factor	Rf	2.77E+02	fraction
Decay rate used	λ	1.93E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.78E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.87E-00	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.79E-00	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.81E+77	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.88E+77	

Remedial Targets

Remedial Target	LYC3	1.44E+75	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.87E-00	mg/l	Ogata Banks
after		9.9E+99	days	

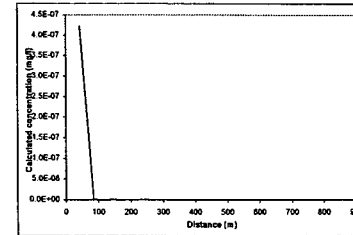
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

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

Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	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
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>oc,i</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	2.95E+01	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	1.11E+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(log<sub>10</sub>x)<sup>0.414</sup>; 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	4.2E-07
86.0	8.6E-11
127.5	8.3E-16
170.0	1.1E-18
212.6	1.6E-22
266.0	2.1E-26
297.5	2.9E-30
340.0	4.0E-34
382.6	5.6E-38
426.0	7.6E-42
467.5	1.0E-46
510.0	1.4E-49
552.6	2.0E-53
596.0	2.7E-57
637.6	3.7E-61
680.0	5.1E-66
722.6	7.1E-69
796.0	9.8E-73
807.6	1.3E-76
860.0	1.9E-80

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: Blass 6 Res A20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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

Tier 3 - Groundwater



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

Contaminant	1,3,5-trimethylbenzene		
Target Concentration	C <sub>T</sub>	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 <sub>0</sub>	1.00E-03	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.60E+02	days
Calculated decay rate	λ	1.93E-03	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance (lateral) to compliance point perpendicular to flow direction	x	1.850E+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	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	7.69E-01	m/d
Retardation factor	Rf	2.77E+02	fraction
Decay rate used	λ	1.93E-03	days <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.78E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	6.22E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	5.96E-01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	1.61E+77	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	1.68E+77	

Remedial Targets

Remedial Target	LYC3	1.91E+75	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	6.22E-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

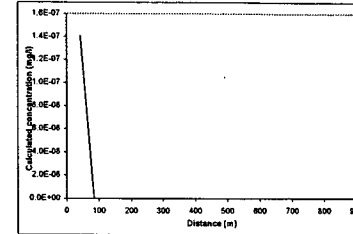
Entry if specify partition coefficient (option)  
Soil water partition coefficient Kd  l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer foc  fraction  
Organic carbon partition coefficient Koc  l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub>  l/kg  
Sorption coefficient for ionised species K<sub>ow</sub>  l/kg  
pH value    
acid dissociation constant pKa

Soil water partition coefficient Kd  l/kg

Dispersivity

Calculate dispersivity 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 (1995) report ax = 0.83(log<sub>10</sub>D)<sup>0.433</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Distance	Concentration
42.5	1.4E-07
82.6	2.6E-16
170.0	3.8E-19
212.6	6.2E-23
255.0	7.1E-27
297.5	9.8E-31
340.0	1.3E-34
382.6	1.8E-38
425.0	2.6E-42
467.6	3.4E-46
510.0	4.7E-50
562.6	6.6E-54
605.0	9.0E-58
637.6	1.2E-61
680.0	1.7E-65
722.6	2.4E-69
765.0	3.3E-73
807.6	4.8E-77

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: Boss 6 Res K20  
Completed by: AJ  
Date: 24.11.2005  
Version: 12

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

Contaminant: 1,4 Dichlorobenzene  
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)

Initial contaminant concentration in groundwater at plume core	$C_0$	9.90E-09	mg/l	Soil water partition coefficient	Kd	7.76E+00	l/kg
Half life for degradation of contaminant in water	$t_{1/2}$	3.60E+02	days	Dispersivity			
Calculated decay rate	$\lambda$	1.93E-03	days <sup>-1</sup>	Calculate dispersivity dependent on distance to compliance point (0) specify dispersivity (1), or calc after Xu & Eckstein (2) ?		2	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	Longitudinal dispersivity	ax	1.11E+01	m
Plume thickness at source	Sy	5.00E+01	m	Transverse dispersivity	az	1.11E+00	m
Saturated aquifer thickness	ds	5.71E+01	m	Vertical dispersivity	ay	1.11E-01	m
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>				
Effective porosity of aquifer	n	1.82E-01	fraction				
Hydraulic gradient	i	7.00E-03	fraction				
Hydraulic conductivity of aquifer	K	2.00E+01	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	7.76E+00	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	7.68E-01	m/d
Retardation factor	Rf	7.35E+01	fraction
Decay rate used	$\lambda$	1.93E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.05E-02	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	$C_{2D}$	1.20E-132	mg/l
Attenuation factor (one way vertical dispersion, $C_{1D}/C_0$ )	AF	7.80E+33	
Attenuation factor (two way vertical dispersion, $C_{2D}/C_0$ )	AF	8.23E+33	

Remedial Targets

Remedial Target	LTC3	7.89E+31	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.26E-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)

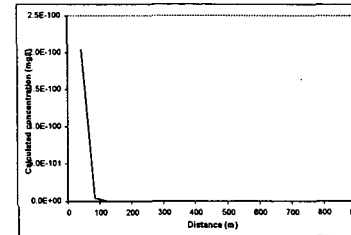
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd		l/kg
Soil water partition coefficient	Kd	7.76E+00	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	3.00E+00	fraction
Organic carbon partition coefficient	Koc	7.76E+00	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc}$		l/kg
Sorption coefficient for ionised species	$K_{oc,1}$		l/kg
pH value	pH		
acid dissociation constant	pKa		

Calculate dispersivity 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  $ax = 0.1 \cdot x$ ,  $az = 0.01 \cdot x$ ,  $ay = 0.001 \cdot x$   
Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} x)^{1.15}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

48.0	1.2E-102
127.6	8.6E-104
170.0	1.7E-105
212.6	3.5E-107
288.6	4.8E-109
340.0	2.8E-112
382.6	5.6E-114

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	2.8E-118
610.0	4.8E-119
662.6	9.1E-121
696.0	1.8E-122
917.6	3.7E-124
880.0	7.6E-126
722.5	1.6E-127
786.0	3.1E-129
807.5	6.2E-131
850.0	1.3E-132

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: Bloss 6 Res K20  
Compiled by: AJ  
Date: 24/11/2005  
Version: 12

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 <sub>T</sub> 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)

Initial contaminant concentration in groundwater at plume core	C <sub>0</sub>	2.12E-02	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days	
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.40E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	7.00E-03	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	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	1.15E+02	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	7.69E-01	m/d
Retardation factor	Rf	1.07E+03	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	7.17E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	2.77E-08	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.85E-08	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1</sub> /C <sub>0</sub> )	AF	7.85E+05	
Attenuation factor (two way vertical dispersion, C <sub>2</sub> /C <sub>0</sub> )	AF	7.98E+05	

Remedial Targets

Remedial Target	LTC3	6.44E+02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		850	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	2.77E-08	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)

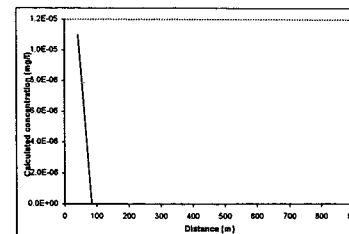
Calculate for non-polar organic chemicals

Entry if specific partition coefficient (option)	Kd		l/kg
Soil water partition coefficient			
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 <sub>ow</sub>		l/kg
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionized species	K <sub>ow</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		
Soil water partition coefficient	Kd	1.15E+02	l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (D)			
Specific dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	αx	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	αz		1.11E+01 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(log<sub>10</sub>μ)<sup>0.111</sup>, αz = αx/10, αy = αx/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	men
85.0	1.1E-05
127.5	6.7E-09
170.0	2.9E-12
212.5	1.8E-16
255.0	7.5E-19
297.5	3.8E-22
340.0	1.9E-25
382.5	9.6E-29
425.0	4.8E-32
467.5	2.4E-35
510.0	1.2E-38
552.5	6.2E-42
595.0	3.2E-45
637.5	1.6E-48
680.0	8.1E-52
722.5	4.1E-55
765.0	2.1E-58
807.5	1.1E-61
850.0	6.4E-65
860.0	2.6E-68

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 6 Res #20
Completed by	AJ
Date	24/11/2005
Version	12



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)

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	$\lambda$	3.80E-04	fraction
Width of plume in aquifer at source (perpendicular to flow)	$Sz$	3.90E+01	m
Plume thickness at source	$Sy$	5.60E+01	m
Saturated aquifer thickness	$da$	5.71E+01	m
Bulk density of aquifer materials	$\rho$	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction
Hydraulic gradient	$i$	7.00E-03	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d
Distance (lateral) to compliance point	$x$	8.50E+02	m
Distance (vertical) to compliance point perpendicular to flow direction	$z$	3.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	$y$	3.00E+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
Longitudinal dispersivity	$ax$	1.114	m
Transverse dispersivity	$az$	1.111	m
Vertical dispersivity	$ay$	0.111	m

Calculated Parameters Variable

Groundwater flow velocity	$v$	7.89E-01	m/d
Retardation factor	$Rf$	8.52E+03	fraction
Decay rate used	$\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	9.03E-05	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	1.12E-213	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.07E-213	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	1.89E+211	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	1.97E+211	

Remedial Targets

Remedial Target	LTC3	1.58E+208	mg/l	For comparison with measured groundwater concentration, Ogata Banks
Distance to compliance point		860	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.12E-213	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+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  $Koc$  9.12E+02 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  l/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  l/kg  
pH value  
acid dissociation constant  $pKa$

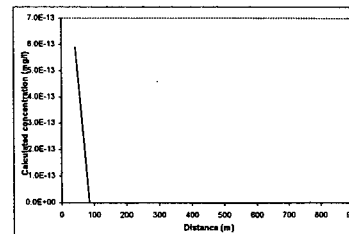
Soil water partition coefficient  $Kd$  9.12E+02 l/kg

Dispersivity

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

Longitudinal dispersivity  $ax$  1.11E+01 m  
Transverse dispersivity  $az$  1.11E+00 m  
Vertical dispersivity  $ay$  1.11E-01 m

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

	mg/l
42.6	6.9E-13
86.0	1.6E-23
127.6	4.5E-34
170.0	1.2E-44
212.6	3.4E-56
266.0	9.1E-68
297.6	2.6E-76
340.0	6.7E-87
382.6	1.8E-97
426.0	4.9E-108
467.6	1.3E-118
610.0	3.9E-129
662.6	9.9E-140
696.0	2.7E-150
637.6	7.3E-161
680.0	2.0E-171
722.6	5.6E-182
766.0	1.6E-192
807.6	4.1E-203
860.0	1.1E-213

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: Biss 6 Res #20  
Completed by: AJ  
Date: 24 11 2006  
Version: 12

Tier 3 - Groundwater



Input Parameters (using pull down menu)

Contaminant	Aliphatic C12-C16	
Target Concentration	C <sub>T</sub> 7.14E-04	mg/l

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

Ogata Banks	Equations in RAD Pub. 20
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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 <sub>0</sub>	2.12E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>
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+01	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	7.00E-03	fraction
Hydraulic conductivity of aquifer	K	2.00E+02	m/d
Distance to compliance point	x	8.90E+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

Parameters values determined from options

Partition coefficient	Kd	1.82E+04	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

Groundwater flow velocity	v	7.69E-01	m/d
Retardation factor	Rf	1.70E+05	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.53E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	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 contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	#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<sub>d</sub> [ ] l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient K<sub>oc</sub> 1.82E+04 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow,s</sub> [ ] l/kg

Sorption coefficient for ionised species K<sub>w,i</sub> [ ] l/kg

pH value pH [ ]

acid dissociation constant pKa [ ]

Source of parameter value

Soil water partition coefficient	Kd	1.82E+04	l/kg
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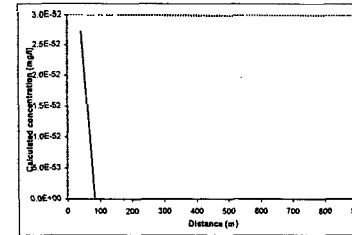
Dispersivity

Calculate dependent on distance to compliance point (D)

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(log<sub>10</sub>x)<sup>0.11</sup>; az = ax/10, ay = ay/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

	mg/l
42.6	2.7E-02
85.0	3.6E-02
127.6	4.4E-02
170.0	5.5E-02
212.5	6.9E-02
255.0	#NUM!
297.5	#NUM!
340.0	#NUM!
382.5	#NUM!
425.0	#NUM!
467.5	#NUM!
510.0	#NUM!
552.5	#NUM!
595.0	#NUM!
637.5	#NUM!
680.0	#NUM!
722.5	#NUM!
765.0	#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. 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	Bleas 6 Res K20
Completed by	AJ
Date	24/11/2005
Version	12

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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	Alcatrium Chloride		
Target Concentration	7.1E-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, '2' for two directions (pull down menu)

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

Enter '1' 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

Half life for degradation of contaminant in water

Width of plume in aquifer at source (perpendicular to flow)

Saturated aquifer thickness

Bulk density of aquifer materials

Effective porosity of aquifer

Hydraulic conductivity of aquifer

Distance (down) to compliance point perpendicular to flow direction

Distance (depth) to compliance point perpendicular to flow direction

Parameters values determined from options

Calculated Parameters Variable

Groundwater flow velocity

Retardation factor

Decay rate used

Rate of contaminant flow due to retardation

Contaminant concentration at distance x, assuming one-way vertical dispersion

Attenuation factor (one way vertical dispersion, C<sub>1</sub>/C<sub>0</sub>)

Attenuation factor (two way vertical dispersion, C<sub>2</sub>/C<sub>0</sub>)

Remedial Targets

Opta Banis

Distance to compliance point

Concentration of contaminant at compliance point

after

Opta Banis

Opta Banis

Opta Banis

Opta Banis

Opta Banis

Opta Banis

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

Calculates for non-polar organic chemicals

Entry for specific partition coefficient (optima)

Soil water partition coefficient

Entry for non-polar organic chemicals (optima)

Fraction of organic carbon in aquifer

Organic carbon partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

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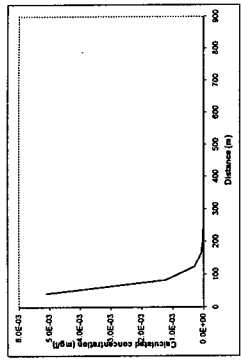
Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient

Soil water partition coefficient



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

This sheet calculates the Tier 2 remedial target for groundwater, based on the distance-concentration graph. The remedial target is based on the source. Three solution methods are included; the preferred option is Opta Banis. 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.

Calculations assessed: Washington Area 8 Groundwater R20  
 Completed by: [Redacted]  
 Date: 24.11.2005  
 Version: 1.2

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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 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 <sub>0</sub>	2.12E-02	mg/l	Soil water partition coefficient	K <sub>d</sub>	5.75E+01	l/kg
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.65E+03	days	Soil water partition coefficient	K <sub>d</sub>	5.75E+01	l/kg
Calculated decay rate	λ	1.90E-04	days <sup>-1</sup>	Dispersivity			
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	Calculate dispersivity dependent on distance to compliance point (D)			
Plume thickness at source	Sy	5.60E+01	m	specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Saturated aquifer thickness	da	5.71E+01	m	Longitudinal dispersivity	ax	1.10E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	Transverse dispersivity	ay	1.10E+00	m
Effective porosity of aquifer	n	1.82E-01	fraction	Vertical dispersivity	az	1.10E-01	m
Hydraulic gradient	i	1.25E-02	fraction	For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x			
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	Xu & Eckstein (1995) report ax = 0.83(log <sub>10</sub> μ <sup>0.4</sup> ); az = ax/10, ay = ax/100 are assumed			
Distance (lateral) to compliance point perpendicular to flow direction	x	8.30E+02	m	Time variant options only			
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	Partition coefficient	K <sub>d</sub>	5.75E+01	l/kg
Time since pollutant entered groundwater	t	9.90E+09	days	Longitudinal dispersivity	ax	11.020	m
Parameters values determined from options				Transverse dispersivity	ay	1.102	m
				Vertical dispersivity	az	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	5.38E+02	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.55E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>10</sub>	4.52E-20	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>20</sub>	4.34E-20	mg/l
Attenuation factor (one way vertical dispersion, C <sub>10</sub> /C <sub>0</sub> )	AF	4.88E+17	
Attenuation factor (two way vertical dispersion, C <sub>20</sub> /C <sub>0</sub> )	AF	4.88E+17	

Remedial Targets

Remedial Target	LTC3	3.39E+14	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>10</sub> /C <sub>0</sub>	4.62E-20	mg/l	Ogata Banks
after		9.8E+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 9.8E+09.

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

Calculate for non-polar organic chemicals

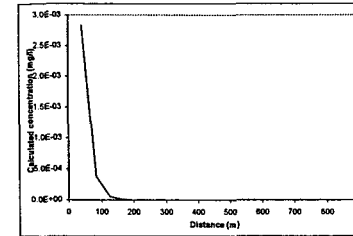
Entry if specify partition coefficient (option)  
Soil water partition coefficient  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer  
Organic carbon partition coefficient  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  
Sorption coefficient for ionised species  
pH value  
acid dissociation constant

K <sub>d</sub>	5.75E+01	l/kg
f <sub>oc</sub>	1.00E+00	fraction
K <sub>oc</sub>	5.75E+01	l/kg
K <sub>ow</sub>		l/kg
K <sub>ow,i</sub>		l/kg
pH		
pKa		

Source of parameter value

Soil water partition coefficient	K <sub>d</sub>	5.75E+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	1.10E+01	m
Transverse dispersivity	ay	1.10E+00	m
Vertical dispersivity	az	1.10E-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<sub>10</sub>μ<sup>0.4</sup>); az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks Distance/Concentration

	mg/l
41.5	2.8E-03
83.0	3.8E-04
124.5	5.6E-06
207.5	8.5E-07
N . 0	1.1E-07
290.5	1.4E-08
332.0	1.9E-09
373.5	2.4E-10
415.0	3.1E-11
456.5	4.1E-12
498.0	6.3E-13
539.5	8.9E-14
681.0	9.0E-16
822.5	1.2E-16
864.0	1.5E-16
705.5	2.0E-17
747.0	2.9E-16
788.5	3.4E-19
830.0	4.6E-20

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	Blossington Area 6 A Downshire K20
Completed by	AJ
Date	24/11/2005
Version	12

Tier 3 - Groundwater

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

Contaminant: Aromatic C21-C35  
Target Concentration C<sub>T</sub>: 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 <sub>0</sub>	2.12E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.65E+03	days
Calculated decay rate	λ	1.90E-04	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.80E+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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	8.30E+02	m
Distance (lateral) to compliance point perpendicular to flow direction	z	1.00E+00	m
Distance (depth) to compliance point perpendicular to flow direction	y	1.00E+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
Longitudinal dispersivity	α <sub>L</sub>	11.020	m
Transverse dispersivity	α <sub>T</sub>	1.102	m
Vertical dispersivity	α <sub>V</sub>	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	4.27E+03	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	3.22E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	3.02E-71	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.90E-71	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>T</sub> )	AF	7.02E+68	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>T</sub> )	AF	7.30E+68	

Remedial Targets

Remedial Target	UIC3	4.02E+05	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>T</sub>	3.02E-71	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<sub>d</sub> 4.57E+02 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient K<sub>oc</sub> 4.57E+02 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K<sub>ow</sub> l/kg

Sorption coefficient for ionised species K<sub>ow</sub> l/kg

pH value pH

acid dissociation constant pK<sub>a</sub>

Soil water partition coefficient K<sub>d</sub> 4.57E+02 l/kg

Dispersivity

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

Longitudinal dispersivity α<sub>L</sub> 11.020 m

Transverse dispersivity α<sub>T</sub> 1.102 m

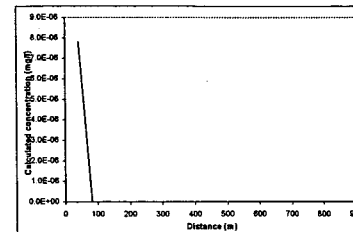
Vertical dispersivity α<sub>V</sub> 0.110 m

For calculated value, assumes α<sub>x</sub> = 0.1 \* α<sub>L</sub>, α<sub>z</sub> = 0.01 \* α<sub>L</sub>, α<sub>y</sub> = 0.001 \* α<sub>L</sub>

Xu & Eckstein (1995) report α<sub>z</sub> = 0.83(log<sub>10</sub>α<sub>L</sub>)<sup>0.75</sup>; α<sub>z</sub> = α<sub>L</sub>/10, α<sub>y</sub> = α<sub>L</sub>/100 are assumed

time variant options only

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Calculated concentrations for distance-concentration graph

Data Banks

From calculation sheet

Distance Concentration

41.6	7.8E-06
83.0	2.9E-09
124.6	1.0E-12
170.0	3.8E-16
207.6	1.4E-19
249.0	4.8E-23
290.6	1.7E-26
332.0	6.3E-30
373.6	2.2E-33
416.0	8.1E-37
458.6	2.9E-40
498.0	1.0E-43
539.6	3.8E-47
581.0	1.4E-50
622.6	4.9E-54
664.0	1.8E-57
706.6	6.4E-61
747.0	2.3E-64
788.6	8.3E-68
830.0	3.0E-71

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 A Downspare K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 13

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 <sub>T</sub>	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
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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 <sub>0</sub>	9.90E-99	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E-99	days	
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	7.80E+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 <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	8.30E+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	1.17E+02	l/kg	see options
Longitudinal dispersivity	αx	11.020	m	see options
Transverse dispersivity	αz	1.102	m	see options
Vertical dispersivity	αy	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity	V	1.37E+00	m/d
Retardation factor	Rf	1.10E+03	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.25E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>EO</sub>	8.44E-99	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>ED</sub>	6.19E-99	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>ED</sub> )	AF	1.54E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>ED</sub> )	AF	1.60E+00	

Remedial Targets

Remedial Target	LYC3	1.84E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>ED</sub> /C <sub>0</sub>	8.44E-99	mg/l	Ogata Banks
after		9.9E+99	days	

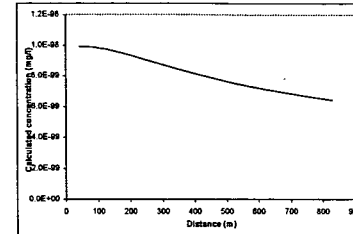
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)	Kd		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	1.17E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>ow,i</sub>		l/kg
pH value	pKa		
acid dissociation constant			
Soil water partition coefficient	Kd	1.17E+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	αx	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	αz		1.10E+01 m
Vertical dispersivity	αy		1.10E-01 m

For calculated value, assumes αx = 0.1 \* x, αz = 0.01 \* z, αy = 0.001 \* y. Xu & Eckstein (1995) report αz = 0.83(log<sub>10</sub>α<sup>1.5</sup>); αz = αz/10, αy = αy/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
41.6	9.9E-99
83.0	9.9E-99
124.5	9.7E-99
168.0	9.5E-99
207.6	9.3E-99
249.0	9.0E-99
290.6	8.8E-99
332.0	8.6E-99
371.6	8.3E-99
416.0	8.1E-99
466.5	7.8E-99
498.0	7.6E-99
539.5	7.5E-99
581.0	7.3E-99
622.5	7.1E-99
664.0	7.0E-99
706.6	1.1E-98
747.0	8.7E-99
790.6	8.6E-99
830.0	8.4E-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 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 A Downshire K20
Completed by	AF
Date	24 11 2005
Version	12



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)

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core $C_0$	9.90E-09	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	7.20E+02	days	
Calculated decay rate $\lambda$	9.63E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance (lateral) to compliance point $x$	3.30E+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+09	days	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient $K_d$	2.14E-01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.020	m	see options
Transverse dispersivity $\alpha_z$	1.102	m	see options
Vertical dispersivity $\alpha_y$	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $R_f$	3.00E+00	fraction
Decay rate used $\lambda$	9.63E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.58E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	1.17E-09	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	1.13E-09	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	8.46E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	8.79E+00	

Remedial Targets

Remedial Target	LTCS	8.46E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point $C_{1D}/C_0$		1.17E-09	mg/l	Ogata Banks
$a/t_{tar}$		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 specific 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  $K_{ow}$  1.10E+01 l/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  1.10E+00 l/kg  
pH value  $pH$  7.0  
acid dissociation constant  $pK_a$  4.75

Soil water partition coefficient  $K_d$  2.14E-01 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0) 2

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

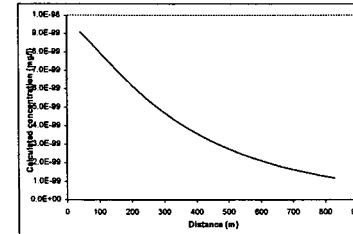
Longitudinal dispersivity  $\alpha_x$  Enter value Calc value Xu & Eckstein 1.10E+01 m

Transverse dispersivity  $\alpha_z$  1.10E+00 m

Vertical dispersivity  $\alpha_y$  1.10E-01 m

For calculated value, assumes  $\alpha_x = 0.1 \times z$ ,  $\alpha_z = 0.01 \times z$ ,  $\alpha_y = 0.001 \times z$

Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} \mu)^{0.5}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration (mg/l)
41.6	9.1E-09
63.0	8.3E-09
124.6	7.5E-09
166.0	6.8E-09
207.6	6.1E-09
249.0	5.4E-09
290.5	4.8E-09
332.0	4.3E-09
373.5	3.8E-09
416.0	3.4E-09
458.5	3.1E-09
488.0	2.8E-09
639.6	2.5E-09
681.0	2.2E-09
622.6	2.0E-09
684.0	1.8E-09
706.6	1.6E-09
747.0	1.4E-09
788.5	1.3E-09
630.0	1.2E-09

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+09

Site being assessed: Bressington Area 6 A Downshire K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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 <sub>T</sub> 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
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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 <sub>0</sub>	1.00E+01	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.90E+99	days	
Calculated decay rate	λ	7.00E-101	days <sup>-1</sup>	
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	p	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	8.30E+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	0.00E+00	l/kg	see options
Longitudinal dispersivity	ax	11.020	m	see options
Transverse dispersivity	az	1.102	m	see options
Vertical dispersivity	ay	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.00E+00	fraction
Decay rate used	λ	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.37E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	6.50E-02	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	6.25E-02	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	1.54E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	1.60E+00	

Remedial Targets

Remedial Target	LTC3	1.54E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	6.60E-02	mg/l	Ogata Banks
after		9.9E+99	days	

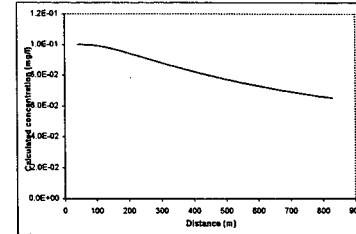
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+99.

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

Calculate for non-polar organic chemicals	
Soil water partition coefficient	Kd 0.00E+00 l/kg
Entry for specific partition coefficient (option)	
Entry for non-polar organic chemicals (option)	
Fraction of organic carbon in aquifer	foc 1.00E+00 fraction
	0.00E+00
Organic carbon partition coefficient	Koc 0.00E+00 l/kg
Entry for basic organic chemicals (option)	
Sorption coefficient for related species	K <sub>ow</sub> n
Sorption coefficient for ionised species	K <sub>ow</sub> -1
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 (D)			
Specify dispersivity (1), or calc after Xu & Eckstein (2) ?			
Longitudinal dispersivity	ax	Enter value	Calc value Xu & Eckstein
Transverse dispersivity	az	1.10E+01	m
Vertical dispersivity	ay	1.10E-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<sub>10</sub>μ)<sup>0.414</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

mg/l	
41.6	1.0E-01
33.0	1.0E-01
124.6	9.6E-02
168.0	9.6E-02
107.6	9.4E-02
249.0	9.1E-02
290.6	8.9E-02
332.0	8.6E-02
373.6	8.4E-02
416.0	8.1E-02
468.0	7.9E-02
498.0	7.7E-02
539.6	7.6E-02
661.0	7.4E-02
622.6	7.2E-02
664.0	7.0E-02
706.6	6.9E-02
747.0	6.8E-02
788.6	6.6E-02
830.0	6.5E-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	Blossington Area 6 A Downshire K20
Completed by	AJ
Date	24/11/2005
Version	12

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

Tier 3 - Soil



Input Parameters	Variable	Value	Unit	Source
Contaminant	Chloroethane			from Tier 1
Target Concentration	C <sub>T</sub>	0.001	mg/l	from Tier 1
Dilution Factor	DF	2.98E+02		from Tier 2

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

Ogata Banks Equations in R&D Pub. 20

Select nature of decay rate (click on brown cell below, then on 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)

Parameter	Value	Unit	Source
Half life for degradation of contaminant in water	5.60E+01	days	
Calculated decay rate	1.24E-02	days <sup>-1</sup>	
Width of plume in aquifer at source	8.00E+01	m	
Plume thickness in aquifer at source		m	
Bulk density of aquifer materials	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	1.82E-01	fraction	
Hydraulic gradient		fraction	
Hydraulic conductivity of saturated aquifer		m/d	
Distance to compliance point	8.30E+02	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	time variant options only
Partition coefficient	6.46E-02	l/kg	see options
Longitudinal dispersivity	1.10E+01	m	see options
Transverse dispersivity	1.10E+00	m	see options
Vertical dispersivity	1.10E-01	m	see options

Parameter values should be checked against Tier 1 and 2

Calculated Parameters	Variable	Value	Unit
Groundwater flow velocity	v	1.38E+00	m/d
Retardation factor	Rf	1.60E+00	fraction
Decay rate used	λ	1.24E-02	d <sup>-1</sup>
Hydraulic gradient used in aquifer flow down-gradient	i	1.25E-02	fraction
Rate of contaminant flow due to retardation	u	8.60E-01	m/d
Ratio of Compliance Point to Source Concentration	C <sub>EP</sub> /C <sub>0</sub>	1.82E-05	fraction
Attenuation factor (C <sub>0</sub> /C <sub>EP</sub> )	AF	5.51E+04	fraction

Remedial Targets

Remedial Target	Value	Unit	Notes
Remedial Target	1.41E+04	mg/l	For comparison with measured pore water concentration.
Ogata Banks	0.001	mg/l	This assumes Tier 1 Remedial Target is based on Target Concentration.
Distance to compliance point	830	m	For comparison with measured soil concentration. This assumes Tier 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration 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

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

Calculate for non-polar organic chemicals

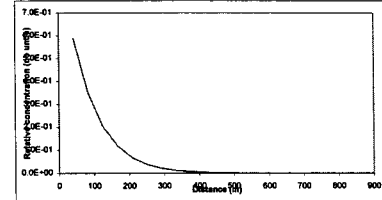
Note: For Non-polar, Calculate Kd as: Kd = Koc, etc.  
Calculate Kd as: Kd = Koc\*(1 + 10\*(pKa-1) + Koc\*(1 + 10\*(pKa-1)))

Parameter	Value	Unit
Soil water partition coefficient		l/kg
Fraction of organic carbon in aquifer	1.00E+00	fraction
Organic carbon partition coefficient	6.46E-02	l/kg
Sorption coefficient for related species		l/kg
Sorption coefficient for ionised species		l/kg
pH value		
Acid dissociation constant		pKa

Soil water partition coefficient Kd 6.46E-02 l/kg  
Define dispersivity (click brown cell and use pull down list)  
Calculate dispersivity (1), or calc after Xu & Eckstein (2)?

Parameter	Value	Unit
Longitudinal dispersivity	11.02	m
Transverse dispersivity	1.10	m
Vertical dispersivity	0.11	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<sub>10</sub>p)<sup>0.11</sup>; az = ax/10, ay = ax/100 are assumed



Calculated (relative) concentrations vs distance-concentration graph

Distance	Relative concentration (NoE00s)
83.0	3.5E-01
186.8	2.0E-01
207.5	6.8E-02
280.8	1.9E-02
332.0	1.3E-02
373.5	7.5E-03
415.0	4.3E-03
456.5	2.5E-03
498.0	1.4E-03
539.5	8.2E-04
581.0	4.7E-04
622.5	2.7E-04
664.0	1.6E-04
705.5	9.1E-05
747.0	5.2E-05
788.5	3.0E-05
830.0	1.7E-05

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

This sheet calculates the Tier3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the 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	Blossington appeal
Completed by	Anna Jeffcoat
Date	25/7/2005
Version	12

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)

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	Source of parameter value
Half life for degradation of contaminant in water	$t_{1/2}$	3.00E+02	days	
Calculated decay rate	$\lambda$	2.31E-03	days <sup>-1</sup>	
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	$\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	$n$	1.02E-01	fraction	
Hydraulic gradient	$i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d	
Distance to compliance point	$x$	8.30E+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	$Kd$	7.94E-01	l/kg	see options
Longitudinal dispersivity	$ax$	11.020	m	see options
Transverse dispersivity	$az$	1.102	m	see options
Vertical dispersivity	$ay$	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	8.42E+00	fraction
Decay rate used	$\lambda$	2.31E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.63E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	2.09E-103	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	2.01E-103	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	4.73E+04	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	4.82E+04	

Remedial Targets

Remedial Target	1TCS	4.79E+01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	2.09E-103	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

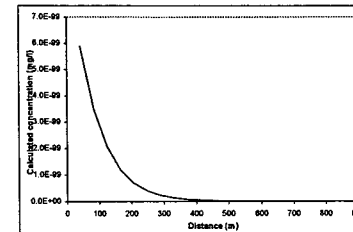
Entry if specify partition coefficient (option)  $Kd$  7.94E-01 l/kg  
 Soil water partition coefficient  
 Entry for non-polar organic chemicals (option)  $foc$  1.00E+00 fraction  
 Fraction of organic carbon in aquifer  
 Organic carbon partition coefficient  $Koc$  7.94E-01 l/kg  
 Entry for labile 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  $Kd$  7.94E-01 l/kg

Dispersivity

Calculate dispersivity on distance to compliance point (D) specifically dispersivity (1), or calculate  $Xu$  & Eckstein (2) ?  
 Longitudinal dispersivity  $ax$  1.10E+01 m  
 Transverse dispersivity  $az$  1.10E+00 m  
 Vertical dispersivity  $ay$  1.10E-01 m

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



Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 Distance Concentration

mg/l	
416	5.9E-09
826	2.5E-09
166.0	1.2E-09
207.6	7.0E-100
249.0	4.1E-100
290.6	2.4E-100
332.0	1.4E-100
373.6	7.9E-101
416.0	4.8E-101
458.6	2.7E-101
498.0	1.6E-101
539.6	9.0E-102
581.0	5.3E-102
622.6	3.1E-102
664.0	1.8E-102
706.6	1.0E-102
747.0	6.1E-103
788.6	3.6E-103
830.0	2.1E-103

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 Downshire K20 b  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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  $C_0$  9.90E-09 mg/l  
Half life for degradation of contaminant in water  $t_{1/2}$  2.28E+02 days  
Calculated decay rate  $\lambda$  3.04E-03 days<sup>-1</sup>  
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  $\rho$  1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-01 fraction  
Hydraulic gradient  $I$  1.25E-02 fraction  
Hydraulic conductivity of aquifer  $K$  2.90E+03 m/d  
Distance (lateral) to compliance point  $x$  9.20E+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

Parameters values determined from options  
Partition coefficient  $K_d$  1.32E+00 V/kg  
Longitudinal dispersivity  $\alpha_x$  11.020 m  
Transverse dispersivity  $\alpha_z$  1.102 m  
Vertical dispersivity  $\alpha_y$  0.110 m

Calculated Parameters Variable

Groundwater flow velocity  $v$  1.37E+00 m/d  
Retardation factor  $R_f$  1.33E+01 fraction  
Decay rate used  $\lambda$  3.04E-03 d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $u$  1.03E-01 m/d  
Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{1D}$  2.33E-107 mg/l  
Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{2D}$  2.24E-107 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ )  $AF$  4.25E+08  
Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  4.42E+08

Remedial Targets

Remedial Target  $LTC3$  4.25E+08 mg/l For comparison with measured groundwater concentration.  
Ogata Banks  
Distance to compliance point 830 m  
Concentration of contaminant at compliance point  $C_{2D}/C_0$  2.33E-107 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  $K_d$  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  $K_{oc}$  1.32E+00 V/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species  $K_{ow}$  V/kg

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

pH value  $pH$

acid dissociation constant  $pK_a$  V/kg

Soil water partition coefficient  $K_d$  1.32E+00 V/kg

Dispersivity

Calculate dependent on distance to compliance point (0) 2

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

Longitudinal dispersivity  $\alpha_x$  Enter value Calc value Xu & Eckstein 1.10E+01 m

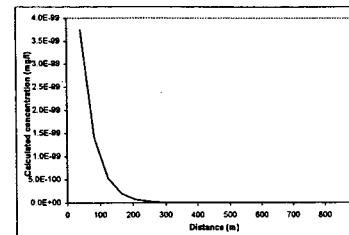
Transverse dispersivity  $\alpha_z$  1.10E+00 m

Vertical dispersivity  $\alpha_y$  1.10E-01 m

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

Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} t)^{0.111}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

time variant options only



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration (mg/l)
41.6	3.7E-09
83.0	1.4E-09
124.5	5.3E-100
166.0	2.0E-100
207.6	7.2E-101
249.0	2.7E-101
290.6	9.7E-102
332.0	3.6E-102
373.5	1.3E-102
415.0	4.8E-103
456.5	1.8E-103
498.0	6.6E-104
539.5	2.4E-104
581.0	9.0E-105
622.5	3.3E-105
664.0	1.2E-105
705.6	4.6E-106
747.0	1.7E-106
788.5	6.3E-107
830.0	2.3E-107

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 Downshire K20 b  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

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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

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 $t_{1/2}$	7.20E+02	days	
Calculated decay rate $\lambda$	9.53E-04	days <sup>-1</sup>	
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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	8.30E+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 $K_d$	2.14E-01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.020	m	see options
Transverse dispersivity $\alpha_z$	1.102	m	see options
Vertical dispersivity $\alpha_y$	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	3.00E+00	fraction
Decay rate used $\lambda$	9.63E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.58E-01	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	1.17E-09	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	1.13E-09	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ ) $AF$	8.46E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ ) $AF$	8.79E+00	

Remedial Targets

Remedial Target LYCS	8.46E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	830	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.17E-09	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)  $K_d$  2.14E-01 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  $K_{oc}$  2.14E-01 l/kg  
 Entry for labile 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  $pK_a$

Soil water partition coefficient  $K_d$  2.14E-01 l/kg

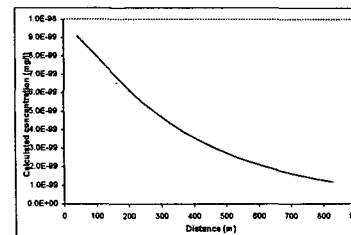
Dispersivity

Calculate dependent on distance to compliance point (0) 2

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

Longitudinal dispersivity  $\alpha_x$  1.10E+01 m  
 Transverse dispersivity  $\alpha_z$  1.10E+00 m  
 Vertical dispersivity  $\alpha_y$  1.10E-01 m

For calculated value, assumes  $\alpha_x = 0.1 \cdot x$ ,  $\alpha_z = 0.01 \cdot z$ ,  $\alpha_y = 0.001 \cdot y$ .  
 Xu & Eckstein (1995) report  $\alpha_x = 0.83(\log_{10} x)^{0.75}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  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.

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  
 From calculation sheet  
 Distance Concentration

41.6	9.1E-09
83.0	8.3E-09
124.5	7.6E-09
166.0	6.8E-09
207.5	6.1E-09
241.0	6.4E-10
290.5	4.8E-09
332.0	4.3E-09
373.5	3.8E-09
416.0	3.4E-09
456.5	3.1E-09
498.0	2.6E-09
631.6	2.6E-09
681.0	2.2E-09
822.5	2.0E-09
864.0	1.8E-09
705.5	1.6E-09
141.0	1.4E-09
188.6	1.3E-09
830.0	1.2E-09

Site being assessed: Blets Downshire 420 b  
 Completed by: AJ  
 Date: 24/1/2005  
 Version: 12

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 <sub>T</sub>	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)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C <sub>0</sub>	9.90E-09	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	9.99E+99	days
Calculated decay rate	λ	8.94E-101	days <sup>-1</sup>
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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	8.30E+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	l/kg
Longitudinal dispersivity	ax	1.102	m
Transverse dispersivity	az	1.102	m
Vertical dispersivity	ay	0.110	m

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

Method	Value	Unit
Calculate for non-polar organic chemicals		
Entry if specify partition coefficient (option)		l/kg
Soil water partition coefficient	Kd	8.91E+00
Entry for non-polar organic chemicals (option)		fraction
Fraction of organic carbon in aquifer	foc	1.00E+00
Organic carbon partition coefficient	Koc	8.91E+00
Entry for ionic organic chemicals (option)		l/kg
Sorption coefficient for related species	K <sub>ow</sub>	
Sorption coefficient for ionised species	K <sub>ow</sub>	
pH value	pH	
acid dissociation constant	pKa	
Soil water partition coefficient	Kd	8.91E+00

Dispersivity	Value	Unit
Calculate dependent on distance to compliance point (0)		
specify dispersivity (1), or calc after Xu & Eckstein (2)?	2	
Longitudinal dispersivity	ax	1.10E+01
Transverse dispersivity	az	1.10E+00
Vertical dispersivity	ay	1.10E-01

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* x, ay = 0.001 \* x  
 Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>ρ<sub>0</sub><sup>0.418</sup>); az = ax/10, ay = ax/100 are assumed

Calculated Parameters Variable

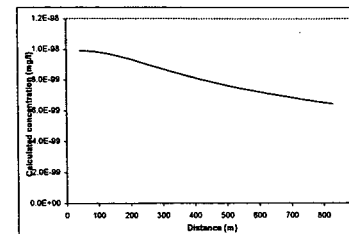
Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	8.42E+01	fraction
Decay rate used	λ	8.94E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.63E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	6.44E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	8.19E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	1.54E+00	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>2D</sub> )	AF	1.60E+00	

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	1.64E-03	mg/l	
Distance to compliance point	830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	6.44E-09	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.

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Calculated concentrations for distance-concentration graph

Ogata Banks  
 From calculation sheet  
 DIN — Concentration

mg/l	9.8E-09
41.6	9.8E-09
83.0	9.8E-09
124.6	9.7E-09
166.0	9.6E-09
207.5	9.3E-09
249.0	9.0E-09
290.5	8.8E-09
332.0	8.6E-09
373.6	8.3E-09
416.0	8.1E-09
458.5	7.8E-09
4W.0	7.6E-09
539.5	7.6E-09
681.0	7.3E-09
822.5	7.1E-09
864.0	7.0E-09
706.6	8.8E-09
747.0	8.7E-09
788.5	8.6E-09
830.0	8.4E-09

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 90E+99

Site being assessed	Bloss Downshire K20 b
Completed by	AJ
Date	24/11/2005
Version	12



Tier 3 -Groundwater



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

Contaminant	Naphthalene		
Target Concentration	C <sub>T</sub>	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
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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 <sub>0</sub>	9.90E-09	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	2.58E+02	days
Calculated decay rate	λ	2.69E-03	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.90E+01	m
Plume thickness at source	Sy	9.90E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	8.30E+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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd	7.24E+00	l/kg
Longitudinal dispersivity	ax	11.020	m
Transverse dispersivity	ay	1.102	m
Vertical dispersivity	az	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	6.87E+01	fraction
Decay rate used	λ	2.69E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.00E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.39E-125	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.34E-125	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	7.12E+26	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	7.40E+26	

Remedial Targets

Remedial Target	LTC3	7.12E+26	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.39E-125	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 7.24E+00 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 7.24E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub>  
Sorption coefficient for ionised species K<sub>ow</sub>  
pH value  
acid dissociation constant pKa

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

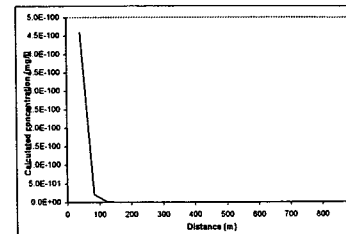
Dispersivity

Calculate dispersivity dependent on distance to compliance point (0) 2

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

Longitudinal dispersivity ax 1.10E+01 m  
Transverse dispersivity ay 1.10E+00 m  
Vertical dispersivity az 1.10E-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<sub>10</sub>ax)<sup>0.42</sup>, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet

Distance	Concentration
	mg/l
41.5	4.6E-100
83.0	2.1E-101
124.5	9.7E-103
186.0	4.4E-104
207.5	2.0E-105
249.0	9.0E-107
290.5	4.1E-108
332.0	1.8E-109
373.5	8.3E-111
415.0	3.7E-112
456.5	1.7E-113
498.0	7.7E-115
639.5	3.6E-116
681.0	1.6E-117
822.5	7.1E-119
864.0	3.2E-120
905.5	1.6E-121
947.0	6.7E-123
988.5	3.1E-124
1030.0	1.4E-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. 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 Downshire K29 b
Completed by	AJ
Date	24 11 2005
Version	12

Tier 3 - Groundwater

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

Contaminant	Phenol
Target Concentration	C <sub>T</sub> 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
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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 <sub>0</sub>	9.90E-09	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.00E+01	days
Calculated decay rate	λ	6.93E-02	days <sup>-1</sup>
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	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	8.30E+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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd	1.05E-01	l/kg
Longitudinal dispersivity	ax	11.020	m
Transverse dispersivity	az	1.102	m
Vertical dispersivity	ay	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	1.08E+00	fraction
Decay rate used	λ	6.93E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	6.94E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.44E-120	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.39E-120	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	6.88E+21	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	7.13E+21	

Remedial Targets

Remedial Target	LTC3	3.49E+16	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		630	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.44E-120	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 Kd  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub>  
Organic carbon partition coefficient K<sub>oc</sub>  
Entry for basic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub>  
Sorption coefficient for ionised species K<sub>ow</sub>  
pH value pH  
acid dissociation constant pKa

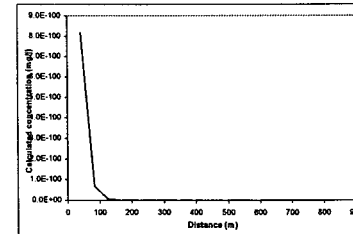
Soil water partition coefficient Kd 1.05E-01 l/kg

Dispersivity

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

Longitudinal dispersivity	ax	11.020	m
Transverse dispersivity	az	1.102	m
Vertical dispersivity	ay	0.110	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<sub>10</sub>x)<sup>0.75</sup>; az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

	mg/l
41.6	8.2E-100
83.0	6.8E-101
124.5	5.6E-102
166.0	4.6E-103
207.5	3.8E-104
249.0	3.1E-105
290.5	2.5E-106
332.0	1.9E-107
373.5	1.6E-108
415.0	1.2E-109
456.5	9.7E-111
498.0	7.6E-112
539.5	6.3E-113
581.0	5.1E-114
622.5	4.1E-116
664.0	3.3E-118
705.5	2.7E-117
747.0	2.2E-118
788.5	1.8E-119
830.0	1.4E-120

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: Biss, Downshire K20 b  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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 <sub>T</sub> 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
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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 <sub>0</sub> 9.90E-09	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub> 7.20E+02	days	
Calculated decay rate	λ 9.93E-04	day <sup>-1</sup>	
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	ds 5.71E+01	m	
Bulk density of aquifer materials	ρ 1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 1.25E-02	fraction	
Hydraulic conductivity of aquifer	K 2.00E+01	m/d	
Distance (lateral) to compliance point perpendicular to flow direction	x 8.30E+02	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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd 2.14E-01	l/kg	see options
Longitudinal dispersivity	ax 11.020	m	see options
Transverse dispersivity	ay 1.102	m	see options
Vertical dispersivity	az 0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.93E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation			
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.17E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.13E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>T</sub> )	AF	8.46E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>T</sub> )	AF	8.79E+00	

Remedial Targets

Remedial Target	LTCS	Value	Unit	Notes
Ogata Banks		8.46E-03	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.17E-09	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

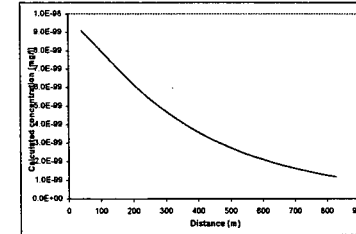
Soil water partition coefficient	Kd	2.14E-01	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Organic carbon partition coefficient	Koc	2.14E-01	l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	K <sub>oc,i</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		

Soil water partition coefficient Kd 2.14E-01 l/kg

Dispersivity

Calculata dependant on distance to compliance point (0)	ax	11.020	m
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	ay	1.102	m
Vertical dispersivity	az	0.110	m

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* z, ay = 0.001 \* x. Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>μ)<sup>0.43</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

41.5	9.1E-09
830.0	1.8E-09
166.0	6.8E-09
207.5	8.1E-09
249.0	6.4E-09
290.5	4.8E-09
332.0	4.3E-09
373.5	3.8E-09
415.0	3.4E-09
456.5	3.1E-09
498.0	2.8E-09
539.5	2.6E-09
581.0	2.2E-09
622.5	2.0E-09
664.0	1.8E-09
705.5	1.6E-09
747.0	1.4E-09
788.5	1.3E-09
830.0	1.2E-09

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+09.

Site being assessed: Bess Downside K20 b  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater



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

Contaminant	sec butylbenzene		
Target Concentration	C <sub>T</sub>	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)

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C <sub>0</sub>	9.90E-09	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	7.20E+22	days
Calculated decay rate	λ	9.83E-04	d <sup>-1</sup>
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	ds	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	8.30E+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
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	2.14E-01	l/kg
Longitudinal dispersivity	αx	1.020	m
Transverse dispersivity	αz	1.102	m
Vertical dispersivity	αy	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	3.00E+00	fraction
Decay rate used	λ	9.83E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	1.17E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	1.13E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	8.45E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	8.79E+00	

Remedial Targets

Remedial Target	Value	Unit	Notes
Remedial Target	LTC3	6.45E-03	mg/l
Ogata Banks			
Distance to compliance point	830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.17E-09	mg/l
after		8.8E+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)

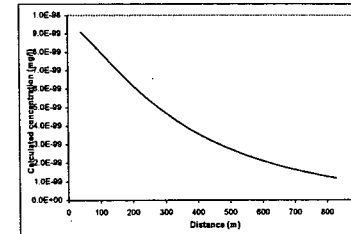
Calculate for non-polar organic chemicals

Soil water partition coefficient	Kd	2.14E-01	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	2.14E-01	l/kg
Organic carbon partition coefficient	K <sub>ow</sub>		l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionized species	pKa		
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	αx	1.10E+01	m
Transverse dispersivity	αz	1.10E+00	m
Vertical dispersivity	αy	1.10E-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(log<sub>10</sub>μ)<sup>0.43</sup>, 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

Ogata Banks  
From calculation sheet

Distance	Concentration	mg/l
41.6	9.1E-09	
83.0	8.3E-09	
124.5	7.6E-09	
166.0	6.8E-09	
207.5	6.1E-09	
249.0	5.4E-09	
290.5	4.8E-09	
332.0	4.3E-09	
373.5	3.8E-09	
415.0	3.4E-09	
456.5	3.1E-09	
498.0	2.8E-09	
539.5	2.6E-09	
581.0	2.2E-09	
622.5	2.0E-09	
664.0	1.8E-09	
705.5	1.6E-09	
747.0	1.4E-09	
788.5	1.3E-09	
830.0	1.2E-09	

Site being assessed: Bless Downhole K20 b  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

Tier 3 - Groundwater

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

Contaminant 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	$C_0$	3.00E+00	mg/l
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days
Calculated decay rate	$\lambda$	7.00E-101	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	$Sz$	8.00E+01	m
Plume thickness at source	$Sy$	9.00E+01	m
Saturated aquifer thickness	$da$	5.71E+01	m
Bulk density of aquifer materials	$\rho$	2.170E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	$n$	1.82E-01	fraction
Hydraulic gradient	$i$	1.25E-02	fraction
Hydraulic conductivity of aquifer	$K$	2.00E+01	m/d
Distance to compliance point	$x$	8.30E+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	$Kd$	9.55E+00	l/kg
Longitudinal dispersivity	$ax$	11.020	m
Transverse dispersivity	$az$	1.102	m
Vertical dispersivity	$ay$	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	9.02E+01	fraction
Decay rate used	$\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	1.52E-02	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion	$C_{1D}$	1.95E+00	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion	$C_{2D}$	1.88E+00	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	1.54E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	1.80E+00	

Remedial Targets

Remedial Target	LYC3	1.54E-02	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.86E+00	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)  $K_{ow}$  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  $Kd$  9.55E+00 l/kg

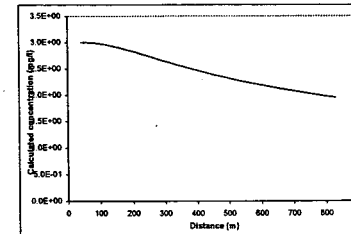
Dispersivity

Calculator dependant on distance to compliance point (0) 2

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

Longitudinal dispersivity	$ax$	Enter value	Calc value Xu & Eckstein	1.10E+01	m
Transverse dispersivity	$az$			1.10E+00	m
Vertical dispersivity	$ay$			1.10E-01	m

For calculated value, assumes  $ax = 0.1 * x$ ,  $az = 0.01 * x$ ,  $ay = 0.001 * x$   
 Xu & Eckstein (1995) report  $ax = 0.83(0.001)^{0.11}$ ,  $az = ax/10$ ,  $ay = ax/100$  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	
41.5	3.0E+00
83.0	3.0E+00
124.5	3.0E+00
166.0	2.9E+00
207.5	2.8E+00
249.0	2.7E+00
290.5	2.7E+00
332.0	2.6E+00
373.5	2.5E+00
415.0	2.4E+00
456.5	2.4E+00
498.0	2.3E+00
539.5	2.3E+00
581.0	2.2E+00
622.5	2.2E+00
664.0	2.1E+00
705.5	2.1E+00
747.0	2.0E+00
788.5	2.0E+00
830.0	2.0E+00

Site being assessed Birstington Area 6 A Downshire K20  
 Completed by AJ  
 Date 24/11/2005  
 Version 12

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 $C_0$	2.30E+01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E-101	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_x$	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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	8.30E+02	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
<b>Parameters values determined from options</b>			
Partition coefficient $K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.020	m	see options
Transverse dispersivity $\alpha_z$	1.102	m	see options
Vertical dispersivity $\alpha_y$	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	days <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.37E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{2D}$	1.50E+01	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{3D}$	1.44E+01	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{2D}$ ) $AF$	1.54E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{3D}$ ) $AF$	1.60E+00	

Remedial Targets

Remedial Target	LTCS	1.54E+00	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	$C_{2D}/C_0$	1.60E+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  $K_d$  0.00E+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  $K_{oc}$  0.00E+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  $pK_a$  l/kg

Soil water partition coefficient  $K_d$  0.00E+00 l/kg

Dispersivity

Calculate dependent on distance to compliance point (0)

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

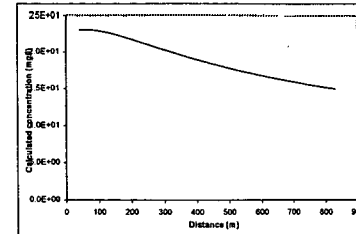
Longitudinal dispersivity  $\alpha_x$  Enter value Calc value Xu & Eckstein 1.10E+01 m

Transverse dispersivity  $\alpha_z$  1.10E+00 m

Vertical dispersivity  $\alpha_y$  1.10E-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  $\alpha_z = 0.83(\log_{10} K_{ow})^{0.5}$ ;  $\alpha_x = \alpha_z/10$ ,  $\alpha_y = \alpha_z/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

41.6	2.3E+01
83.0	2.3E+01
124.5	2.3E+01
166.0	2.2E+01
207.5	2.2E+01
249.0	2.1E+01
290.5	2.0E+01
332.0	2.0E+01
373.5	1.9E+01
415.0	1.9E+01
456.5	1.8E+01
498.0	1.8E+01
539.5	1.7E+01
581.0	1.7E+01
622.5	1.7E+01
664.0	1.6E+01
705.5	1.6E+01
747.0	1.6E+01
788.5	1.5E+01
830.0	1.5E+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: Basingstoke Area 6 A Downshire K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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



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

Contaminant Styrene  
Target Concentration  $C_T$  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)

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  $t_{1/2}$  2.10E+02 days

Calculated decay rate  $\lambda$  3.30E-03 days<sup>-1</sup>  
Width of plume in aquifer at source (perpendicular to flow)  $S_z$  8.00E+01 m

Plume thickness at source  $S_y$  5.90E+01 m  
Saturated aquifer thickness  $d_a$  5.71E+01 m

Bulk density of aquifer materials  $\rho$  1.70E+00 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-01 fraction

Hydraulic gradient  $i$  1.25E-02 fraction  
Hydraulic conductivity of aquifer  $K$  2.00E+01 m/d

Distance (lateral) to compliance point  $x$  8.30E+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

Parameters values determined from options  
Partition coefficient  $K_d$  4.64E+00 V/kg  
Longitudinal dispersivity  $\alpha_x$  1.102 m  
Transverse dispersivity  $\alpha_z$  1.102 m  
Vertical dispersivity  $\alpha_y$  0.110 m

Calculated Parameters Variable

Groundwater flow velocity	$v$	1.37E+00	m/d
Retardation factor	$Rf$	4.43E+01	fraction
Decay rate used	$\lambda$	3.30E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	$u$	3.10E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	1.35E-121	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	1.30E-121	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	$AF$	7.34E+22	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	$AF$	7.64E+22	

Remedial Targets

Remedial Target	LYC3	3.87E+23	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	1.35E-121	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)

Soil water partition coefficient  $K_d$  4.64E+00 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  $K_{oc}$  4.64E+00 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 pH

acid dissociation constant  $pK_a$  V/kg

Soil water partition coefficient  $K_d$  4.64E+00 V/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

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

Longitudinal dispersivity  $\alpha_x$  1.10E+01 m

Transverse dispersivity  $\alpha_z$  1.10E+00 m

Vertical dispersivity  $\alpha_y$  1.10E-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  $\alpha_x = 0.83(\log_{10} t)^{0.43}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

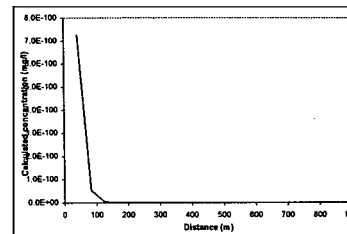
time variant options only

Partition coefficient  $K_d$  4.64E+00 V/kg see options

Longitudinal dispersivity  $\alpha_x$  1.102 m see options

Transverse dispersivity  $\alpha_z$  1.102 m see options

Vertical dispersivity  $\alpha_y$  0.110 m see options



Calculated concentrations for distance-concentration graph

Ogata Bank  
From calculation sheet  
Distance Concentration

	mg/l
41.6	7.3E-100
83.0	6.3E-101
124.6	3.9E-102
166.0	2.8E-103
207.6	2.0E-104
249.0	1.4E-105
290.6	1.0E-106
373.6	6.2E-109
416.0	3.7E-110
456.6	2.6E-111
498.0	1.9E-112
539.6	1.4E-113
622.0	9.7E-116
666.0	3.9E-118
748.6	1.9E-120
830.0	1.3E-121

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 Bank. 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 Devonshire K20 b  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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Tier 3 - Groundwater

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

Contaminant	Sulphide
Target Concentration	C <sub>T</sub> 2.50E-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 <sub>0</sub> 9.20E-01	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub> 9.90E+09	days	
Calculated decay rate	λ 7.00E-101	days <sup>-1</sup>	
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 91.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n 1.82E-01	fraction	
Hydraulic gradient	i 1.25E-02	fraction	
Hydraulic conductivity of aquifer	K 2.00E+01	m/d	
Distance (laterally) to compliance point	x 8.30E+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	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient	Kd 0.00E+00	l/kg	see options
Longitudinal dispersivity	ax 11.020	m	see options
Transverse dispersivity	az 1.102	m	see options
Vertical dispersivity	ay 0.110	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v 1.37E+00	m/d
Retardation factor	Rf 1.00E+00	fraction
Decay rate used	λ 7.00E-101	days <sup>-1</sup>
Rate of contaminant flow due to retardation	u 1.37E+00	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub> 4.03E-01	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub> 3.88E-01	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1</sub> /C <sub>0</sub> )	AF 1.54E+00	
Attenuation factor (two way vertical dispersion, C <sub>2</sub> /C <sub>0</sub> )	AF 1.80E+00	

Remedial Targets

Remedial Target	Value	Unit	Source
Ogata Banks	LTC3 3.94E-04	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point	830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub> 4.03E-01	mg/l	Ogata Banks
after	9.8E+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)

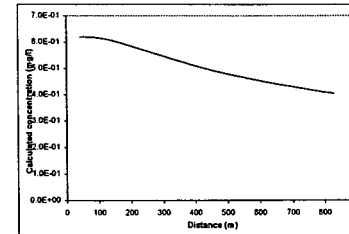
Calculate for non-polar organic chemicals

Variable	Value	Unit
Soil water partition coefficient	Kd	l/kg
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 0.00E+00	l/kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K <sub>oc</sub>	l/kg
Sorption coefficient for ionized species	K <sub>oc,i</sub>	l/kg
pH value	pH	
acid dissociation constant	pKa	
Soil water partition coefficient	Kd 0.00E+00	l/kg

Dispersivity

Variable	Value	Unit
Calculate dependant on distance to compliance point (0)		
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2	
Longitudinal dispersivity	ax 1.10E+01	m
Transverse dispersivity	az 1.10E+00	m
Vertical dispersivity	ay 1.10E-01	m

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* z, ay = 0.001 \* y  
 Xu & Eckstein (1995) report ax = 0.63(log<sub>10</sub> x)<sup>0.83</sup>; az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks

Distance to compliance point	mg/l
41d	6.2E-01
83.0	6.2E-01
124.6	6.1E-01
159.0	6.0E-01
207.6	5.8E-01
249.0	5.7E-01
292.5	6.6E-01
332.0	6.3E-01
373.6	6.2E-01
416.0	5.0E-01
456.6	4.9E-01
498.0	4.8E-01
538.5	4.7E-01
581.0	4.6E-01
622.5	4.5E-01
664.0	4.4E-01
705.6	4.3E-01
747.0	4.2E-01
788.5	4.1E-01
830.0	4.0E-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: Bessington Area 6 A Downshire K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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R&D Publication20 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<sub>T</sub> 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

Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core C <sub>0</sub>	9.90E-09	mg/l	
Half life for degradation of contaminant in water t <sub>1/2</sub>	9.99E+09	days	
Calculated decay rate λ	6.94E-101	day <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) Sz	8.00E+01	m	
Plume thickness at source Sy	8.00E+01	m	
Saturated aquifer thickness da	5.71E+01	m	
Bulk density of aquifer materials ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer n	1.82E-01	fraction	
Hydraulic gradient i	1.28E-02	fraction	
Hydraulic conductivity of aquifer K	2.00E+01	m/d	
Distance to compliance point x	8.30E+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	0.00E+00	m	
Time since pollutant entered groundwater t	9.90E+09	days	time variant options only
<b>Parameters values determined from options</b>			
Partition coefficient Kd	2.14E-01	l/kg	see options
Longitudinal dispersivity ax	11.020	m	see options
Transverse dispersivity az	1.102	m	see options
Vertical dispersivity ay	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity v	1.37E+00	m/d
Retardation factor Rf	3.00E+00	fraction
Decay rate used λ	6.94E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation u	4.58E-01	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion C <sub>1D</sub>	6.44E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion C <sub>2D</sub>	9.19E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>T</sub> ) AF	1.54E+00	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>T</sub> ) AF	1.69E+00	

Remedial Targets

Remedial Target	Value	Unit	Source
LTC3	1.54E-03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	830	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub> 6.44E-09	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

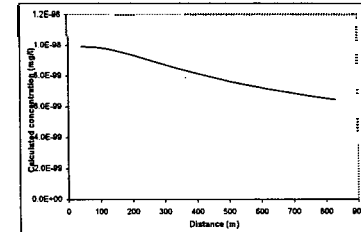
Entry if specify partition coefficient (option)  
Soil water partition coefficient Kd 2.14E-01 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer foc 1.00E+00 fraction  
Organic carbon partition coefficient Koc 2.14E-01 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub> l/kg  
Sorption coefficient for ionised species K<sub>oc1</sub> l/kg  
pH value pH  
acid dissociation constant pKa

Soil water partition coefficient Kd 2.14E-01 l/kg

Dispersivity

Calculate dependent on distance to compliance point (1) 2  
specify dispersivity (1), or calc after Xu & Eckstein (2)  
Longitudinal dispersivity ax 1.10E+01 m  
Transverse dispersivity az 1.10E+00 m  
Vertical dispersivity ay 1.10E-01 m

For calculated value, assumes ax = 0.1 \* x, az = 0.01 \* z, ay = 0.001 \* x  
Xu & Eckstein (1995) report ax = 0.83(log<sub>10</sub>p)<sup>0.44</sup>, az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Output calculation sheet

Distance	Concentration	mg/l
41.5	9.9E-09	
83.0	9.9E-09	
124.5	9.7E-09	
166.0	9.6E-09	
207.5	9.3E-09	
249.0	9.0E-09	
290.5	8.8E-09	
332.0	8.6E-09	
373.5	8.3E-09	
415.0	8.1E-09	
456.5	7.8E-09	
498.0	7.6E-09	
539.5	7.6E-09	
581.0	7.3E-09	
622.5	7.1E-09	
664.0	7.0E-09	
705.5	6.8E-09	
747.0	6.7E-09	
788.5	6.6E-09	
830.0	6.4E-09	

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+09

Site being assessed: Bliss Downshire K20 b  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

Tier 3 -Groundwater

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

Contaminant	Total Cyanide		
Target Concentration	C <sub>T</sub>	1.90E-02	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 <sub>0</sub>	6.40E+01	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	2.92E+01	days
Calculated decay rate	λ	2.38E-02	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	2.80E+01	m
Plume thickness at source	Sy	5.90E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	8.30E+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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd	9.90E+00	l/kg
Longitudinal dispersivity	ax	11.020	m
Transverse dispersivity	az	1.102	m
Vertical dispersivity	ay	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	9.35E+01	fraction
Decay rate used	λ	2.38E-02	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.47E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	8.33E-122	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	8.01E-122	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	7.68E+122	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	7.98E+122	

Remedial Targets

Remedial Target	LYCS	7.98E+122	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	8.33E-122	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	9.90E+00	l/kg
Entry for non-polar organic chemicals (option)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer	Koc	9.90E+00	l/kg
Organic carbon partition coefficient	K <sub>ow</sub>		l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species	K <sub>ow</sub>		l/kg
Sorption coefficient for ionised species	pKa		
pH value			
acid dissociation constant			

Soil water partition coefficient Kd 9.90E+00 l/kg

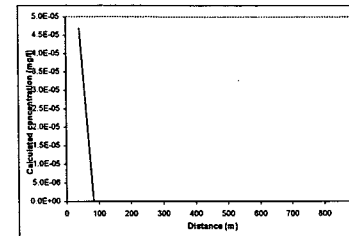
Dispersivity

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	1.10E+01	m
Transverse dispersivity	az			1.10E+00	m
Vertical dispersivity	ay			1.10E-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<sub>10</sub>ax)<sup>0.75</sup>, 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.

Site being assessed	Blossington Area 6 A Downshire K20
Completed by	AJ
Date	24 11 2005
Version	12

Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance Concentration

Distance	Concentration
41.5	4.7E-06
83.0	3.4E-11
124.5	2.6E-17
166.0	1.8E-23
207.5	1.3E-29
249.0	9.1E-36
290.5	6.4E-42
332.0	4.6E-48
373.5	3.3E-54
416.0	2.3E-60
456.5	1.7E-66
498.0	1.2E-72
539.5	8.6E-79
581.0	6.1E-85
622.5	4.4E-91
664.0	3.1E-97
705.5	2.2E-103
747.0	1.6E-109
71.6	1.2E-116
830.0	8.3E-122

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  $C_T$  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) 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 $C_0$	1.47E-01	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	9.90E+99	days	
Calculated decay rate $\lambda$	7.00E-101	fraction	
Width of plume in aquifer at source (perpendicular to flow) $S_z$	8.00E+01	m	
Plume thickness at source $S_y$	5.80E+01	m	
Saturated aquifer thickness $d_a$	5.71E+01	m	
Bulk density of aquifer materials $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	8.30E+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 $K_d$	0.00E+00	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.020	m	see options
Transverse dispersivity $\alpha_z$	1.102	m	see options
Vertical dispersivity $\alpha_y$	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	1.00E+00	fraction
Decay rate used $\lambda$	7.00E-101	d <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	1.37E+00	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{20}$	9.58E-02	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{20}$	9.19E-02	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{20}$ ) $AF$	1.54E+00	
Attenuation factor (two way vertical dispersion, $C_0/C_{20}$ ) $AF$	1.60E+00	

Remedial Targets

Remedial Target	Value	Unit	Source
Remedial Target LTC3	1.54E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	830	m	
Concentration of contaminant at compliance point after	5.68E-02	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  $K_d$  0.00E+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  $K_{oc}$  0.00E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species  $K_{ow}$  0.00E+00 l/kg  
Sorption coefficient for ionised species  $K_{ow,i}$  0.00E+00 l/kg  
pH value  
acid dissociation constant  $pK_a$

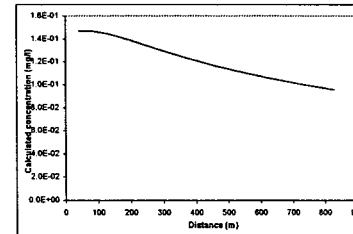
Soil water partition coefficient  $K_d$  0.00E+00 l/kg

Dispersivity

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

Longitudinal dispersivity  $\alpha_x$  1.10E+01 m  
Transverse dispersivity  $\alpha_z$  1.10E+00 m  
Vertical dispersivity  $\alpha_y$  1.10E-01 m

For calculated value, assumes  $\alpha_x = 0.1 \%$ ,  $\alpha_z = 0.01 \%$ ,  $\alpha_y = 0.001 \%$   
Xu & Eckstein (1995) report  $\alpha_z = 0.83(\log_{10} t)^{0.4}$ ,  $\alpha_x = \alpha_z/10$ ,  $\alpha_y = \alpha_z/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks Distance/Concentration

Distance (m)	Concentration (mg/l)
41.6	1.6E-01
68.0	1.6E-01
124.5	1.4E-01
110.0	1.4E-01
207.5	1.4E-01
249.0	1.3E-01
290.5	1.3E-01
332.0	1.3E-01
373.5	1.2E-01
415.0	1.2E-01
456.5	1.2E-01
498.0	1.1E-01
689.5	1.1E-01
681.0	1.1E-01
622.5	1.1E-01
664.0	1.0E-01
706.5	1.0E-01
747.0	9.8E-02
788.5	9.7E-02
830.0	9.6E-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: Bressington Area @ A. Downshire K20  
Compiled by: AJ  
Date: 24.11.2005  
Version: 12

Tier 3 - Groundwater

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

Contaminant	1,2,4-trimethylbenzene
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 <sub>0</sub>	1.3.00E+03	mg/l	Source of parameter value
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.80E+02	days	
Calculated decay rate	λ	1.93E-03	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+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 <sup>3</sup>	
Effective porosity of aquifer		1.82E-01	fraction	
Hydraulic gradient		1.25E-02		
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	8.30E+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	2.95E+01	l/kg	see options
Longitudinal dispersivity	ax	11.020	m	see options
Transverse dispersivity	az	1.102	m	see options
Vertical dispersivity	ay	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	2.77E+02	fraction
Decay rate used	λ	1.93E-03	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	4.97E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>EO</sub>	1.21E-56	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>EB</sub>	1.18E-59	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>EO</sub> )	AF	2.49E+53	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>EB</sub> )	AF	2.88E+53	

Remedial Targets

Remedial Target	LTC3	2.49E+53	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>EB</sub> /C <sub>0</sub>	1.21E-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)

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)	foc	1.00E+00	fraction
Fraction of organic carbon in aquifer			
Organic carbon partition coefficient	Koc	2.95E+01	l/kg
Entry for ionic organic chemicals (option)	K <sub>ow</sub>		l/kg
Sorption coefficient for related species			
Sorption coefficient for ionised species	K <sub>ow,i</sub>		l/kg
pH value	pH		
acid dissociation constant	pKa		

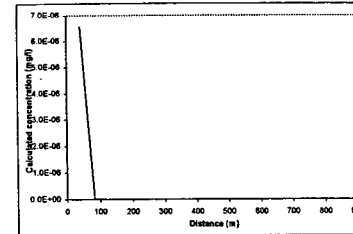
Soil water partition coefficient Kd 2.95E+01 l/kg

Dispersivity

Calculate dispersivity 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				1.10E+00 m
Vertical dispersivity	ay				1.10E-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<sub>10</sub>Q)<sup>0.41</sup>; az = ax/10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
41.5	0.6E-06
83.0	1.4E-08
124.5	3.1E-11
166.0	6.6E-14
207.5	1.4E-16
249.0	3.0E-19
290.5	6.3E-22
332.0	1.3E-24
373.5	2.9E-27
415.0	6.1E-30
456.6	1.3E-32
498.0	2.8E-35
539.5	5.9E-38
581.0	1.3E-40
622.5	2.7E-43
664.0	5.7E-46
705.5	1.2E-48
747.0	2.6E-51
788.5	5.6E-54
830.0	1.2E-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 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: Bloss Downshire K2D b  
Compiled by: AJ  
Date: 24/11/2005  
Version: 12

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Tier 3 - Groundwater

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

Contaminant Target Concentration  $C_T$  1.5 5 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 of parameter value
Initial contaminant concentration in groundwater at plume core $C_0$	1.00E-03	mg/l	
Half life for degradation of contaminant in water $t_{1/2}$	3.00E+02	days	
Calculated decay rate $\lambda$	1.93E-03	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow) $S_z$	8.00E+03	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 $\rho$	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer $n$	1.82E-01	fraction	
Hydraulic gradient $i$	1.25E-02	fraction	
Hydraulic conductivity of aquifer $K$	2.00E+01	m/d	
Distance to compliance point $x$	8.30E+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	time variant options only
Parameters values determined from options			
Partition coefficient $K_d$	2.95E+01	l/kg	see options
Longitudinal dispersivity $\alpha_x$	11.020	m	see options
Transverse dispersivity $\alpha_z$	1.102	m	see options
Vertical dispersivity $\alpha_y$	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity $v$	1.37E+00	m/d
Retardation factor $Rf$	2.77E+02	fraction
Decay rate used $\lambda$	1.93E-03	days <sup>-1</sup>
Rate of contaminant flow due to retardation $u$	4.97E-03	m/d
Contaminant concentration at distance $x$ , assuming one-way vertical dispersion $C_{1D}$	4.02E-07	mg/l
Contaminant concentration at distance $x$ , assuming two-way vertical dispersion $C_{2D}$	3.87E-07	mg/l
Attenuation factor (one way vertical dispersion, $C_{1D}/C_0$ ) $AF$	2.49E+53	
Attenuation factor (two way vertical dispersion, $C_{2D}/C_0$ ) $AF$	2.59E+53	

Remedial Targets

Remedial Target	LTG3	2.49E+51	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	$C_{1D}/C_0$	4.02E-07	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)

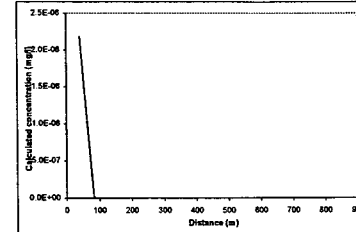
Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)		
Soil water partition coefficient $K_d$		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 $K_{oc}$	2.95E+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 $pK_a$		
Soil water partition coefficient $K_d$	2.95E+01	l/kg

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

Dispersivity	Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity $\alpha_x$		1.10E+01 m
Transverse dispersivity $\alpha_z$		1.10E+00 m
Vertical dispersivity $\alpha_y$		1.10E-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  $\alpha_x = 0.83(\log_{10} K_{ow})^{0.5}$ ;  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
41.6	2.2E-06
83.0	4.8E-09
124.6	1.0E-11
164.0	2.2E-14
207.6	4.7E-17
249.0	9.9E-20
292.0	1.5E-23
373.6	9.5E-28
416.0	2.0E-30
456.6	4.3E-33
498.0	9.2E-36
639.6	2.0E-38
661.0	4.2E-41
622.6	8.9E-44
664.0	1.9E-47
705.6	4.1E-50
747.0	8.7E-52
711.6	1.9E-54
830.0	4.0E-57

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 Downside K20 b  
Completed by: AJ  
Date: 24 11 2005  
Version: 12

Tier 3 - Groundwater



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

Contaminant: 1,4 Dichlorobenzene  
 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 RADPub. 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
$C_0$	9.90E-09	mg/l	
$t_{1/2}$	3.60E+02	days	
$\lambda$	1.93E-03	days <sup>-1</sup>	
Sz	8.00E+01	m	
Sy	3.50E+01	m	
da	5.71E+01	m	
$\rho$	1.70E+00	g/cm <sup>3</sup>	
n	1.82E-01	fraction	
i	1.25E-02	fraction	
K	2.00E+01	m/d	
x	8.30E+02	m	
z	0.00E+00	m	
y	0.00E+00	m	
t	9.90E+09	days	
Kd	7.76E+00	l/kg	
ax	11.020	m	
az	1.102	m	
ay	0.110	m	

Calculated Parameters Variable

v	1.37E+00	m/d
Rf	7.35E+01	fraction
$\lambda'$	1.93E-03	d <sup>-1</sup>
u	1.87E-02	m/d
$C_{E0}$	4.63E-121	mg/l
$C_{E2}$	4.45E-121	mg/l
AF	2.14E+22	
AF	2.22E+22	

Remedial Targets Remedial Target LYC3 2.14E+22 mg/l For comparison with measured groundwater concentration.

Distance to compliance point	830	m
Concentration of contaminant at compliance point	$C_{E0}/C_0$ 4.63E-121	mg/l
after	8.9E+09	days

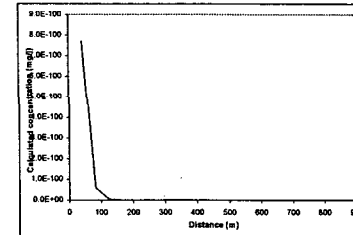
Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target. The recommended value for time when calculating the remedial target is 9.9E+09.

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

Calculate for non-polar organic chemicals

Kd	7.76E+00	l/kg
foc	1.00E+00	fraction
Koc	7.76E+00	l/kg
K <sub>ow</sub>		
K <sub>ow</sub>		
pH		
pKa		
Kd	7.76E+00	l/kg
ax	1.10E+01	m
az	1.10E+00	m
ay	1.10E-01	m

For calculated value, assumes  $ax = 0.1 \times z$ ,  $az = 0.01 \times x$ ,  $ay = 0.001 \times z$   
 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

Ogata Banks From calculation sheet Distance Concentration

41.5	7.7E-100
83.0	6.0E-101
124.5	4.6E-102
166.0	3.6E-103
207.5	2.7E-104
249.0	2.1E-105
290.5	1.6E-106
332.0	1.2E-107
373.5	9.0E-109
415.0	6.8E-110
456.6	5.2E-111
498.0	4.0E-112
539.5	3.0E-113
581.0	2.3E-114
622.6	1.8E-115
664.0	1.3E-116
705.5	1.0E-117
747.0	7.9E-119
788.5	6.0E-120
830.0	4.6E-121

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: Bless Downshire X20 b  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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

Tier 3 - Groundwater

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, '2' for two directions (pull down menu)

Enter '1' if degradation rate is for the substance (pull down menu), '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  $C_0$  2.12E-02 mg/l

Half life for degradation of contaminant in water  $t_{1/2}$  1.23E-03 days

Calculated decay rate  $\lambda$  3.80E-04 days<sup>-1</sup>

Width of plume in aquifer at source (perpendicular to flow)  $Sz$  5.82E-01 m

Plume thickness at source  $Sz$  5.82E-01 m

Estimated aquifer thickness  $da$  5.21E-01 m

Bulk density of aquifer material  $\rho$  1.70E+00 g/cm<sup>3</sup>

Effective porosity of aquifer  $n$  1.22E-01 fraction

Hydraulic gradient  $i$  1.25E-02 fraction

Hydraulic conductivity of aquifer  $K$  2.00E-01 m/d

Distance to compliance point  $x$  8.30E-02 m

Distance (along) 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 initial groundwater  $t$  9.90E-99 days

Parameters values determined from options

Partition coefficient  $Kd$  1.15E+02

Longitudinal dispersivity  $\alpha_x$  1.10E+00 m

Transverse dispersivity  $\alpha_z$  1.10E+00 m

Vertical dispersivity  $\alpha_y$  0.110 m

Calculated Parameters Variable

Groundwater flow velocity  $v$  1.37E+00 m/d

Retardation factor  $Rf$  1.07E+03

Decay rate used  $\lambda$  3.80E-04 d<sup>-1</sup>

Rate of contaminant flow due to retardation  $u$  1.28E-03 m/d

Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{1D}$  1.33E-47 mg/l

Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{2D}$  1.28E-47 mg/l

Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ )  $AF$  1.80E+45

Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  1.86E+45

Remedial Target  $TC3$  1.16E+43 mg/l

Distance to compliance point 830 m

Concentration of contaminant at compliance point  $C_{p,CO}$  1.33E-47 mg/l

after 9.9E+99 days

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

Contaminant Aliphatic C8-C10 mg/l

Target Concentration  $C_T$  1.1E-04 mg/l

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

Soil water partition coefficient  $Kd$  1.00E+00

Entry for non-polar organic chemicals (option)  $Kd$  1.00E+00

Entry for ionic organic chemicals (option)  $Koc$  1.15E+02

Fraction of organic carbon in aquifer  $foc$  1.15E+02

Organic carbon partition coefficient  $Koc$  1.15E+02

Entry for ionic organic chemicals (option)  $Koc$  1.15E+02

Sorption coefficient for related species  $K_{oc}$  1.15E+02

Sorption coefficient for related species  $K_{oc}$  1.15E+02

Sorption coefficient for related species  $K_{oc}$  1.15E+02

pH value  $pH$  7.00

acid dissociation constant  $pKa$  7.00

Soil water partition coefficient  $Kd$  1.15E+02

Source of parameter value

Calculate dependent on distance to compliance point (0)  $Kd$  1.15E+02

Calculate dependent on distance to compliance point (0)  $Kd$  1.15E+02

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

Longitudinal dispersivity  $\alpha_x$  1.10E+01

Transverse dispersivity  $\alpha_z$  1.10E+00

Vertical dispersivity  $\alpha_y$  1.10E-01

For calculated value, assumes  $\alpha_x = 0.1 \times r_w$ ,  $\alpha_z = 0.01 \times r_w$ ,  $\alpha_y = 0.001 \times r_w$

Xu & Eckstein (1995) report  $\alpha_x = 0.25(D_{org})^{0.5}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

For comparison with measured groundwater concentration.

Remedial Target  $TC3$  1.16E+43 mg/l

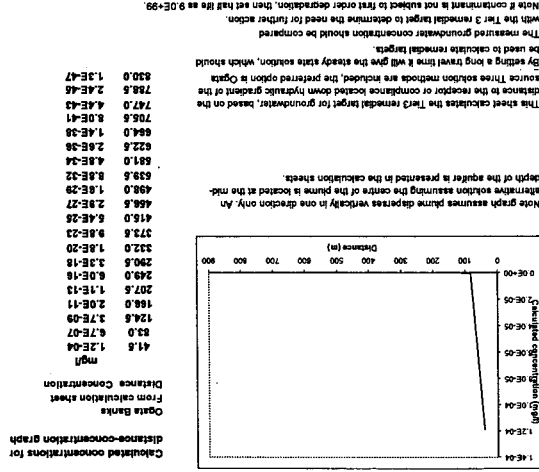
Distance to compliance point 830 m

Concentration of contaminant at compliance point  $C_{p,CO}$  1.33E-47 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.



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.

Enter value  $Kd$  & Eckstein

Enter value  $Koc$  & Eckstein (2) ?

Longitudinal dispersivity  $\alpha_x$  1.10E+01

Transverse dispersivity  $\alpha_z$  1.10E+00

Vertical dispersivity  $\alpha_y$  1.10E-01

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 as 9.0E+99.

Version 12

Date 24 11 2005

Computed By AL

The being assessed Deansgate Ave & A Donnington K20



Tier 3 - Groundwater



**Input Parameters (using pull down menu)**

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**  $C_0$  2.12E-02 mg/l

**Half life for degradation of contaminant in water**  $t_{1/2}$  1.83E+03 days

**Calculated decay rate**  $\lambda$  3.80E-04 days<sup>-1</sup>

**Width of plume in aquifer at source (perpendicular to flow)**  $Sz$  8.00E+01 m

**Plume thickness at source**  $Sy$  2.50E+01 m

**Saturated aquifer thickness**  $da$  5.71E+01 m

**Bulk density of aquifer materials**  $\rho$  1.70E+00 g/cm<sup>3</sup>

**Effective porosity of aquifer**  $n$  1.82E-01 fraction

**Hydraulic gradient**  $i$  1.25E-02 fraction

**Hydraulic conductivity of aquifer**  $K$  2.00E+01 m/d

**Distance (lateral) to compliance point perpendicular to flow direction**  $x$  6.30E+02 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+02	W/g	see options
Longitudinal dispersivity	ax	11.020	m	see options
Transverse dispersivity	az	1.102	m	see options
Vertical dispersivity	ay	0.110	m	see options

**Calculated Parameters**

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	8.52E+03	fraction
Decay rate used	$\lambda$	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	1.81E-04	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	$C_{1D}$	1.12E-153	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	$C_{2D}$	1.07E-153	mg/l
Attenuation factor (one way vertical dispersion, $C_0/C_{1D}$ )	AF	1.90E+151	
Attenuation factor (two way vertical dispersion, $C_0/C_{2D}$ )	AF	1.97E+151	

**Remedial Targets**

Remedial Target	LYCS	1.38E+149	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		530	m	
Concentration of contaminant at compliance point	$C_{2D}/C_0$	1.12E-163	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)**

Soil water partition coefficient  $Kd$  9.12E+02 W/g

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+02 W/g

**Entry for ionic organic chemicals (option)**

Sorption coefficient for related species  $K_{oc}$  W/g

Sorption coefficient for ionised species  $K_{oc}$  W/g

pH value  $pH$

acid dissociation constant  $pKa$

**Source of parameter value**

Soil water partition coefficient  $Kd$  9.12E+02 W/g

**Dispersivity**

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

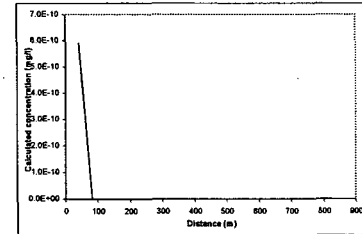
Longitudinal dispersivity  $ax$  11.020 m

Transverse dispersivity  $az$  1.102 m

Vertical dispersivity  $ay$  0.110 m

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

Xu & Eckstein (1995) report  $ax = 0.83(\log_{10} x)^{1.14}$ ;  $az = ax/10$ ,  $ay = ax/100$  are assumed



**Calculated concentrations for distance-concentration graph**

Ogata Banks From calculation sheet

Distance	Concentration
	mg/l
41.6	6.9E-10
83.0	1.8E-17
124.5	4.8E-26
166.0	1.2E-32
207.6	3.4E-40
249.1	9.1E-48
290.6	2.4E-56
332.0	6.7E-63
373.5	1.8E-70
415.0	4.8E-78
456.5	1.3E-85
498.0	3.6E-93
539.5	9.7E-101
581.0	2.6E-108
622.5	7.0E-116
664.0	1.9E-123
705.5	5.1E-131
747.0	1.4E-138
788.5	3.7E-146

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: Brossington Area 6 A Downshire K20  
 Completed by: AJ  
 Date: 24/11/2005  
 Version: 12

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

Tier 3 - Groundwater

**Input Parameters (using pull down menu)**

Contaminant: Aliphatic C12-C18  
 Target Concentration: 1.14E+04 mg/l  
 Equations in RAD Pub. 20: Ogata Banks

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

Calculate for non-polar organic chemicals  
 Entry if apathy partition coefficient (option)  
 Entry for non-polar organic chemicals (option)  
 Entry for non-polar organic chemicals (option)  
 Fraction of organic carbon in aquifer  
 Organic carbon partition coefficient  
 Sorption coefficient for labeled species  
 Sorption coefficient for non-labeled species  
 pH value  
 acid dissociation constant  
 Soil water partition coefficient

**Dispersivity**

Calculate dispersivity on distance to compliance point (D)  
 Dispersivity: 2

**Calculate for non-polar organic chemicals**

For calculated value, assume  $\alpha x = 0.1$ ,  $\alpha z = 0.01$ ,  $\alpha y = 0.001$ ,  $\alpha z = \alpha x / 10$ ,  $\alpha y = \alpha x / 100$  are assumed  
 X & Eckstein (1995) report  $\alpha x = 0.031$ ,  $\alpha z = \alpha x / 10$ ,  $\alpha y = \alpha x / 100$  are assumed

**Longitudinal dispersivity**  
 Longitudinal dispersivity: 1.10E+01 m  
 Transverse dispersivity: 1.10E+00 m  
 Vertical dispersivity: 1.10E-01 m

**Hydraulic conductivity of aquifer**  
 Hydraulic conductivity of aquifer: 2.00E-01 m/d  
 Hydraulic gradient: 1.29E-01 fraction  
 Effective porosity of aquifer: 1.82E-01 fraction  
 Bulk density of aquifer materials: 1.70E+00 g/cm<sup>3</sup>  
 Saturated aquifer thickness: 5.21E+01 m  
 Plume thickness at source: 5.00E+01 m  
 Width of plume in aquifer at source (perpendicular to flow): 8.00E+01 m  
 Calculated decay rate: 3.00E-04 days<sup>-1</sup>  
 Half life for degradation of contaminant in water: 1.33E+03 days  
 Initial contaminant concentration in groundwater at plume core: 2.12E+02 mg/l

**Distance (later) to compliance point perpendicular to flow direction**  
 Distance (later) to compliance point perpendicular to flow direction: 0.00E+00 m  
 Distance (depth) to compliance point perpendicular to flow direction: 0.00E+00 m  
 Three point entered groundwater parameter values determined from options  
 Partition coefficient: 1.82E+04  
 Retardation factor (two way vertical dispersion, C/C<sub>0</sub>): 1.102  
 Longitudinal dispersivity: 1.102  
 Transverse dispersivity: 1.102  
 Vertical dispersivity: 0.110

**Groundwater flow velocity**  
 Groundwater flow velocity: 1.37E+00 m/d  
 Retardation factor: 1.70E+05  
 Decay rate used: 3.00E-04 d<sup>-1</sup>  
 Rate of contaminant flow due to retardation: 8.08E-08 m/d  
 Contaminant concentration at distance x, assuming one-way vertical dispersion: 8.08E-08 mg/l  
 Contaminant concentration at distance x, assuming two-way vertical dispersion: 8.08E-08 mg/l  
 Attenuation factor (two way vertical dispersion, C/C<sub>0</sub>): 8.08E-08 mg/l

**Remedial Targets**

Remedial Target: LTO3 #NUM!  
 Ogata Banks  
 Distance to compliance point: 830 m  
 Concentration of contaminant at compliance point after: 8.9E+99 mg/l  
 Ogata Banks

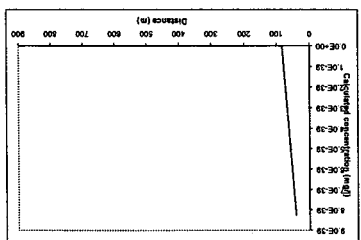
**Calculated Parameters**

Variable: V  
 Value: 1.37E+00 m/d  
 Groundwater flow velocity  
 Variable: Rf  
 Value: 1.70E+05 fraction  
 Retardation factor  
 Variable: λ  
 Value: 3.00E-04 d<sup>-1</sup>  
 Decay rate used  
 Variable: U  
 Value: 8.08E-08 m/d  
 Rate of contaminant flow due to retardation  
 Variable: C<sub>0</sub>  
 Value: 8.08E-08 mg/l  
 Contaminant concentration at distance x, assuming one-way vertical dispersion  
 Variable: C<sub>x</sub>  
 Value: 8.08E-08 mg/l  
 Contaminant concentration at distance x, assuming two-way vertical dispersion  
 Variable: AF  
 Value: 8.08E-08 mg/l  
 Attenuation factor (two way vertical dispersion, C/C<sub>0</sub>)  
 Variable: Vd  
 Value: 0.110 m  
 Vertical dispersivity  
 Variable: Vt  
 Value: 1.102 m  
 Transverse dispersivity  
 Variable: Vl  
 Value: 1.102 m  
 Longitudinal dispersivity  
 Variable: Kd  
 Value: 1.82E+04 mg  
 Partition coefficient  
 Variable: L  
 Value: 5.21E+01 m  
 Saturated aquifer thickness  
 Variable: W  
 Value: 8.00E+01 m  
 Width of plume in aquifer at source (perpendicular to flow)  
 Variable: S<sub>0</sub>  
 Value: 5.00E+01 m  
 Plume thickness at source  
 Variable: ρ<sub>s</sub>  
 Value: 1.70E+00 g/cm<sup>3</sup>  
 Bulk density of aquifer materials  
 Variable: n<sub>e</sub>  
 Value: 1.82E-01 fraction  
 Effective porosity of aquifer  
 Variable: i  
 Value: 1.29E-01 fraction  
 Hydraulic gradient  
 Variable: K<sub>v</sub>  
 Value: 2.00E-01 m/d  
 Hydraulic conductivity of aquifer  
 Variable: X  
 Value: 0.00E+00 m  
 Distance (later) to compliance point perpendicular to flow direction  
 Variable: Z  
 Value: 0.00E+00 m  
 Distance (depth) to compliance point perpendicular to flow direction  
 Variable: Y  
 Value: 0.00E+00 m  
 Three point entered groundwater parameter values determined from options  
 Variable: P  
 Value: 1.82E+04  
 Partition coefficient  
 Variable: Rf  
 Value: 1.102  
 Retardation factor  
 Variable: λ  
 Value: 3.00E-04  
 Decay rate used  
 Variable: U  
 Value: 8.08E-08  
 Rate of contaminant flow due to retardation  
 Variable: C<sub>0</sub>  
 Value: 8.08E-08  
 Contaminant concentration at distance x, assuming one-way vertical dispersion  
 Variable: C<sub>x</sub>  
 Value: 8.08E-08  
 Contaminant concentration at distance x, assuming two-way vertical dispersion  
 Variable: AF  
 Value: 8.08E-08  
 Attenuation factor (two way vertical dispersion, C/C<sub>0</sub>)

**For comparison with measured groundwater concentration.**

Ogata Banks  
 Distance to compliance point: 830 m  
 Concentration of contaminant at compliance point after: 8.9E+99 mg/l  
 Ogata Banks

Care should be used when calculating remedial targets using the time variant option 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.



Calculated concentrations for Ogata Banks

From calculation sheet

Distance Concentration

Distance (m)	Concentration (mg/l)
0	1.82E+04
100	1.82E+04
200	1.82E+04
300	1.82E+04
400	1.82E+04
500	1.82E+04
600	1.82E+04
700	1.82E+04
800	1.82E+04
830	0
900	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 point, 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.

See being assessed: Designation Area 9 A Downhole K20

Completed by: EJ

Date: 24 11 2005

Version: 12

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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	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)

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 <sub>0</sub>	2.12E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	3.65E+03	days
Calculated decay rate	λ	1.90E-04	d <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	5.90E+01	m
Saturated aquifer thickness	ds	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point	x	8.30E+02	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
<b>Parameters values determined from options</b>			
Partition coefficient	Kd	2.29E+06	l/kg
Longitudinal dispersivity	ax	11.020	m
Transverse dispersivity	az	1.102	m
Vertical dispersivity	ay	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	2.14E+07	fraction
Decay rate used	λ	1.90E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	6.42E-06	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	#NUM!	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	#NUM!	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	#NUM!	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	#NUM!	

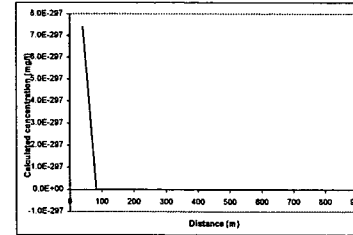
Remedial Targets

Remedial Target	LTC3	#NUM!	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	#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)

<b>Calculates for non-polar organic chemicals</b>	
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 retarded species	K <sub>ow</sub>
Sorption coefficient for ionised species	K <sub>oc</sub>
pH value	pH
acid dissociation constant	pKa
Soil water partition coefficient	Kd 2.29E+06 l/kg
<b>Dispersivity</b>	
Calculate dependent on distance to compliance point (0)	
specify dispersivity (1), or calc after Xu & Eckstein (2) ?	2
Longitudinal dispersivity	ax 11.020 m
Transverse dispersivity	az 1.102 m
Vertical dispersivity	ay 0.110 m
For calculated value, assumes ax = 0.1 * x, az = 0.01 * z, ay = 0.001 * y. Xu & Eckstein (1995) report az = 0.83(log <sub>10</sub> ax) <sup>0.41</sup> ; az = ax/10, ay = ax/100 are assumed	



Calculated concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Concentration
	mg/l
41.5	7.4E-287
83.0	#NUM!
124.5	#NUM!
166.0	#NUM!
207.5	#NUM!
249.0	#NUM!
290.6	#NUM!
332.0	#NUM!
373.5	#NUM!
415.0	#NUM!
456.5	#NUM!
498.0	#NUM!
539.5	#NUM!
581.0	#NUM!
622.6	#NUM!
664.0	#NUM!
705.5	#NUM!
747.0	#NUM!
788.5	#NUM!
830.0	#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 5 A Davanahire K20
Completed by	AJ
Date	24/11/2005
Version	12

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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: 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  
Half life for degradation of contaminant in water  $t_{1/2}$  7.30E+02 days  
Calculated decay rate  $\lambda$  9.50E-04 days<sup>-1</sup>  
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  $\rho$  1.70E+03 g/cm<sup>3</sup>  
Effective porosity of aquifer  $n$  1.82E-01 fraction  
Hydraulic gradient  $i$  1.28E-02  
Hydraulic conductivity of aquifer  $K$  2.00E+01 m/d  
Distance to compliance point  $x$  8.30E+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  $K_d$  1.45E+01 l/kg see options  
Longitudinal dispersivity  $\alpha_x$  11.020 m see options  
Transverse dispersivity  $\alpha_z$  1.102 m see options  
Vertical dispersivity  $\alpha_y$  0.110 m see options

Calculated Parameters Variable

Groundwater flow velocity  $v$  1.37E+00 m/d  
Retardation factor  $Rf$  1.36E+02 fraction  
Decay rate used  $\lambda$  9.50E-04 d<sup>-1</sup>  
Rate of contaminant flow due to retardation  $u$  1.01E-02 m/d  
Contaminant concentration at distance  $x$ , assuming one-way vertical dispersion  $C_{1D}$  2.52E-23 mg/l  
Contaminant concentration at distance  $x$ , assuming two-way vertical dispersion  $C_{2D}$  2.43E-23 mg/l  
Attenuation factor (one way vertical dispersion,  $C_0/C_{1D}$ )  $AF$  8.40E+20  
Attenuation factor (two way vertical dispersion,  $C_0/C_{2D}$ )  $AF$  8.74E+20

Remedial Targets

Remedial Target: LTC3 6.00E+17 mg/l For comparison with measured groundwater concentration.  
Ogata Banks  
Distance to compliance point 830 m  
Concentration of contaminant at compliance point  $C_{1D}/C_0$  2.62E-23 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)

Soil water partition coefficient  $K_d$  1.45E+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  $K_{oc}$  1.45E+01 l/kg

Entry for ionic organic chemicals (option)

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

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

pH value  $pH$

acid dissociation constant  $pK_a$

Soil water partition coefficient  $K_d$  1.45E+01 l/kg

Dispersivity

Calculate dispersivity dependent on distance to compliance point (0)

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

Longitudinal dispersivity  $\alpha_x$  11.020 m

Transverse dispersivity  $\alpha_z$  1.102 m

Vertical dispersivity  $\alpha_y$  0.110 m

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

Xu & Eckstein (1995) report  $\alpha_x = 0.63(\log_{10} C_0)^{0.11}$ ,  $\alpha_z = \alpha_x/10$ ,  $\alpha_y = \alpha_x/100$  are assumed

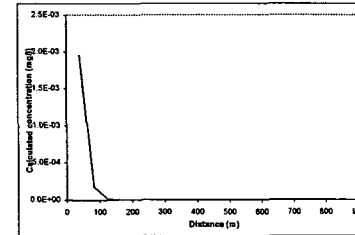
time variant options only

see options

see options

see options

see options



Calculated concentrations for distance-concentration graph

Ogata Banks Distance-Concentration

41.5 1.3E-03  
83.0 1.8E-04  
124.6 1.6E-05  
166.0 1.5E-06

287.6 1.3E-07  
332.0 1.0E-09  
376.6 8.3E-12  
416.0 7.4E-13  
454.6 1.0E-14  
495.0 6.9E-16  
610.6 6.3E-17  
622.6 4.3E-18  
664.0 3.8E-19  
705.6 3.6E-20  
747.0 3.1E-21  
788.6 2.6E-22  
830.0 2.2E-23

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: Botsington Area 6 A Downshire K20  
Completed by: RJ  
Date: 24/11/2005  
Version: 12

R&D Publication20 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<sub>T</sub> 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
C <sub>0</sub>	2.40E+00	mg/l	Soil water partition coefficient
t <sub>1/2</sub>	2.19E+03	days	
λ	3.17E-04	days <sup>-1</sup>	
Sz	3.00E+01	m	
Sy	5.00E+01	m	
da	2.71E+01	m	
ρ	1.70E+00	g/cm <sup>3</sup>	
n	1.02E-01	fraction	
i	1.25E-02	fraction	
K	2.00E+01	m/d	
x	8.30E+02	m	
z	0.00E+00	m	
y	0.00E+00	m	
t	9.90E+99	days	time variant options only
Kd	5.00E-01	1/kg	see options
ax	11.020	m	see options
az	1.102	m	see options
ay	0.110	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: K<sub>d</sub> 5.00E-01 1/kg

Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer: f<sub>oc</sub> 1.00E+00 fraction

Organic carbon partition coefficient: K<sub>oc</sub> 5.00E-01 1/kg

Entry for ionic organic chemicals (option)  
Sorption coefficient for related species: K<sub>ow</sub> 1.00E+00 1/kg

Sorption coefficient for ionised species: K<sub>ow</sub> 1.00E+00 1/kg

pH value: pH 7.00

acid dissociation constant: pK<sub>a</sub> 4.00

Dispersivity

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

Longitudinal dispersivity: ax 1.00E+01 m

Transverse dispersivity: az 1.00E+00 m

Vertical dispersivity: ay 1.00E-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<sub>10</sub>p<sup>0.1+1.1</sup>); az = az/10, ay = ay/100 are assumed

Calculated Parameters Variable

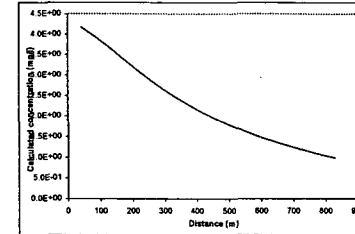
v	1.37E+00	m/d
Rf	5.87E+00	fraction
λ	3.17E-04	d <sup>-1</sup>
u	2.42E-01	m/d
C <sub>ep</sub>	9.82E-01	mg/l
C <sub>ep</sub>	9.44E-01	mg/l
AF	4.48E+00	
AF	4.84E+00	

Remedial Targets

Remedial Target	LTCS	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks		1.20E-01	mg/l	
Distance to compliance point		830	m	
Concentration of contaminant at compliance point after	C <sub>100</sub> /C <sub>0</sub>	9.82E-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 9.9E+99.

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Calculated concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Concentration
41.6	4.2E+00
166.0	3.8E+00
207.6	3.4E+00
249.0	3.2E+00
290.5	2.9E+00
332.0	2.6E+00
373.6	2.3E+00
416.0	2.1E+00
458.5	1.9E+00
498.0	1.8E+00
539.6	1.7E+00
611.0	1.6E+00
622.5	1.4E+00
664.0	1.3E+00
706.5	1.2E+00
747.0	1.1E+00
738.6	1.1E+00
830.0	9.8E-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: Bixington Area & A Downshire K20  
Completed by: RJ  
Date: 24/11/2005  
Version: 12

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 <sub>T</sub>	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 <sub>0</sub>	7.70E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	7.30E-02	days
Calculated decay rate	λ	9.50E-04	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m
Plume thickness at source	Sy	8.00E+01	m
Saturated aquifer thickness	da	5.71E+01	m
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.00E+01	m/d
Distance to compliance point perpendicular to flow direction	x	6.30E+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
Parameters values determined from options			
Partition coefficient	Kd	9.12E-01	l/kg
Longitudinal dispersivity	αx	11.020	m
Transverse dispersivity	αz	1.102	m
Vertical dispersivity	αy	0.110	m

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	9.52E+00	fraction
Decay rate used	λ	9.50E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation			
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	3.01E-04	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.90E-04	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>T</sub> )	AF	2.56E+02	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>T</sub> )	AF	2.48E+02	

Remedial Targets

Remedial Target	LTC3	1.82E-01	mg/l	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		830	m	
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>T</sub>	3.01E-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 **9.12E-01** l/kg  
 Soil water partition coefficient Kd **9.12E-01** l/kg  
 Entry for non-polar organic chemicals (option) f<sub>oc</sub> **1.00E+00** fraction  
 Fraction of organic carbon in aquifer f<sub>oc</sub> **1.00E+00** fraction  
 Organic carbon partition coefficient K<sub>oc</sub> **9.12E-01** l/kg  
 Entry for ionic organic chemicals (option) K<sub>ow</sub> **9.12E-01** l/kg  
 Sorption coefficient for related species K<sub>ow</sub> **9.12E-01** l/kg  
 Sorption coefficient for ionised species K<sub>ow</sub> **9.12E-01** l/kg  
 pH value pH **9.12E-01** l/kg  
 acid dissociation constant pKa **9.12E-01** l/kg

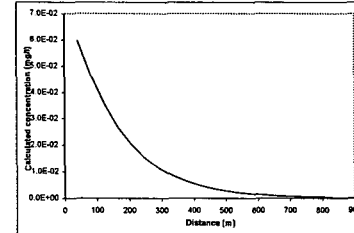
Soil water partition coefficient Kd **9.12E-01** l/kg

Dispersivity Calculate dependent on distance to compliance point (0) **2**

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

Variable	Value	Unit	Source
Longitudinal dispersivity	αx	11.020	m
Transverse dispersivity	αz	1.102	m
Vertical dispersivity	αy	0.110	m

For calculated value, assumes αx = 0.1 \* x, αz = 0.01 \* z, αy = 0.001 \* y  
 Xu & Eckstein (1995) report αx = 0.83(log<sub>10</sub>x)<sup>0.833</sup>, αz = αx/10, αy = αx/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
From calculation sheet  
Distance Concentration

Distance	Concentration
41.5	6.0E-02
63.0	4.6E-02
124.6	3.6E-02
168.0	2.7E-02
207.5	2.0E-02
249.0	1.6E-02
290.5	1.1E-02
332.0	8.8E-03
373.5	6.8E-03
416.9	4.9E-03
468.6	3.7E-03
481.0	2.8E-03
639.5	1.1E-03
681.0	1.0E-03
822.6	1.2E-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	Blossington Area 5 A Davonsdale K2D
Completed by	AJ
Date	24/11/2005
Version	12



Tier 3 -Groundwater



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

Contaminant: Aromatic C8-C10  
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 <sub>0</sub>	2.12E-02	mg/l	
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days	
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>	
Width of plume in aquifer at source (perpendicular to flow)	Sz	8.00E+01	m	
Plume thickness at source	Sy	5.90E+01	m	
Saturated aquifer thickness	da	5.71E+01	m	
Bulk density of aquifer materials	ρ	1.70E+00	g/cm <sup>3</sup>	
Effective porosity of aquifer	n	1.82E-01	fraction	
Hydraulic gradient	i	1.25E-02	fraction	
Hydraulic conductivity of aquifer	K	2.00E+01	m/d	
Distance to compliance point	x	6.30E+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	5.75E+00	l/kg	see options
Longitudinal dispersivity	ax	11.020	m	see options
Transverse dispersivity	az	1.102	m	see options
Vertical dispersivity	ay	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	5.47E+01	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	u	2.51E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>1D</sub>	2.38E-07	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>2D</sub>	2.29E-07	mg/l
Attenuation factor (one way vertical dispersion, C <sub>1D</sub> /C <sub>0</sub> )	AF	8.90E+04	
Attenuation factor (two way vertical dispersion, C <sub>2D</sub> /C <sub>0</sub> )	AF	9.25E+04	

Remedial Targets

Remedial Target	LYC3	6.35E+01	mg/l	For comparison with measured groundwater concentration.
Distance to compliance point		830	m	
Concentration of contaminant at compliance point after	C <sub>1D</sub> /C <sub>0</sub>	2.38E-07	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 5.75E+00 l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 5.75E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub> l/kg  
Sorption coefficient for ionised species K<sub>ow</sub>+1 l/kg  
pH value pH  
acid dissociation constant pKa

Source of parameter value

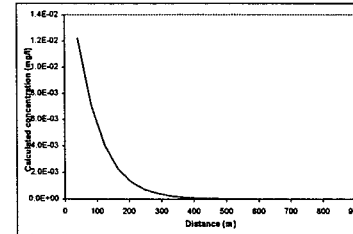
Soil water partition coefficient Kd 5.75E+00 l/kg

Dispersivity

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

Longitudinal dispersivity ax 1.10E+01 m  
Transverse dispersivity az 1.10E+00 m  
Vertical dispersivity ay 1.10E-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<sub>10</sub>t)<sup>0.433</sup>; az = ax/10, ay = az/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks  
Distance: 0 to 830 m

	mg/l
41.6	1.2E-02
83.0	7.1E-03
124.6	4.0E-03
166.0	2.3E-03
207.6	1.3E-03
249.0	7.2E-04
290.5	4.0E-04
332.0	2.3E-04
373.5	1.3E-04
416.0	7.2E-05
458.6	4.1E-05
498.0	2.3E-05
539.6	1.3E-05
581.0	7.2E-06
622.5	4.1E-06
664.0	2.3E-06
706.0	1.3E-06
748.0	4.2E-07
788.0	2.4E-07

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 A Downshire K20  
Completed by: AJ  
Date: 24/11/2005  
Version: 12

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	C <sub>T</sub>	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 <sub>0</sub>	2.12E-02	mg/l
Half life for degradation of contaminant in water	t <sub>1/2</sub>	1.83E+03	days
Calculated decay rate	λ	3.80E-04	days <sup>-1</sup>
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.800E+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 <sup>3</sup>
Effective porosity of aquifer	n	1.82E-01	fraction
Hydraulic gradient	i	1.25E-02	fraction
Hydraulic conductivity of aquifer	K	2.80E+01	m/d
Distance to compliance point	x	1.830E+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	9.12E+00	l/kg	see options
Longitudinal dispersivity	ax	11.020	m	see options
Transverse dispersivity	az	1.102	m	see options
Vertical dispersivity	ay	0.110	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.37E+00	m/d
Retardation factor	Rf	8.62E+01	fraction
Decay rate used	λ	3.80E-04	d <sup>-1</sup>
Rate of contaminant flow due to retardation	U	1.59E-02	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C <sub>0D</sub>	1.19E-09	mg/l
Contaminant concentration at distance x, assuming two-way vertical dispersion	C <sub>0B</sub>	1.15E-09	mg/l
Attenuation factor (one way vertical dispersion, C <sub>0</sub> /C <sub>1D</sub> )	AF	1.78E+07	
Attenuation factor (two way vertical dispersion, C <sub>0</sub> /C <sub>1B</sub> )	AF	1.85E+07	

Remedial Targets Remedial Target LYC3 1.27E+04 mg/l For comparison with measured groundwater concentration.

Ogata Banks			
Distance to compliance point		830	m
Concentration of contaminant at compliance point	C <sub>1D</sub> /C <sub>0</sub>	1.19E-09	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)  
Soil water partition coefficient Kd  l/kg  
Entry for non-polar organic chemicals (option)  
Fraction of organic carbon in aquifer f<sub>oc</sub> 1.00E+00 fraction  
Organic carbon partition coefficient K<sub>oc</sub> 9.12E+00 l/kg  
Entry for ionic organic chemicals (option)  
Sorption coefficient for related species K<sub>ow</sub>  l/kg  
Sorption coefficient for ionised species K<sub>ow</sub>  l/kg  
pH value pH   
acid dissociation constant pKa

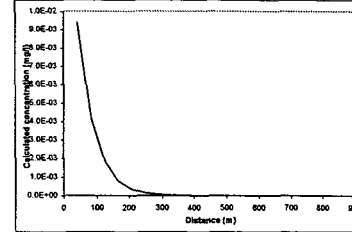
Soil water partition coefficient Kd 9.12E+00 l/kg

Dispersivity Calculate dependent on distance to compliance point (0)  2

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

Longitudinal dispersivity	ax	1.10E+01	m
Transverse dispersivity	az	1.10E+00	m
Vertical dispersivity	ay	1.10E-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<sub>10</sub>p)<sup>0.411</sup>; az = ax\*10, ay = ax/100 are assumed



Calculated concentrations for distance-concentration graph

Ogata Banks From calculation sheet Distance Concentration

	mg/l
41.6	9.4E-03
83.0	4.2E-03
124.5	1.8E-03
170.0	7.1E-04
207.6	3.4E-04
249.0	1.6E-04
296.5	6.3E-05
332.0	2.7E-05
373.6	1.2E-05
415.0	6.1E-06
456.6	2.2E-06
488.0	9.5E-07
539.5	4.1E-07
581.0	1.8E-07
622.6	7.7E-08
664.0	3.3E-08
705.6	1.4E-08
747.0	6.3E-09
788.6	2.7E-09
830.0	1.2E-09

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 A Dounshirk K20
Completed by	AJ
Date	24/11/2005
Version	12

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