

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant Target Concentration	C _T	Benzo(b)fluoranthene 6.36E-05	mg/l	from Level 1

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

Ogata Banks Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Source of parameter value

Initial contaminant concentration in groundwater at plume core	C ₀	1.00E+00	mg/l	
Half life for degradation of contaminant in water	t _{1/2}	1.22E+03	days	
Calculated decay rate	λ	5.69E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+02	m	
Plume thickness at source	Sy	1.98E+00	m	
Saturated aquifer thickness	da	2.10E+00	m	
Bulk density of aquifer materials	ρ	1.36E+00	g/cm ³	
Effective porosity of aquifer	n	8.00E-02	fraction	
Hydraulic gradient	i	1.33E-02	fraction	
Hydraulic conductivity of aquifer	K	8.64E-02	m/d	
Distance to compliance point	x	1.25E+01	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	3.65E+07	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	5.34E+04	l/kg	see options
Longitudinal dispersivity	ax	1.25E+00	m	see options
Transverse dispersivity	az	1.25E-01	m	see options
Vertical dispersivity	ay	1.25E-02	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.44E-02	m/d	
Retardation factor	Rf	9.09E+05	fraction	
Decay rate used	λ	6.26E-10	d ⁻¹	
Rate of contaminant flow due to retardation	u	1.58E-08	m/d	
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	0.00E+00	mg/l	
Attenuation factor (one way vertical dispersion, CO/CED)	AF	breakthrough at compliance point		

Remedial Targets

Remedial Target	No impact	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	12.5	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	0.00E+00	mg/l
		3.7E+07	days

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

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient

Kd 5.34E+04 l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer

foc fraction

Organic carbon partition coefficient

Koc l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

K_{oc,i} l/kg

Sorption coefficient for ionised species

K_{oc,i} l/kg

pH value

pH

acid dissociation constant

pKa

Fraction of organic carbon in aquifer

foc fraction

Soil water partition coefficient

Kd 5.34E+04 l/kg

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

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

Longitudinal dispersivity

ax

Enter value 0.00E+00

Calc value Xu & Eckstein 1.25E+00

Transverse dispersivity

az

0.00E+00

1.25E-01

Vertical dispersivity

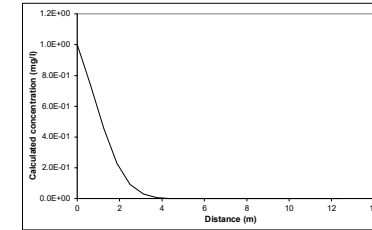
ay

0.00E+00

1.25E-02

Note values of dispersivity must be > 0

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

Xu & Eckstein (1995) report ax = 0.83(log₁₀)^{2.414}; az = ax/10, ay = ax/100 are assumed

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

Note

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

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

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

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

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

Site being assessed: Llanwern Phase 4C
Completed by: XMBB/JWG
Date: #####
Version: 2

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet
Distance Concentration

	mg/l
0	1.0E+00
0.6	7.40E-01
1.3	4.56E-01
1.9	2.29E-01
2.5	9.16E-02
3.1	2.89E-02
3.8	7.15E-03
4.4	1.37E-03
5.0	2.06E-04
5.6	2.36E-05
6.3	1.15E-06
6.9	7.77E-08
7.5	0.00E+00
8.1	0.00E+00
8.8	0.00E+00
9.4	0.00E+00
10.0	0.00E+00
10.6	0.00E+00
11.3	0.00E+00
11.9	0.00E+00
12.5	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Variable	Value	Unit	Source
Contaminant	Cyanide		from Level 1
Target Concentration	1.00E-03	mg/l	from Level 1

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

Ogata Banks	Equations in HRA publication
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Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Variable	Value	Unit	Source
Initial contaminant concentration in groundwater at plume core	6.03E-01	mg/l	RLRE Appendix K
Half life for degradation of contaminant in water	1.50E+01	days	RLRE Appendix K
Calculated decay rate	4.62E-02	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	7.50E+01	m	Assumed NE flow - approx from RLRE fig
Plume thickness at source	1.98E+00	m	Atkins report Table 2-2
Saturated aquifer thickness	2.10E+00	m	Atkins report Table 2-2
Bulk density of aquifer materials	1.36E+00	g/cm ³	Atkins report Table 5-3
Effective porosity of aquifer	8.00E-02	fraction	RLRE Table 5.3.1
Hydraulic gradient	1.33E-02	fraction	RLRE Table 5.3.1
Hydraulic conductivity of aquifer	8.64E-02	m/d	Atkins Section 2.4.2.1
Distance to compliance point	1.25E+01	m	Half of 25m grid
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	3.65E+06	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	5.00E+00	l/kg	see options
Longitudinal dispersivity	ax	1.25E+00	m	see options
Transverse dispersivity	az	1.25E-01	m	see options
Vertical dispersivity	ay	1.25E-02	m	see options

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.44E-02 m/d
Retardation factor	Rf	8.60E+01
Decay rate used	λ	5.37E-04 d ⁻¹
Rate of contaminant flow due to retardation	u	1.67E-04 m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	9.46E-08 mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	AF	6.38E+06

Remedial Targets

Remedial Target	6.38E+03	mg/l	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	12.5	m	
Concentration of contaminant at compliance point	9.46E-08	mg/l	Ogata Banks
after	3.7E+06	days	

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

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient

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

Fraction of organic carbon in aquifer

Soil water partition coefficient

Kd

foc

Koc

K_{oc,ion}K_{oc,ion}

pH

pKa

foc

Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

Note values of dispersivity must be > 0

For calculated value, assumes ax = 0.1 * x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = 0.83(log₁₀)^{2.414}; az = ax/10, ay = ax/100 are assumed

Enter value

Calc value Xu & Eckstein

0.00E+00

0.00E+00

0.00E+00

0.00E+00

0.00E+00

0.00E+00

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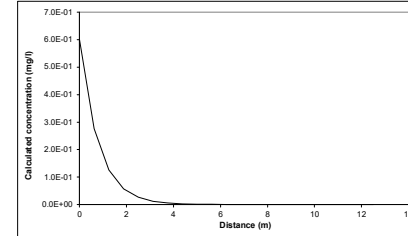
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Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

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

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

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

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

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

Site being assessed:	Llanwern steelworks HIA
Completed by:	Roz Cox
Date:	#####
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	6.0E-01
0.6	2.75E-01
1.3	1.26E-01
1.9	5.75E-02
2.5	2.63E-02
3.1	1.20E-02
3.8	5.48E-03
4.4	2.50E-03
5.0	1.14E-03
5.6	5.23E-04
6.3	2.39E-04
6.9	1.09E-04
7.5	4.98E-05
8.1	2.28E-05
8.8	1.04E-05
9.4	4.75E-06
10.0	2.17E-06
10.6	9.92E-07
11.3	4.53E-07
11.9	2.07E-07
12.5	9.46E-08

R&D Publication 20 Remedial Targets Worksheet, Release 3.2



Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Fluoranthene		from Level 1
Target Concentration	C _T	2.35E-03	mg/l	from Level 1

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

Ogata Banks Equations in HRA publication

Approach for simulating vertical dispersion:

Simulate vertical dispersion in 1 direction

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

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

Source of parameter value	Variable	Value	Unit	Source
	C ₀	1.00E+00	mg/l	
	t _{1/2}	8.80E+02	days	
	λ	7.88E-04	days ⁻¹	
Width of plume in aquifer at source (perpendicular to flow)	S _Z	1.00E+02	m	
Plume thickness at source	S _y	1.98E+00	m	
Saturated aquifer thickness	da	2.10E+00	m	
Bulk density of aquifer materials	ρ	1.36E+00	g/cm ³	
Effective porosity of aquifer	n	8.00E-02	fraction	
Hydraulic gradient	i	1.33E-02	fraction	
Hydraulic conductivity of aquifer	K	8.64E-02	m/d	
Distance to compliance point	x	1.25E+01	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	3.65E+06	days	time variant options only

Parameters values determined from options

Partition coefficient	K _d	2.81E+03	l/kg	see options
Longitudinal dispersivity	ax	1.25E+00	m	see options
Transverse dispersivity	az	1.25E-01	m	see options
Vertical dispersivity	ay	1.25E-02	m	see options

Calculated Parameters Variable

Groundwater flow velocity	v	1.44E-02	m/d	
Retardation factor	R _f	4.77E+04	fraction	
Decay rate used	λ	1.65E-08	d ⁻¹	
Rate of contaminant flow due to retardation	u	3.01E-07	m/d	
Contaminant concentration at distance x, assuming one-way vertical dispersion	C _{ED}	0.00E+00	mg/l	
Attenuation factor (one way vertical dispersion, CO/CED)	AF	breakthrough at compliance point		

Remedial Targets

Remedial Target	Value	Unit	For comparison with measured groundwater concentration.
Ogata Banks	No impact	mg/l	
Distance to compliance point	12.5	m	
Concentration of contaminant at compliance point after	C _{ED} /C ₀	0.00E+00	mg/l
		3.7E+06	days

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

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient

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

Fraction of organic carbon in aquifer

Soil water partition coefficient

K_d 2.81E+03 l/kg

foc fraction

K_{oc} l/kgK_{oc,i} l/kgK_{oc,i} l/kg

pH

pKa

foc fraction

K_d 2.81E+03 l/kg

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

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

Longitudinal dispersivity

Transverse dispersivity

Vertical dispersivity

Note values of dispersivity must be > 0

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

Xu & Eckstein (1995) report ax = 0.83(log₁₀)^{2.414}; az = ax/10, ay = ax/100 are assumed

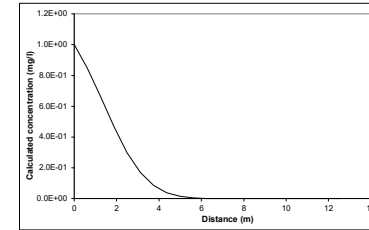
Enter value

Calc value Xu & Eckstein

0.00E+00 1.25E+00 1.04E+00

0.00E+00 1.25E-01 1.04E-01

0.00E+00 1.25E-02 1.04E-02



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

Note

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The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

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

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

Site being assessed: Llanwern reference tables

Completed by: XMBB/JWG

Date: #####

Version: 2

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	1.0E+00
0.6	8.46E-01
1.3	6.80E-01
1.9	4.67E-01
2.5	2.98E-01
3.1	1.69E-01
3.8	8.54E-02
4.4	3.81E-02
5.0	1.49E-02
5.6	5.14E-03
6.3	1.55E-03
6.9	4.09E-04
7.5	9.43E-05
8.1	1.90E-05
8.8	1.89E-06
9.4	2.86E-07
10.0	3.79E-08
10.6	0.00E+00
11.3	0.00E+00
11.9	0.00E+00
12.5	0.00E+00