

Appendix D

Detailed Quantitative Risk Assessment

DQRA Methodology

Overview

This DQRA has been completed using the Environment Agency’s Remedial Targets Methodology (RTM) and supporting worksheet to evaluate the sources identified in **Section 6**.

A Level 1 to 3 RTM assessment has been completed to generate soil remedial targets for the known sources of contamination at the site to prevent significant harm to controlled waters. The remedial targets set for the sources identified seek to prevent or limit the continued input of pollutants into groundwater. Where pollution of groundwater has already occurred, as is the case at Victoria North, the remedial target seeks to minimise further entry of contaminants into groundwater from each defined source.

Gas works area

Exposure assumptions

Remediation criteria have been developed for the contaminants identified within the former gas works area using the Environment Agency’s Remedial Targets Methodology (RTM) workbook⁶. Input parameters and outputs from RTM are presented in tables below and later in this Appendix. All contaminants have been modelled to Level 3, including those contaminants identified as being a hazardous substance under the Groundwater Directive⁷ where these are already present in groundwater beneath the site.

Within the site boundary, there is effectively no unsaturated zone that is not made ground and therefore attenuation of contaminants in the unsaturated zone is not relevant. Dilution in groundwater flow within the Collyhurst Sandstone aquifer (the sandstone beneath the former gas works area) is considered below. Site-specific aquifer parameters were determined from the findings of the ground investigations to support the assessment where possible.

The target concentrations chosen are identified in **Table 58**. The data show that hazardous substances including benzo(a)pyrene and PFOS are already present in the groundwater beneath the site. In accordance with the Environment Agency’s Remedial Targets Methodology, where contaminants are already present in groundwater, and where the environmental standard is lower than the background concentration, then the BGS baseline concentration should be set as the target concentration. Therefore, for certain contaminants, the concentration in the River Irk upstream of the site or published background concentrations for the region have been used.

Level 1 soil parameters

A summary of the model parameters used in Level 1 calculations for the gas works area is presented below and in **Table 56**.

Soil porosity

No site-specific data is available for the effective porosity of the soil source. However, this has been estimated based on empirical relationship derived from the soil bulk density and moisture content, using the calculation provided in RTM.

Bulk density of soil zone

Laboratory compaction testing on made ground materials taken during the ground investigation in the area of the former gas works confirmed dry bulk densities in the range 1.77 to 2.01 Mg/m³ and an optimum moisture content of 10-14% (see Section 5 of GIR [1]). The median of these ranges has been used in the Level 1 assessment.

⁶ Environment Agency (2006) Remedial Targets Methodology

⁷ <http://wfd.uk.org/resources/groundwater-hazardous-substances-standards>

Fraction of organic carbon

Site-specific data has been used for this parameter, being the average fraction of organic carbon (foc) content of the made ground.

Parameter		Unit	Value used in Level 1 Assessment	Source
Bulk density of soil zone material	p	g/cm ³	1.9	Site measurement
Moisture Content		%	12	Site measurement
Fraction of organic carbon (soil)	foc	-	0.058	Site measurement (made ground)
Water filled soil porosity	ϕ _w	fraction	0.228	Calculated based on above parameters
Air filled soil porosity	ϕ _a	fraction	0.089	Calculated based on above parameters

Table 56 Summary of parameters used in Level 1 RTM for the gas works area

Level 2 and 3 aquifer parameters

A summary of the model parameters used in Level 2 and 3 is provided in **Table 57** below.

Infiltration

The rainfall has been taken from Met Office data⁸ for the climate station at Woodford for the period 1991 to 2020. The annual average rainfall is 868.40mm/yr (0.0024m/d).

The former gas works area lies within proposed development plot RB05b, which is currently proposed for a future primary school use.

The Environment Agency has stated that no infiltration of surface water drainage will be permitted into the ground where adverse levels of contamination are known. Surface water will be collected and stored in permeable paving areas, and an attenuation basin in St. Catherine’s Wood. Surface water will be discharged at a controlled rate into the River Irk via a new outfall.

A value of 10% of the site covered with soft landscaping is considered to be a conservative assessment for the school Plot RB05b and within this area 100% of rainfall is assumed to infiltrate. The calculated infiltration rate within the gas works site area is therefore 0.00024m/d.

Area of contaminant source

The area of the gas works has been calculated based on the mapped extent of historical buildings and observations of soil contamination. The approximate area is 1200m².

Hydraulic conductivity of aquifer in which dilution occurs

No site-specific data is available for hydraulic conductivity within the bedrock aquifers. Published values⁹ for hydraulic conductivity within the Collyhurst Sandstone are >1m/d⁻¹ and the range 3.7 x 10⁻⁵ to 10m/day¹⁰ for the Kinnerton/Collyhurst Sandstone with a geometric mean of 0.4m/d and median of 0.8m/d.

Hydraulic gradient of water table

The groundwater hydraulic gradient was calculated from the groundwater elevation measured on site during the spot monitoring rounds undertaken as part of the 2022 GI. A value of 0.032 is used in the assessment, based on two wells which had response zones in the Collyhurst Sandstone (BH309 and BH310).

Width of contaminant source perpendicular to groundwater flow

This measurement is taken from the footprint of former gas works buildings, which has been correlated with observations of contaminated ground during the GI. The width of the source is 22m and the length parallel to groundwater flow is 52m.

Mixing zone thickness

The Collyhurst sandstone extends to great depth (over 200m) however the thickness of the mixing zone along the groundwater pathway is substantially less, given that groundwater is believed to discharge into the River Irk. This parameter has been calculated in the model.

⁸ <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcqrqyr80>

⁹ Baseline Report Series: 8. The Permo-Triassic Sandstones of Manchester and East Cheshire. Groundwater systems and water quality commissioned report CR/03/265N. Technical Report NC/99/74/8. <https://nora.nerc.ac.uk/id/eprint/3573/1/CR03265N.pdf>

¹⁰ Environment Agency and BGS (1997) The physical properties of major aquifers in England and Wales. Hydrogeology Group Technical Report WD/97/34. Environment Agency R&D Publication 8 <https://nora.nerc.ac.uk/id/eprint/13137/1/WD97034.pdf>

Bulk density of aquifer materials

The average bulk unit weight value for the Collyhurst Sandstone from ground investigation data is 22kN/m³ or 2.24g/cm³.

Aquifer effective porosity

No site-specific data is available for the effective porosity of the aquifer. Literature values quote a porosity at outcrop within the Collyhurst Sandstone of 20 to 24% with an arithmetic mean of 25%.

The estimated porosity using the empirical relationship derived from the soil bulk density (see above), particle density (recommended value provided by the EA in the RTM User Manual) and moisture content (site specific data), together with site-specific moisture content for the Collyhurst Sandstone in the range 8.7 to 17.3% with an average of 12% gives a porosity for the aquifer of 28%.

Aquifer fraction of organic carbon

No site-specific data is available for the fraction of organic carbon in the aquifer. Literature values quote a range for Permo-Triassic Sandstones between 0.00028 to 0.0015. A value of 0.0015 has been selected for use in the assessment.

Biodegradation

Half-lives for contaminants have been obtained from various literature sources. Dissolved oxygen levels measured in groundwater from the Collyhurst sandstone exceed 0.5mg/l and therefore, based on Environment Agency guidance¹¹ aerobic conditions are likely to prevail over anaerobic. Therefore, half-lives have been based on aerobic rates of degradation.

The RTM model calculates degradation by using a single decay rate (half-life) to quantify degradation of a contaminant as it migrates towards a selected compliance point. For this assessment, degradation is assumed to be limited to the dissolved phase only. In effect this means that when calculating attenuation caused by degradation, the model applies the decay rate to the un-retarded travel time and not the retarded travel time; for slow moving organic contaminants (e.g. PAH and heavier TPH fractions) this substantially reduces the rates of predicted degradation and can under predict levels of degradation.

Distance to compliance point

The distance to the compliance point (the River Irk) has been taken as 50 metres. This is the approximate distance from the gas works to the river but is also the default compliance distance for all hazardous substances in all aquifers from contaminants already in groundwater.

Parameter		Unit	Range	Value used in Assessment	Source
Effective Rainfall	E	m/d	0.0024	0.0024	Met Office data
Infiltration Factor		%	10	10	Assumption based on future school site with minimal infiltration
Infiltration rate	Inf	m/d	0.00024	0.00024	Calculated
Length of site parallel to flow	L	m	52	52	Site specific
Hydraulic conductivity of aquifer	K	m/d	3.7x10 ⁻⁵ to 10m/day.	0.4	Literature value, geometric mean
Hydraulic Gradient	I	m/m	0.032	0.032	Site specific
Width of site parallel to flow	W	m	22	22	Site specific
Depth of Mixing	M _z	m	Base of aquifer not penetrated	Calculated	RTM
Bulk density of aquifer materials		g/cm³	22kN/m³	2.24	Site specific
Aquifer effective porosity		%	20 to 30%	25	Literature value, arithmetic mean
Distance to compliance point		M	50	50	Estimate; max allowed for hazardous substances
Fraction of organic carbon in sandstone aquifer	F _{oc}	-	0.00028 to 0.0015	0.0015	Literature value

Table 57 Summary of parameters used in Level 2 and 3 RTM for the gas works area

¹¹ Environment Agency (2000) Guidance on the Assessment and Monitoring of Natural Attenuation of Contaminants in Groundwater, R&D Publication 95

Parameter (WFD Classification)	Unit	Target concentration	Source	Henry's Law Constant	Source	Kd	Source	Koc (l/kg)	Source	Biodegradation half-life (days)	Source
Benzo(a)pyrene (Hazardous)	mg/l	0.00001	Background concentration in Irk upstream of site is <0.00001mg/l (see Table 5), therefore limit of detection applied as target	1.92E-05	A	N/A - non-polar organic	-	1.30E+05	B	294	L
TPH - Ali C8-C10 (Hazardous)	mg/l	0.3	WHO	8.20E+01	TPHCWG	N/A - non-polar organic	-	3.20E+04	B	N/A	-
TPH - Ali C10-C12 (Hazardous)	mg/l	0.3	WHO	1.30E+02	TPHCWG	N/A - non-polar organic	-	2.50E+05	B	N/A	-
TPH - Ali C12-C16 (Hazardous)	mg/l	0.3	WHO	5.40E+02	TPHCWG	N/A - non-polar organic	-	5.00E+06	B	N/A	-
TPH - Aro C8-C10 (Hazardous)	mg/l	0.3	WHO	4.90E-01	TPHCWG	N/A - non-polar organic	-	1.60E+03	B	294	M
TPH - Aro C10-C12 (Hazardous)	mg/l	0.09	WHO	1.40E-01	TPHCWG	N/A - non-polar organic	-	2.50E+03	B	258	M
TPH - Aro C12-C16 (Hazardous)	mg/l	0.09	WHO	5.40E-02	TPHCWG	N/A - non-polar organic	-	5.00E+03	B	162	M
TPH - Aro C16-C21 (Hazardous)	mg/l	0.09	WHO	1.30E-02	TPHCWG	N/A - non-polar organic	-	1.60E+04	B	1310	M
TPH - Aro C21-C35 (Hazardous)	mg/l	0.09	WHO	6.80E-04	TPHCWG	N/A - non-polar organic	-	1.30E+05	B	1813	M
Anthracene (Hazardous)	mg/l	0.0001	EQS	1.81E-04	Arup database	N/A - non-polar organic	-	5.62E+03	I	460	M
Fluoranthene (Hazardous)	mg/l	0.000006	EQS	6.29E-05	Environment Agency SR7	N/A - non-polar organic	-	1.82E+04	K	290	L
Zinc (Non-hazardous)	mg/l	0.1115	BGS baseline concentration, 95%ile	Not volatile	-	501	G	N/A	-	N/A	-
Nickel (Non-hazardous)	mg/l	0.0153	BGS baseline concentration, 95%ile	Not volatile	-	500		-	-	N/A	-
Ammoniacal Nitrogen (Non-hazardous)	mg/l	0.6	EQS	Not volatile	-	0.4	J	-	-	1095	J
PFOS (Hazardous)	mg/l	6.5E-07	EQS for PFOS	1.29E-07	Environment Agency 2004	N/A - non-polar organic	-	6.31E+02	N	N/A	-
PFOA (UNCLASSIFIED)	mg/l	6.5E-07	EQS for PFOS	3.63E-05	CONCAWE, 2016	N/A - non-polar organic	-	9.33E+01	N	N/A	-

A - Technical report P5-079/TR1, converted for 15C
B - CL:AIRE (2017) Petroleum Hydrocarbons in Groundwater
C- LQM/CIEH S4UL Report (2015) Publication No. S4UL3213. Assumes pH 6 rather than 7, cautious value
D - BP Oil International, 2001 (BP RISC database)
E - Thorne et al., 2005
F - Converted from mean log kd from USEPA (2005) <http://epa.gov/athens/publications/reports/Ambrose600R05074PartitionCoefficients.pdf> TABLE 1 (value 2.7 median)
G - Converted from mean log kd from USEPA (2005) <http://epa.gov/athens/publications/reports/Ambrose600R05074PartitionCoefficients.pdf> TABLE 1
H - Value from Nickel SGV TABLE 4
I - LQM/CIEH 2nd Edition converted from Log koc
J - From Buss for clean sand and gravel. Range is 0.2-0.6 for Sherwood Sandstone group, of which Chester Formation is part.
K - Environment Agency SR7 converted from Log
L – Aerobic biodegradation mid-point, from Howard 1991
M – Aerobic biodegradation maximum, Howard, 1991
N – Literature values obtained for human health PFAS risk assessment

Table 58 Chemical parameters used in RTM

Remediation targets for gas works

Table 59 below summarises the remediation criteria generated using RTM for the gas works area, which are designed to be protective of controlled waters.

Contaminant	Level 1 target (mg/kg)	Level 1 target (mg/l)	Level 2 target (mg/kg)	Level 2 target (mg/l)	Level 3 target (mg/kg)	Level 3 target (mg/l)
Ammoniacal nitrogen	0.312	0.6	2.38	4.58	4.53	8.72
Zinc	55.9	0.1115	427	0.852	487	0.972
Benzo(a)Pyrene	0.0754	0.00001	0.576	0.0000764	3.63	0.000481
Fluoranthene	0.00633	0.000006	0.0484	0.0000459	0.311	0.000295
Anthracene	0.0326	0.0001	0.249	0.000764	0.9	0.00274
TPH – Aliphatic C8-C10	558	0.3	4260	2.29	4860	2.61
TPH – Aliphatic C10-C12	4350	0.3	33300	2.29	37900	2.61
TPH – Aliphatic C12-C16	87000	0.3	665000	2.29	758000	2.61
TPH – Aromatic C8-C10	27.9	0.3	213	2.29	1342	14.4
TPH – Aromatic C10-C12	13.1	0.09	99.8	0.688	772	5.3
TPH – Aromatic C12-C16	26.1	0.09	200	0.688	3858	13.3
TPH – Aromatic C16-C21	83.5	0.09	638	0.688	1120	1.2
TPH – Aromatic C21-C35	679	0.09	5190	0.688	8101	1.1

Table 59 Target concentrations for the protection of controlled waters in former gas works area

TP422/TP423 PFAS outlier

Exposure assumptions

Remediation criteria have been developed for the contaminants identified within the PFAS outlier identified at TP422/TP423 using the Environment Agency’s Remedial Targets Methodology (RTM) workbook¹². Input parameters and outputs from RTM are presented in tables below and later in this Appendix. All contaminants have been modelled to Level 3, including those contaminants identified as being a hazardous substance under the Groundwater Directive¹³ where these are already present in groundwater beneath the site.

Within the site boundary, there is effectively no unsaturated zone that is not made ground and therefore attenuation of contaminants in the unsaturated zone is not relevant. Dilution in groundwater flow within the Collyhurst Sandstone aquifer (the sandstone beneath the PFAS source zone) is considered below. Site-specific aquifer parameters were determined from the findings of the ground investigations to support the assessment where possible.

Level 1 soil parameters

A summary of the model parameters used in Level 1 is presented in Table 60 below.

Soil porosity

No site-specific data is available for the effective porosity of the soil source. However, this has been estimated based on empirical relationship derived from the soil bulk density and moisture content, using the calculation provided in RTM.

Bulk density of soil zone

Laboratory compaction testing on made ground materials taken during the ground investigation in the area of the former gas works (where TP422/TP423 are located) confirmed dry bulk densities in the range 1.77 to 2.01 Mg/m³ and an optimum moisture content of 10-14% (see Section 5 of GIR [1]). The median of these ranges has been used in the Level 1 assessment.

¹² Environment Agency (2006) Remedial Targets Methodology

¹³ <http://wfd.uk.org/resources/groundwater-hazardous-substances-standards>

Fraction of organic carbon

Site-specific data has been used for this parameter, being the average fraction of organic carbon (foc) content of the made ground.

Parameter		Unit	Value used in Level 1 Assessment	Source
Bulk density of soil zone material	p	g/cm ³	1.9	Site measurement
Moisture Content		%	12	Site measurement
Fraction of organic carbon (soil)	foc	-	0.058	Site measurement (made ground)
Water filled soil porosity	ϕ _w	fraction	0.228	Calculated based on above parameters
Air filled soil porosity	ϕ _a	fraction	0.089	Calculated based on above parameters

Table 60 Summary of parameters used in Level 1 RTM – TP422/TP423 outlier

Level 2 and 3 aquifer parameters

A summary of the model parameters used in Level 2 and 3 is provided in **Table 61** below.

Infiltration

The rainfall has been taken from Met Office data¹⁴ for the climate station at Woodford for the period 1991 to 2020. The annual average rainfall is 868.40mm/yr (0.0024m/d).

TP422/TP423 lies within proposed development plot RB05b, which is currently proposed for a future primary school use.

The Environment Agency has stated that no infiltration of surface water drainage will be permitted into the ground where adverse levels of contamination are known. Surface water will be collected and stored in permeable paving areas, and an attenuation basin in St. Catherine’s Wood. Surface water will be discharged at a controlled rate into the River Irk via a new outfall.

A value of 10% of the site covered with soft landscaping is considered to be a conservative assessment for the school Plot RB05b and within this area 100% of rainfall is assumed to infiltrate. The calculated infiltration rate is therefore 0.00024m/d.

Area of contaminant source

The area of the soil PFAS source at TP422/TP423 has been calculated based on the observations of soil contamination. The approximate area is 2800m².

Hydraulic conductivity of aquifer in which dilution occurs

No site-specific data is available for hydraulic conductivity within the bedrock aquifers. Published values¹⁵ for hydraulic conductivity within the Collyhurst Sandstone are >1m/d⁻¹ and the range 3.7 x 10⁻⁵ to 10m/day¹⁶ for the Kinnerton/Collyhurst Sandstone with a geometric mean of 0.4m/d and median of 0.8m/d.

Hydraulic gradient of water table

The groundwater hydraulic gradient was calculated from the groundwater elevation measured on site during the spot monitoring rounds undertaken as part of the 2022 GI. A value of 0.032 is used in the assessment, based on two wells which had response zones in the Collyhurst Sandstone (BH309 and BH310).

Width of contaminant source perpendicular to groundwater flow

This measurement is taken from the soil contamination data for PFAS. The width of the source is 70m and the length parallel to groundwater flow is 40m.

Mixing zone thickness

The Collyhurst sandstone extends to great depth (over 200m) however the thickness of the mixing zone along the groundwater pathway is substantially less, given that groundwater is believed to discharge into the River Irk. This parameter has been calculated in the model.

¹⁴ <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcqrqyr80>

¹⁵ Baseline Report Series: 8. The Permo-Triassic Sandstones of Manchester and East Cheshire. Groundwater systems and water quality commissioned report CR/03/265N. Technical Report NC/99/74/8. <https://nora.nerc.ac.uk/id/eprint/3573/1/CR03265N.pdf>

¹⁶ Environment Agency and BGS (1997) The physical properties of major aquifers in England and Wales. Hydrogeology Group Technical Report WD/97/34. Environment Agency R&D Publication 8 <https://nora.nerc.ac.uk/id/eprint/13137/1/WD97034.pdf>

Bulk density of aquifer materials

The average bulk unit weight value for the Collyhurst Sandstone from ground investigation data is 22kN/m³ or 2.24g/cm³.

Aquifer effective porosity

No site-specific data is available for the effective porosity of the aquifer. Literature values quote a porosity at outcrop within the Collyhurst Sandstone of 20 to 24% with an arithmetic mean of 25%.

The estimated porosity using the empirical relationship derived from the soil bulk density (see above), particle density (recommended value provided by the EA in the RTM User Manual) and moisture content (site specific data), together with site-specific moisture content for the Collyhurst Sandstone in the range 8.7 to 17.3% with an average of 12% gives a porosity for the aquifer of 28%.

Aquifer fraction of organic carbon

No site-specific data is available for the fraction of organic carbon in the aquifer. Literature values¹⁷ quote a range for Permo-Triassic Sandstones between 0.00028 to 0.0015. A value of 0.0015 has been selected for use in the assessment.

Biodegradation

PFAS does not readily biodegrade, therefore no biodegradation has been allowed for in the calculations.

Distance to compliance point

The distance to the compliance point (the River Irk) has been taken as 50 metres. This is the approximate distance from the TP422/TP423 source to the river, but is also the default compliance distance for all hazardous substances in all aquifers from contaminants already in groundwater.

Parameter		Unit	Range	Value used in Assessment	Source
Effective Rainfall	E	m/d	0.0024	0.0024	Met Office data
Infiltration Factor		%	10	10	Assumption based on future school site with minimal infiltration
Infiltration rate	Inf	m/d	0.00024	0.00024	Calculated
Length of site parallel to flow	L	m	40	40	Site specific
Hydraulic conductivity of aquifer	K	m/d	3.7x10 ⁻⁵ to 10m/day.	0.4	Literature value, geometric mean
Hydraulic Gradient	I	m/m	0.032	0.032	Site specific
Width of site parallel to flow	W	m	70	70	Site specific
Depth of Mixing	M _z	m	Base of aquifer not penetrated	Calculated	RTM
Bulk density of aquifer materials		g/cm³	22kN/m³	2.24	Site specific
Aquifer effective porosity		%	20 to 30%	25	Literature value, arithmetic mean
Distance to compliance point		M	50	50	Estimate, maximum permissible for hazardous substances
Fraction of organic carbon in sandstone aquifer	Foc	-	0.00028 to 0.0015	0.0015	Literature value

Table 61 Summary of parameters used in Level 2 and 3 RTM TP422/TP423 PFAS outlier

¹⁷ Golder Associates and Environment Agency CONSIM Version 2.5 User Manual

Remediation targets for TP422/TP423 PFAS outlier

Table 62 below summarises the remediation criteria generated using RTM for the TP422/TP423 PFAS outlier, which are designed to be protective of controlled waters.

Contaminant	Level 1 target (mg/kg)	Level 1 target (mg/l)	Level 2 target (mg/kg)	Level 2 target (mg/l)	Level 3 target (mg/kg)	Level 3 target (mg/l)
PFOS	2.35E-05	6.5E-06	1.82E-04	4.97E-06	1.87E-04	5.10E-06
PFOA	3.6E-06	6.5E-06	2.75E-05	4.97E-06	2.82E-05	5.10E-06

Table 62 Target concentrations for the protection of controlled waters in TP422/TP423 outlier

Carriage Shed area

Exposure assumptions

The remediation criteria for the carriage shed are the same as those proposed for the former gas works area. This is for the following reasons:

- The former carriage shed is located over the Manchester Marl bedrock, which is not considered to be a receptor for the purposes of this risk assessment, therefore the closest sandstone unit has been used as a surrogate, assuming that groundwater flow towards the river joins the Collyhurst Sandstone before reaching the Irk. Site-specific aquifer parameters were determined from the findings of the ground investigations to support the assessment where possible.
- As some of the contaminants identified within the former Carriage Shed are hazardous, a maximum distance to the compliance zone of 50m is permitted. This is the same as the distance assumed for the gas works;
- The contaminants of concern within the carriage shed are similar to those assumed in the gas works, with the exception of PFOS and PFOA which are present in the carriage shed footprint;

The area of the carriage shed is larger than the gas works (roughly 2400m² compared to the gas works footprint of 1200m². However, area is not used in the RTM calculations.

The target concentrations chosen are identified in **Table 63**. The data show that hazardous substances including benzo(a)pyrene and PFOS are already present in the groundwater beneath the site. In accordance with the Environment Agency’s Remedial Targets Methodology, where contaminants are already present in groundwater, and where the environmental standard is lower than the background concentration, then the BGS baseline concentration should be set as the target concentration. Therefore, for certain contaminants, the concentration in the River Irk upstream of the site or published background concentrations for the region have been used.

Remediation targets for carriage shed

Table 63 below summarises the remediation criteria generated using RTM for the gas works area, which are designed to be protective of controlled waters.

Contaminant	Level 1 target (mg/kg)	Level 1 target (mg/l)	Level 2 target (mg/kg)	Level 2 target (mg/l)	Level 3 target (mg/kg)	Level 3 target (mg/l)
Benzo(a)Pyrene	0.0754	0.00001	0.576	0.0000764	3.63	0.000481
Fluoranthene	0.00633	0.000006	0.0484	0.0000459	0.311	0.000295
Anthracene	0.0326	0.0001	0.249	0.000764	0.9	0.00274
TPH – Aliphatic C8-C10	558	0.3	4260	2.29	4860	2.61
TPH – Aliphatic C10-C12	4350	0.3	33300	2.29	37900	2.61
TPH – Aliphatic C12-C16	87000	0.3	665000	2.29	758000	2.61
TPH – Aromatic C8-C10	27.9	0.3	213	2.29	1342	14.4
TPH – Aromatic C10-C12	13.1	0.09	99.8	0.688	772	5.3
TPH – Aromatic C12-C16	26.1	0.09	200	0.688	3858	13.3
TPH – Aromatic C16-C21	83.5	0.09	638	0.688	1120	1.2
TPH – Aromatic C21-C35	679	0.09	5190	0.688	8101	1.1
PFOS	2.35E-05	6.5E-06	1.82E-04	4.97E-06	1.87E-04	5.10E-06
PFOA	3.6E-06	6.5E-06	2.75E-05	4.97E-06	2.82E-05	5.10E-06

Table 63 Target concentrations for the protection of controlled waters in former carriage shed area

Re-use of site-won soils in St. Catherine’s Wood/Red Bank terrace

Context

A regrading exercise is proposed within the HIF Infrastructure boundary to create the desired development platform levels and stable slopes. No general re-use criteria have been generated for the Red Bank Plateau area. The reason for this is that the future development plots are to be covered with buildings and hardstanding, and very little infiltration is anticipated through the made ground in the final, developed condition of the site. Currently, the majority of the site is vegetated ground with little hardstanding and no enclosed surface water drainage system. The development is therefore expected to significantly reduce infiltration within the proposed development plots and the made ground is unlikely to pose a significant risk to controlled waters. The identified ‘sources’ of contamination within Red Bank Plateau (namely the gas works, the carriage shed, TP422/TP423 and TP405A outlier areas) are to receive targeted remediation, as discussed elsewhere in this document.

A limited amount of regrading is proposed within the St. Catherine’s Wood and Red Bank Terrace areas of the site, as shown in **Drawing 14**. These areas are to be public open space and parkland, where infiltration through the ground will not be prevented by surface water drainage. Much of the area is formed of steep slopes, which will remain following completion of the HIF Infrastructure scheme, which will promote runoff of surface water into the River Irk. The areas are also to be planted, which will reduce the amount of infiltration possible.

Material cut from Red Bank Terrace and St. Catherine’s Wood is expected to be moved within a short distance in the same setting i.e. material from Red Bank Terrace will be placed within Red Bank Terrace to regrade the existing slope. As material is generally being moved within a few metres within the same environmental setting, it is not anticipated to pose a risk to the water environment, as the available evidence suggests that the current site condition is not having a significant impact on the quality of the River Irk (discussed in **Section 6.2.5**).

There is a possibility that material from elsewhere within the site boundary (termed ‘re-used material’ for the purposes of this report) might be used to make up a shortfall of material within the Red Bank Terrace or St. Catherine’s Wood areas. This re-used material would not have been sourced from the same area of the site and will be placed closer to the River Irk, therefore has the potential to create a new risk to the water environment. It is therefore considered appropriate to generate re-use criteria for such material, to ensure no new environmental risks are introduced. The need for material re-use is to be determined by BAM based on their earthworks calculations and the proposed landform they are to create as part of the HIF Infrastructure works.

Exposure assumptions

Due to the proximity of Red Bank Terrace or St. Catherine’s Wood to the river, there is a shorter distance over which any dissolved contamination can attenuate before reaching the river compared to Red Bank Plateau. Based on the current understanding of the cut and fill requirements within the Site, such material may be placed within two zones: close to the River Irk (within 50m) and further away (a distance between 50m and 130m from the river). These zones are illustrated in **Drawing 13**.

Reuse criteria for materials placed within these zones have been developed for the contaminants of concern using the Environment Agency’s Remedial Targets Methodology (RTM) workbook¹⁸, assuming that the re-used material is the source. Input parameters and outputs from RTM are presented in the tables below and later in this Appendix.

The target concentrations chosen are discussed in the previous section.

Level 1 soil parameters

A summary of the model parameters used in Level 1 is presented in **Table 64**.

Soil porosity

No site-specific data is available for the effective porosity of the soil source. However, this has been estimated based on the empirical relationship derived from the soil bulk density and moisture content.

Bulk density of soil zone

As the re-used material may be derived from anywhere within the HIF Infrastructure site, data relating to soil bulk density and moisture content have been used for made ground site-wide. Estimated bulk unit weight for the made ground generally is 18kN/m-3 (1.8g/cm) with a natural moisture content average of 21%.

Parameter		Unit	Value used in Level 1 Assessment	Source
Bulk density of soil zone material	p	g/cm³	1.8	Site measurement
Fraction of organic carbon (soil)	foc	-	0.058	Site measurement (made ground)
Moisture Content		%	21	Site measurement
Water filled soil porosity	ϕ _w	fraction	0.312	Calculated based on above parameters
Air filled soil porosity	ϕ _a	fraction	0.152	Calculated based on above parameters

Table 64 Summary of parameters used in Level 1 RTM for re-used soils in St. Catherines Wood and Red Bank Terrace

Level 2 and 3 aquifer parameters

A summary of the Level 2 and 3 model parameters used to generate re-use criteria for Zones 1 and 2 are presented in **Table 65**.

Infiltration

The rainfall has been taken from Met Office data¹⁹ for the climate station at Woodford for the period 1991 to 2020. The annual average rainfall is 868.40mm/yr (0.0024m/d).

The St. Catherine’s Wood and Red Bank Terrace areas will be predominantly public open space, comprising slopes with access paths and planting. Some runoff is expected from the slopes and evapotranspiration from planting, but it is likely that a high proportion of the rainfall will infiltrate. The assumed infiltration rate in these areas is 60%. The calculated infiltration rate within the open space areas is therefore 0.0014m/d.

Hydraulic conductivity of aquifer in which dilution occurs

The re-used material may be placed either within St. Catherine’s Wood or Red Bank Terrace. There are two principal aquifers within the site boundary: the Collyhurst Sandstone and the Chester Formation. The proposed fill to public open space areas is over Manchester Marl and Chester Formation. Of these, the Chester Formation is taken to be the aquifer in which dilution occurs as this is likely to be providing some base flow to the River Irk. The use of the Chester Formation is considered to provide a conservative assessment of the potential groundwater impact.

No site-specific data is available for hydraulic conductivity within the bedrock aquifer. Published values²⁰ for hydraulic conductivity within the Chester Formation range from 3.1x10⁻⁴- to 15 m/d, with a median of 1.5 and a geometric mean of 0.57m/d. Another source gives the hydraulic conductivity of the Chester Formation of the Manchester area as 0.5 to 5m/d²¹.

¹⁸ Environment Agency (2006) Remedial Targets Methodology

¹⁹ <https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcqrqyr80>

²⁰ Baseline Report Series: 8. The Permo-Triassic Sandstones of Manchester and East Cheshire. Groundwater systems and water quality commissioned report CR/03/265N. Technical Report NC/99/74/8. <https://nora.nerc.ac.uk/id/eprint/3573/1/CR03265N.pdf>

²¹ Environment Agency and BGS (1997) The physical properties of major aquifers in England and Wales. Hydrogeology Group Technical Report WD/97/34. Environment Agency R&D Publication 8 <https://nora.nerc.ac.uk/id/eprint/13137/1/WD97034.pdf>

Hydraulic gradient of water table

The groundwater hydraulic gradient was calculated from the groundwater elevation measured on site during the spot monitoring rounds undertaken as part of the 2022 GI. Calculated hydraulic gradients in the Chester Formation are in the range 0.023 to 0.045. The mean of these values has been taken as the hydraulic gradient beneath the site.

Width of contaminant source perpendicular to groundwater flow

Zone 1 (river bank to 50m)

The areas of proposed fill within Zone 1 vary from location to location. Some small areas of fill are proposed close to the Irk, although the largest areas of fill placement are against existing slopes in Zone 2.

The width of the placed fill areas within Zone 1 ranges from 17 to 82m. A median width of 50m has been adopted for use in this assessment. The length parallel to groundwater flow ranges from 21 to 28m, with a median length of 25m, which has been used for this assessment.

Zone 2 (50m to 130m from river bank)

The width of the placed fill areas within Zone 2 ranges from 37 to 63m. A median width of 50m has been adopted for use in this assessment. The length parallel to groundwater flow ranges from 53 to 73m, with a median of 63m, which has been used for this assessment.

Mixing zone thickness

The Chester Formation extends to great depth (over 300m) however, the thickness of the mixing zone along the groundwater pathway is substantially less, given that groundwater is believed to discharge into the River Irk. This parameter has been calculated in the model.

Bulk density of aquifer materials

The average bulk unit weight value for the Chester Formation from ground investigation data is 21kN/m³, or 2.1g/cm³.

Aquifer effective porosity

No site-specific data is available for the effective porosity of the aquifer. Literature values²² quote a porosity at outcrop within the Chester Formation of 20 to 30%.

Core porosity data for the Chester Formation is in the range 12.4 to 33.2% with a median of 23.5% and an arithmetic mean of 23.2%³⁰.

Aquifer fraction of organic carbon

No site-specific data is available for the fraction of organic carbon in the aquifer. Literature values quote a range for Permo-Triassic Sandstones between 0.00028 to 0.0015. A value of 0.0015 has been selected for use in the assessment.

Distance to compliance point

The distance to the compliance point (the River Irk) has been set at 25m for re-used materials placed in Zone 1, and 90m for re-used materials placed in Zone 2. For hazardous substances, a distance to compliance point of 50m has been used for materials placed in Zone 2.

²² Environment Agency and BGS (1997) The physical properties of major aquifers in England and Wales. Hydrogeology Group Technical Report WD/97/34. Environment Agency R&D Publication 8 <https://nora.nerc.ac.uk/id/eprint/13137/1/WD97034.pdf>

Parameter		Unit	Range	Value used in Assessment	Source
Effective Rainfall	E	m/d	0.0024	0.0024	Met Office data
Infiltration Factor		%	60	60	Assumption based on soft landscaping use
Infiltration rate	Inf	m/d	0.0014	0.0014	Calculated
Length of Zone 1 parallel to flow	L	m	21 to 28	25	Median of site measurement
Width of Zone 1 parallel to flow	W	m	17 to 82	50	Median of site measurement
Length of Zone 2 parallel to flow	L	m	53 to 73	63	Median of site measurement
Width of Zone 2 parallel to flow	W	m	37 to 63	50	Median of site measurement
Hydraulic conductivity of aquifer	K	m/d	3.1x10-4 to 15 Median: 1.5 Mean: 0.57	0.57	Literature value, geometric mean
Saturated aquifer thickness		m	150 to 1300	150	Minimum thickness of Chester Formation sandstone
Hydraulic Gradient	I	m/m	0.023 to 0.045	0.034	Site specific
Depth of Mixing	MZ	m	Base of aquifer not penetrated	Calculated	RTM
Bulk density of aquifer materials (sandstone)		g/cm3	21kN/m3	2.1	Site specific
Aquifer effective porosity		%	20 to 30% 12.4 to 33.2 Median 23.5 Mean 23.2	23.2	Literature value, arithmetic mean
Distance to compliance point (Zone 1)		m	0 to 50	25	Median distance within Zone 1
Distance to compliance point (Zone 2)		m	50 to 130	90 (50m for hazardous substances)	Median distance within Zone 2
Fraction of organic carbon in aquifer	foc	-	0.00028 to 0.0015	0.0015	Literature value for Permo-Triassic Sandstone, maximum

Table 65 Summary of parameters used for Level 2 and 3 RTM, Zones 1 and 2

RTM targets for re-use

Table 66 and Table 67 below summarise the remediation criteria generated using RTM for the re-use of fill materials close to the river, which are designed to be protective of controlled waters.

Contaminant	Level 1 target (mg/kg)	Level 1 target (mg/l)	Level 2 target (mg/kg)	Level 2 target (mg/l)	Level 3 target (mg/kg)	Level 3 target (mg/l)
Nickel	7.65	0.02	26.5	0.05	26.5	0.05
Zinc	55.90	0.11	191	0.38	191	0.38
Benzo(a)Pyrene	0.08	0.00001	0.26	0.00003	0.4	0.00006
Fluoranthene	0.01	0.00001	0.02	0.00002	0.04	0.00003
Anthracene	0.03	0.0001	0.11	0.0003	0.15	0.0005
TPH – Aliphatic C8-C10	559	0.3	1910	1.03	1910	1.03
TPH – Aliphatic C10-C12	4350	0.3	14900	1.03	14900	1.03
TPH – Aliphatic C12-C16	87000	0.3	297000	1.03	297000	1.03
TPH – Aromatic C8-C10	27.9	0.3	95.4	1.03	153	1.6
TPH – Aromatic C10-C12	13.1	0.09	44.7	0.31	76	0.5
TPH – Aromatic C12-C16	26.1	0.09	90.3	0.31	208	0.7
TPH – Aromatic C16-C21	83.5	0.09	289	0.31	323	0.3
TPH – Aromatic C21-C35	679	0.09	2350	0.31	2543	0.3
PFOS	2.39E-05	6.5E-07	8.17E-05	2.22E-06	8.17E-05	2.22E-06
PFOA	3.63E-06	6.5E-07	1.24E-05	2.22E-06	1.24E-05	2.22E-06

Table 66 Target concentrations for the protection of controlled waters in re-used fill in Zone 1

Contaminant	Level 1 target (mg/kg)	Level 1 target (mg/l)	Level 2 target (mg/kg)	Level 2 target (mg/l)	Level 3 target (mg/kg)	Level 3 target (mg/l)
Nickel	7.65	0.0153	26.4	0.0528	27.9	0.0558
Zinc	55.9	0.1115	191	0.380	191	0.382
Benzo(a)Pyrene	0.0754	0.00001	0.257	0.00003	0.7	0.00009
Fluoranthene	0.00633	0.000006	0.02	0.00002	0.06	0.00005
Anthracene	0.0326	0.0001	0.113	0.0003	0.21	0.0006
TPH – Aliphatic C8-C10	559	0.3	1900	1.02	1910	1.02
TPH – Aliphatic C10-C12	4350	0.3	14800	1.02	14800	1.02
TPH – Aliphatic C12-C16	87000	0.3	297000	1.02	297000	1.02
TPH – Aromatic C8-C10	27.9	0.3	95.1	1.02	236	2.53
TPH – Aromatic C10-C12	13.1	0.09	44.5	0.307	124	0.853
TPH – Aromatic C12-C16	2.61	0.09	90.1	0.31	429	1.48
TPH – Aromatic C16-C21	83.5	0.09	288	0.31	359	0.386
TPH – Aromatic C21-C35	679	0.09	2340	0.31	2740	0.364
PFOS	2.32E-05	6.5E-07	7.95E-05	2.22E-06	7.92E-05	2.22E-06
PFOA	3.63E-06	6.5E-07	1.24E-05	2.22E-06	1.24E-05	2.22E-06

Table 67 Target concentrations for the protection of controlled waters in re-used fill in Zone 2

Shallow Groundwater Screen against WQS

[illegible]

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Concentration exceeds GAC		100.00		<div>Hole Ref</div> <div>Sample Ref</div> <div>Easting</div> <div>Northing</div> <div>Hole Elevation (mOD)</div> <div>Sample Depth (mbgl)</div> <div>Piezometer top (mbgl)</div> <div>Piezometer base (mbgl)</div> <div>Sample Date</div> <div>Investigation</div> <div>Response zone</div>				GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
Limit of Detection value exceeds GAC		<0.1						200	100		100	1	
								384479.67	384479.67	384487.32		384476.006	384476.006
								399554.7	399554.7	399426.078		399396.975	399396.975
								40.45	40.45	30.377		30.168	30.168
								10.8	10.8	3.48		3.08	3.55
								14	14	5.5		5.5	5.5
								19.6	19.6	9		10	10
								10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
								NW1604	NW1604	NW1604		River Works 2021/	iver Works 2021/2
				Chester	Chester	Chester	Chester	Chester	Chester				
				Formation	Formation	Formation	Formation	Formation	Formation				
Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max						
Metal													
Antimony	0.005	DWS	mg/l	6 of 6	1	0.0029841666666667	0.0059	0.002005	0.002	0.005	0.0059	0.002	0.001
Arsenic	0.05	EQS	mg/l	6 of 6	0	0.009954	0.039	0.001124	0.0026	0.039	0.014	0.001	0.002
Beryllium	0.004	USEPA	mg/l	1 of 6	0	0.0007166666666667	0.002	<0.0001	<0.0001	0.002	<0.0001	<0.001	<0.001
Cadmium	0.005	EQS	mg/l	2 of 6	0	0.0007416666666667	0.0038	<0.00003	<0.00003	0.0038	0.00019	<0.0002	<0.0002
Calcium	-	-	mg/l	No GAC	-	173.333333333333	227	120	100	215	170	208	227
Chromium	0.0047	EQS	mg/l	5 of 6	1	0.0083005	0.045	0.000643	0.00026	0.045	0.0019	<0.001	0.001
Copper	0.03375	EQS	mg/l	6 of 6	1	0.0169886666666667	0.078	0.003132	0.0022	0.078	0.0046	0.003	0.011
Iron (dissolved)	2.488	BGS	mg/l	3 of 3	0	0.99	1.65		1.1		0.22	1.65	
Lead	0.00958	EQS	mg/l	4 of 6	2	0.155793333333333	0.866	<0.00009	0.00024	0.866	0.00043	<0.001	0.067
Magnesium	-	-	mg/l	No GAC	-	22.5	28	27	28		11	24	
Manganese	2.41	BGS	mg/l	6 of 6	0	0.717123666666667	1.01	0.746742	0.85	0.79	0.023	0.883	1.01
Mercury	0.001	DWS	mg/l	0 of 6	0	0.000055	<0.0001	<0.00001	<0.00001	<0.00001	<0.00001	<0.0001	<0.0001
Nickel	0.01607	EQS	mg/l	6 of 6	1	0.0068431666666667	0.024	0.001259	0.0021	0.024	0.0027	0.005	0.006
Potassium	-	-	mg/l	No GAC	-	8.575	12	7.1	7.6		7.6	12	
Selenium	0.01	DWS	mg/l	6 of 6	0	0.0028045	0.0069	0.000387	0.00054	0.005	0.0069	0.002	0.002
Sodium	200	EUDWS	mg/l	4 of 4	0	26	38	38	13		16	37	
Titanium (dissolved)	-	-	mg/l	No GAC	-	#DIV/0!							
Vanadium	0.02	EQS*	mg/l	3 of 6	1	0.0061666666666667	0.03	<0.0006	<0.0006	0.03	0.0028	<0.001	0.002
Zinc	0.1115	EQS	mg/l	6 of 6	1	0.163774	0.923	0.003744	0.0039	0.923	0.022	0.005	0.025
Inorganic													
pH	<6 - >9	EQS*	pH Units	No GAC	-	7.12333333333333	7.22	7	7.2	7.03	7.2	7.22	7.09
Cyanide	0.001	EQS	mg/l	4 of 6	4	0.949166666666667	5.246	<0.04	<0.04	5.246	0.29	0.038	0.041
Complex Cyanide	-	EQS	mg/l	No GAC	-	1.83266666666667	5.112			5.112	0.36		0.026
Cyanide (free) (w)	0.001	EQS	mg/l	3 of 3	3	0.136333333333333	0.26			0.134	0.26		0.015
Thiocyanate	-	EQS	mg/l	No GAC	-	0.34	0.7			0.7	<0.02		0.3
Chloride	250	EQS*	mg/l	6 of 6	0	28.3333333333333	42	22	28	14	23	41	42
Ammoniacal Nitrogen as N	7.2	U/S	mg/l	3 of 6	1	1.68083333333333	7.4	2.5	7.4	<0.02	<0.015	0.13	<0.02
DOC (w)	-	-	mg/l	No GAC	-	3.23333333333333	3.7	3.5	3.3	3.5	<2	3.4	3.7
BOD (settled, 5 day)	-	-	mg/l	No GAC	-	#DIV/0!							
Hardness Total	-	mg/l CaCO3	No GAC	-	-	549.8	670		370	617	475	617	670
Total hardness	-	-	mg/l	No GAC	-	410	410	410					
Nitrate (w)	50	DWS	mg/l	2 of 4	0	5.025	13	<0.5	<0.1		13	6.5	
Nitrite (w)	0.5	DWS	mg/l	0 of 4	0	0.2	<0.5	<0.5	<0.1	<0.1		<0.1	
Sulphate (w)	400	EQS*	mg/l	4 of 4	0	175.5	325	98	79		200	325	
Sulphide	-	-	mg/l	No GAC	-	0.1552765	0.5	0.018106	0.073		0.03	0.5	
Total Alkalinity as CaCO3	-	-	mg/l	No GAC	-	340	390	390	380		250		
Phenol and mineral oils													
Phenol	0.0077	EQS	mg/l	0 of 1	0	<0.001	<0.001					<0.001	
Phenol (Monohydric)	0.0077	EQS	mg/l	0 of 6	0	0.055	<0.1	<0.1	<0.1	<0.01	<0.1	<0.01	<0.01
Phenols, Total	-	-	mg/l	No GAC	-	#DIV/0!							
Cresols	-	-	mg/l	No GAC	-	#DIV/0!							
TPH													
Ali >C10-C12 (w)	0.3	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005
Ali >C12-C16 (w)	0.3	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005
Ali >C16-C21 (w)	-	-	mg/l	No GAC	-	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005
Ali >C21-C35 (w)	-	-	mg/l	No GAC	-	0.0054	0.015	<0.001		0.015	<0.001	<0.005	<0.005
Ali >C35-C44 (w)	-	-	mg/l	No GAC	-	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005
Ali >C5-C6 (w)	15	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001
Ali >C6-C8 (w)	15	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001
Ali >C8-C10 (w)	0.3	WHO	mg/l	0 of 5	0	0.00304	<0.005	<0.0001		<0.005	<0.0001	<0.005	<0.005
Aliphatics >C5-35	-	-	mg/l	No GAC	-	#DIV/0!							
Total Aliphatics (w)	-	-	mg/l	No GAC	-	0.00833333333333333	0.015			0.015		<0.005	<0.005
Aro >C10-C12 (w)	0.09	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005
Aro >C12-C16 (w)	0.09	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005
Aro >C16-C21 (w)	0.09	WHO	mg/l	1 of 5	0	0.0034	<0.005	<0.001		0.005	<0.001	<0.005	<0.005
Aro >C21-C35 (w)	0.09	WHO	mg/l	0 of 5	0	0.0064	<0.01	<0.001		<0.01	<0.001	<0.01	<0.01
Aro >C35-C44 (w)	-	-	mg/l	No GAC	-	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005
Aro >C5-C7 (w)	0.01	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001
Aro >C7-C8 (w)	0.7	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001
Aro >C8-C10 (w)	0.3	WHO	mg/l	0 of 5	0	0.00304	<0.005	<0.0001		<0.005	<0.0001	<0.005	<0.005
Aromatics >C10-44	-	-	mg/l	No GAC	-	<0.001	<0.001	<0.001		<0.001	<0.001		
Total Aromatics (w)	-	-	mg/l	No GAC	-	<0.01	<0.01			<0.01	<0.001	<0.01	<0.01
TPH (Ali & Aro >C5-C44) (w)	-	-	mg/l	No GAC	-	0.0133333333333333	0.02			0.02		<0.01	<0.01
Total Aliphatics and Aromatics C10-C44	-	-	mg/l	No GAC	-	#DIV/0!							
Total Aliphatics and Aromatics C5-C35	-	-	mg/l	No GAC	-	#DIV/0!							
Total Aromatics C5-C35	-	-	mg/l	No GAC	-	#DIV/0!							
PAH													
Acenaphthene	2	USEPA	mg/l	2 of 5	0	0.0000227	0.00011		0.00002	<0.00001	0.00011	<0.00001	<0.00001
Dibenz-a-h-anthracene	-	-	mg/l	No GAC	-	0.0000255	<0.00001	<0.00001		<0.00001	<0.00001	<0.00001	<0.00001
Fluoranthene	6.30E-06	EQS	mg/l	4 of 5	4	0.0001973	0.00013	0.00002	0.00013	0.00001	0.00001	<0.00001	0.00006
Fluorene	-	-	mg/l	No GAC	-	0.0000218	0.00005	0.00001	<0.00001	<0.00001	0.00005	<0.00001	<0.00001
Indeno(1,2,3-cd)pyrene	-	-	mg/l	No GAC	-	0.0000964	0.00004	<0.00001	0.00004	<0.00001		<0.00001	0.00002
Phenanthrene	-	-	mg/l	No GAC	-	0.0000964	0.00008	0.00001	0.00008	0.00003		<0.00001	0.00004
Pyrene	-	-	mg/l	No GAC	-	0.0002509	0.00013	0.00001	0.00013	0.00001		0.00001	0.00007
Naphthalene (w)	0.002	EQS	mg/l	2 of 5	0	0.00001	0.00034	<0.00005	<0.00001	<0.00001	0.00034	0.00001	<0.00001
Total PAH 16MS (w)	-	-	mg/l	No GAC	-	0.0013773	0.00069	<0.0002		0.00069	0.0006	0.00002	0.00031
Pah,Total	-	-	mg/l	No GAC	-								

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

								Hole Ref	GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
								Sample Ref	200	100		100	1	
								Easting	384479.67	384479.67	384487.32		384476.006	384476.006
								Northing	399554.7	399554.7	399426.078		399396.975	399396.975
								Hole Elevation (mOD)	40.45	40.45	30.377		30.168	30.168
								Sample Depth (mbgl)	10.8	10.8	3.48		3.08	3.55
								Piezometer top (mbgl)	14	14	5.5		5.5	5.5
								Piezometer base (mbgl)	19.6	19.6	9		10	10
								Sample Date	10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
								Investigation	NW1604	NW1604	NW1604		River Works 2021/iver Works 2021/2	
								Response zone	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation
Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max							
BTEX - Ethyl Benzene (w)	0.02	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001			<0.001	<0.001	<0.001
BTEX - m & p Xylene (w)	0.03	EQS*	mg/l	0 of 3	0	<0.001	<0.001				<0.001		<0.001	<0.001
BTEX - o Xylene (w)	0.03	EQS*	mg/l	0 of 3	0	<0.001	<0.001				<0.001		<0.001	<0.001
Xylene	0.03	EQS*	mg/l	0 of 2	0	<0.001	<0.001		<0.001			<0.001		<0.001
VOC						#DIV/0!								
1,1,1,2-Tetrachloroethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,1,1-Trichloroethane	0.1	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1,2,2-Tetrachloroethane	0.14	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1,2-Trichloroethane	0.4	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1-Dichloroethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,1-Dichloroethene	0.05	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1-Dichloropropene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,2,3 Trichlorobenzene	0.0004	EQS	mg/l	0 of 1	0	<0.003	<0.003						<0.003	
1,2,3-Trichloropropane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,2,4-Trichlorobenzene	0.0004	EQS	mg/l	0 of 1	0	<0.003	<0.003						<0.003	
1,2,4-Trimethylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,2-Dibromo-3-Chloropropane	0.001	WHO	mg/l	0 of 1	0	<0.002	<0.002						<0.002	
1,2-Dibromoethane	0.0004	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,2-Dichlorobenzene	0.02	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,2-Dichloroethane	0.01	EQS	mg/l	0 of 1	0	<0.002	<0.002						<0.002	
1,2-Dichloropropane	0.04	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,3,5-Trimethylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,3-Dichlorobenzene	0.02	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,3-Dichloropropane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,4-Dichlorobenzene	0.02	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,2-Dichloropropane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Chlorotoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Chlorotoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Isopropyltoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bromobenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bromochloromethane			mg/l	No GAC	-	<0.005	<0.005						<0.005	
Bromodichloromethane	0.06	WHO	mg/l	0 of 1	0	<0.01	<0.01						<0.01	
Bromoforn	0.1	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Bromomethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Carbon Disulphide			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Carbon Tetrachloride	0.012	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Chlorobenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Chloroethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Chloroethene	0.0005	DWS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Chloroform	0.0025	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Chloromethane			mg/l	No GAC	-	<0.01	<0.01						<0.01	
Dibromochloromethane	0.1	WHO	mg/l	0 of 1	0	<0.003	<0.003						<0.003	
Dibromomethane	0.02	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Dichlorodifluoromethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Dichloromethane	0.02	EQS	mg/l	0 of 1	0	<0.005	<0.005						<0.005	
Hexachlorobutadiene	0.0006	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Isopropylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
MTBE (w)	0.015	WHO	mg/l	0 of 3	0	<0.001	<0.001				<0.001		<0.001	<0.001
Sec-Butylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Styrene	0.05	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Tert-Butylbenzene			mg/l	No GAC	-	<0.002	<0.002						<0.002	
Tetrachloroethene	0.01	DWS	mg/l	1 of 1	0	0.003	0.003						0.003	
Trichloroethene	0.01	DWS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Trichlorofluoromethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
cis 1,2-Dichloroethene	0.05	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
cis 1,3-Dichloropropene	0.02	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
n-Butylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
n-propylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
trans 1,2-Dichloroethene	0.05	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
trans 1,3-Dichloropropene	0.02	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
SVOC						#DIV/0!								
2,4,5-Trichlorophenol			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2,4,6-Trichlorophenol	0.2	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,4-Dichlorophenol	0.0042	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,4-Dimethylphenol	0.1	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,4-Dinitrotoluene	0.1	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,6-Dinitrotoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Chloronaphthalene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Chlorophenol	0.05	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2-Methylnaphthalene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Methylphenol	0.1	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2-Nitrophenol			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Bromophenyl Phenyl Ether			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Chloro-3-Methylphenol	0.04	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
4-Nitrophenol			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bis(2-chloroethoxy)methane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bis(2-chloroethyl)ether			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bis(2-ethylhexyl)phthalate	0.0013	EQS	mg/l	0 of 1	0	<0.01	<0.01						<0.01	
Butylbenzyl phthalate	0.0075	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Carbazole			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Di-N-Butyl Phthalate	0.008	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Di-N-Octyl Phthalate	0.02	EQS*	mg/l	0 of 1	0	<0.01	<0.01						<0.01	
Dibenzofuran			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Diethyl phthalate	0.2	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Dimethyl phthalate	0.8	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Hexachlorobenzene	0.001	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Hexachlorocyclopentadiene	0.05	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Hexachloroethane	0.04	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Isophorone	7	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
Sample Ref	200	100		100	1	
Easting	384479.67	384479.67	384487.32		384476.006	384476.006
Northing	399554.7	399554.7	399426.078		399396.975	399396.975
Hole Elevation (mOD)	40.45	40.45	30.377		30.168	30.168
Sample Depth (mbgl)	10.8	10.8	3.48		3.08	3.55
Piezometer top (mbgl)	14	14	5.5		5.5	5.5
Piezometer base (mbgl)	19.6	19.6	9		10	10
Sample Date	10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
Investigation	NW1604	NW1604	NW1604		River Works 2021/iver Works 2021/2	
Response zone	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max
Nitrobenzene	0.0004	EQS	mg/l	No GAC	-	<0.001	<0.001
PCP; (Pentachlorophenol) (w)			mg/l	0 of 1	0	<0.001	<0.001
n-Nitroso-n-dipropylamine			mg/l	No GAC	-	<0.001	<0.001
Herbicides						#DIV/0!	
Ametryne (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Atraton (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Atrazine (w)	0.0006	EQS	mg/l	0 of 0	0	#DIV/0!	
Prometon (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Prometryn (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Propazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Simazine (w)	0.001	EQS	mg/l	0 of 0	0	#DIV/0!	
Simetryn (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Terbutylazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,3,6-TBA (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4,5-T (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4,5-TP; (Fenoprop); (Silvex) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4-D (w)	0.0003	EQS	mg/l	0 of 0	0	#DIV/0!	
2,4-DB (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4-DP; (Dichlorprop)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
4-CPA (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Benazolin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Bentazone (w)	0.5	EQS*	mg/l	0 of 0	0	#DIV/0!	
Bromoxynil (w)	0.1	EQS*	mg/l	0 of 0	0	#DIV/0!	
Clopyralid (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Dicamba (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Diclofop (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Flamprop (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Flamprop-isopropyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Ioxynil (w)	0.01	EQS*	mg/l	0 of 0	0	#DIV/0!	
MCPA (w)	0.012	EQS*	mg/l	0 of 0	0	#DIV/0!	
MCPB (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
MCPP; (Mecoprop) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Picloram (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Triclopyr (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Bromacil (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Carbetamide (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorbufam (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorpropham (w)	0.01	EQS*	mg/l	0 of 0	0	#DIV/0!	
Chlortoluron (w)	0.002	EQS*	mg/l	0 of 0	0	#DIV/0!	
Cyanazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Diuron (w)	0.0002	EQS	mg/l	0 of 0	0	#DIV/0!	
Isoproturon (w)	0.0003	EQS	mg/l	0 of 0	0	#DIV/0!	
Linuron (w)	0.0005	EQS	mg/l	0 of 0	0	#DIV/0!	
Monuron (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Pirimicarb (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Propham (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Cyfluthrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Cypermethrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Deltamethrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Fenvalerate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Permethrin (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Pesticides						#DIV/0!	
Aldrin (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorothalonil (w)	0.000035	EQS	mg/l	0 of 0	0	#DIV/0!	
Dichlobenil (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Dieldrin (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!	
Endosulphan I (Alpha) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Endosulphan II (Beta) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Endosulphan Sulphate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Endrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Heptachlor (w)	0	EQS	mg/l	0 of 0	0	#DIV/0!	
Heptachlor epoxide (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!	
Isodrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Pendimethalin (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Permethrin II (trans) (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Quintozene (PCNB) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Tecnazene (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Triadimefon (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Triallate (w)	0.00025	EQS*	mg/l	0 of 0	0	#DIV/0!	
Trifluralin (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!	
alpha-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
beta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
cis-Chlordane (Alpha) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
delta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
gamma-Hexachlorocyclohexane (HCH) / L	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDD (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDE (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDT (2,4) (w)	0.000025	EQS	mg/l	0 of 0	0	#DIV/0!	
o,p-Methoxychlor (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
p,p-DDE (4,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
p,p-DDT (4,4) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!	
trans-Chlordane (Gamma) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Azinphos-ethyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Azinphos-methyl (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Carbophenothion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorfenvinphos (w)	0.0001	EQS	mg/l	0 of 0	0	#DIV/0!	
Chlorpyrifos (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!	
Chlorpyrifos-methyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Coumaphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
Sample Ref	200	100		100	1	
Easting	384479.67	384479.67	384487.32		384476.006	384476.006
Northing	399554.7	399554.7	399426.078		399396.975	399396.975
Hole Elevation (mOD)	40.45	40.45	30.377		30.168	30.168
Sample Depth (mbgl)	10.8	10.8	3.48		3.08	3.55
Piezometer top (mbgl)	14	14	5.5		5.5	5.5
Piezometer base (mbgl)	19.6	19.6	9		10	10
Sample Date	10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
Investigation	NW1604	NW1604	NW1604		River Works 2021/iver Works 2021/2	
Response zone	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max
Diazinon (Dimpylate) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!	
Dichlorvos (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Dimethoate (w)	0.00048	EQS	mg/l	0 of 0	0	#DIV/0!	
Disulfoton (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Ethion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Fenitrothion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Fenthion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Malathion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Methyl Parathion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Mevinphos (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Parathion (Ethyl Parathion) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Phorate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Phosalone (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Pirimiphos-methyl (w)	0.000015	EQS*	mg/l	0 of 0	0	#DIV/0!	
Propetamphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!	
Triazophos (w)	0.000005	EQS*	mg/l	0 of 0	0	#DIV/0!	
Other						#DIV/0!	
2,3,4,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!	
2,3,5,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!	
2-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
3+4-Methylphenol			mg/l	No GAC	-	<0.001	<0.001
3-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
4-Chlorophenyl Phenyl Ether			mg/l	No GAC	-	#DIV/0!	
4-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
Aliphatics >C10-44			mg/l	No GAC	-	#DIV/0!	
Alkalinity (total) (w) Colorimetry			mg/l CaCO3	No GAC	-	294	294
Aluminium (dissolved)	15	EQS*	mg/l	0 of 0	0	#DIV/0!	
Aniline			mg/l	No GAC	-	#DIV/0!	
Azobenzene			mg/l	No GAC	-	#DIV/0!	
Benzyl Alcohol			mg/l	No GAC	-	#DIV/0!	
Bis(2-chloroisopropyl)ether			mg/l	No GAC	-	<0.001	<0.001
Bis(2-ethylhexyl) adipate			mg/l	No GAC	-	#DIV/0!	
Cobalt (dissolved)	3	EQS*	mg/l	0 of 0	0	#DIV/0!	
Cyhalothrin-lambda (w)			mg/l	No GAC	-	#DIV/0!	
Demeton-S (w)			mg/l	No GAC	-	#DIV/0!	
Diiflubenzuron (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Diphenylamine			mg/l	No GAC	-	#DIV/0!	
Ecoli (Faecal Coliforms) (w)	0	EUDWS	cfu/100ml	0 of 1	0	<1	<1
Endrin Aldehyde (w)			mg/l	No GAC	-	#DIV/0!	
Endrin Ketone (w)			mg/l	No GAC	-	#DIV/0!	
Fensulphothion (w)			mg/l	No GAC	-	#DIV/0!	
Fluroxypyr (w)			mg/l	No GAC	-	#DIV/0!	
Intestinal Enterococci (Faecal Streptococci/Faecal Enterococci)			cfu/100ml	No GAC	-	5	5
Iron (Soluble)			mg/l	No GAC	-	0.24	0.24
M-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!	
Methabenzthiazuron (w)			mg/l	No GAC	-	#DIV/0!	
Monolinuron (w)			mg/l	No GAC	-	#DIV/0!	
Naphthalene1-methyl-			mg/l	No GAC	-	#DIV/0!	
Naphthols (2-Naphthalenesulfonic acid, 1-hydroxy-)			mg/l	No GAC	-	#DIV/0!	
P-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!	
Perylene			mg/l	No GAC	-	<0.001	<0.001
Resorcinol			mg/l	No GAC	-	#DIV/0!	
Silver (dissolved)	0.05	EQS*	mg/l	0 of 0	0	#DIV/0!	
Telodrin (w)			mg/l	No GAC	-	#DIV/0!	
Terbutryn (w)	0.065	EQS	mg/l	0 of 0	0	#DIV/0!	
Tin (dissolved)	25	EQS*	mg/l	0 of 0	0	#DIV/0!	
Trichloronate (w)			mg/l	No GAC	-	#DIV/0!	
Trimethylphenol			mg/l	No GAC	-	#DIV/0!	
Xylenols & Ethylphenols			mg/l	No GAC	-	#DIV/0!	
Chloroxuron (w)			mg/l	No GAC	-	#DIV/0!	
Demeton-O (w)			mg/l	No GAC	-	#DIV/0!	
Dimefuron (w)			mg/l	No GAC	-	#DIV/0!	
Ethiofencarb (w)			mg/l	No GAC	-	#DIV/0!	
Metoxuron (w)			mg/l	No GAC	-	#DIV/0!	
Pencycuron (w)			mg/l	No GAC	-	#DIV/0!	
Permethrin I (cis) (w)			mg/l	No GAC	-	#DIV/0!	
Phenmedipham (w)			mg/l	No GAC	-	#DIV/0!	
Prothiofos (Tokuthion) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-DDD (4,4) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-Methoxychlor (w)			mg/l	No GAC	-	#DIV/0!	
cis1,3-Dichloropropene			mg/l	No GAC	-	#DIV/0!	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Concentration exceeds GAC						100.00	Hole Ref		BH310	BH310	GEO_BH203	GEO_BH203	BH203
Limit of Detection value exceeds GAC						<0.1	Sample Ref		3WBH-BH310 4.3	3WBH-BH310 4.3	3WBH-BH310 4.3	3WBH-BH310 4.3	3WBH-BH310 4.3
							Easting		384838.09	384838.09	384845.747	384845.747	100
							Northing		399638.18	399638.18	399748.863	399748.863	
							Hole Elevation (mOD)		32.6	32.6	41.891	41.891	
							Sample Depth (mbgl)		4.3	4.3	12.3	12.3	
							Piezometer top (mbgl)		8	8	18	18	
							Piezometer base (mbgl)		16	16	24	24	
							Sample Date		26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021
							Investigation		326R	326R	NW1604	NW1604	
							Response zone		Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone St Catherine's Wood
Contaminant Name		GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max					
Metal													
Antimony	0.005	DWS	mg/l	1 of 5	0	0.000902	<0.001		<0.001	<0.001	<0.001	<0.001	0.00051
Arsenic	0.05	EQS	mg/l	5 of 5	0	0.00638	0.011		0.007	0.007	0.011	0.003	0.0039
Beryllium	0.004	USEPA	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.001	<0.0001
Cadmium	0.005	BGS	mg/l	2 of 5	0	0.000186	0.0003		<0.0002	<0.0002	0.0002	0.0003	<0.00003
Calcium	-	-	mg/l	No GAC	-	235	834		834	70	91	95	85
Chromium	0.0047	EQS	mg/l	3 of 5	0	0.001656	0.004		0.002	<0.001	0.004	<0.001	0.00028
Copper	0.03375	EQS	mg/l	5 of 5	1	0.01352	0.043		0.013	0.004	0.043	0.007	0.0006
Iron (dissolved)	1	EQS	mg/l	1 of 1	0	0.018	0.018						0.018
Lead	0.00958	EQS	mg/l	5 of 5	2	0.025182	0.088		0.025	0.008	0.088	0.004	0.00091
Magnesium	-	-	mg/l	No GAC	-	45	45						45
Manganese	2.41	BGS	mg/l	5 of 5	0	1.0842	1.92		1.92	1.31	0.722	0.809	0.66
Mercury	0.001	DWS	mg/l	1 of 5	0	0.000094	<0.0001		<0.0001	<0.0001	<0.0001	<0.0001	0.00007
Nickel	0.01607	EQS	mg/l	5 of 5	1	0.00604	0.02		0.005	0.002	0.02	0.002	0.0012
Potassium	-	-	mg/l	No GAC	-	4.1	4.1						4.1
Selenium	0.01	DWS	mg/l	1 of 5	0	0.000874	<0.001		<0.001	<0.001	<0.001	<0.001	0.00037
Sodium	200	EUDWS	mg/l	1 of 1	0	18	18						18
Titanium (dissolved)	-	-	mg/l	No GAC	-	#DIV/0!							
Vanadium	0.02	EQS*	mg/l	2 of 5	0	0.00172	0.004		0.002	<0.001	0.004	<0.001	<0.0006
Zinc	0.1115	EQS	mg/l	5 of 5	1	0.05166	0.137		0.038	0.024	0.137	0.055	0.0043
Inorganic													
pH	<6 ->9	EQS*	pH Units	No GAC	-	7.384	7.84		7.4	7.5	7.84	7.08	7.1
Cyanide	0.001	EQS	mg/l	2 of 5	2	0.0138	<0.04		0.01	0.009	<0.005	<0.005	<0.04
Complex Cyanide	-	mg/l	No GAC	-	-	0.005025	0.009			0.009	<0.005	<0.005	0.0011
Cyanide (free) (w)	0.001	EQS	mg/l	0 of 4	0	0.00875	<0.02			<0.005	<0.005	<0.005	<0.02
Thiocyanate	-	mg/l	No GAC	-	-	0.43	1.5			0.1	1.5	0.1	<0.02
Chloride	250	EQS*	mg/l	5 of 5	0	37	39		37	39	35	38	36
Ammoniacal Nitrogen as N	0.6	EQS	mg/l	5 of 5	5	2.628	4.04		2.27	1.22	3.81	4.04	1.8
DOC (w)	-	mg/l	No GAC	-	-	3.12	4.3		2.4	<2	4.3	3.6	3.3
BOD (settled, 5 day)	-	mg/l	No GAC	-	-	#DIV/0!							
Hardness Total	-	mg/l CaCO3	No GAC	-	-	747	2463		2463	262	345	358	307
Total hardness	-	mg/l	No GAC	-	-	#DIV/0!							
Nitrate (w)	50	DWS	mg/l	0 of 1	0	<0.1	<0.1						<0.1
Nitrite (w)	0.5	DWS	mg/l	0 of 1	0	<0.1	<0.1						<0.1
Sulphate (w)	400	EQS*	mg/l	2 of 2	0	27.5	38		17				38
Sulphide	-	mg/l	No GAC	-	-	0.021	0.021						0.021
Total Alkalinity as CaCO3	-	mg/l	No GAC	-	-	290	290						290
Phenol and mineral oils													
Phenol	0.0077	EQS	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.001	<0.0001
Phenol (Monohydric)	0.0077	EQS	mg/l	0 of 5	0	0.028	<0.1		<0.01	<0.01	<0.01	<0.01	<0.1
Phenols, Total	-	mg/l	No GAC	-	-	<0.002	<0.002						<0.002
Cresols	-	mg/l	No GAC	-	-	<0.0001	<0.0001						<0.0001
TPH													
Ali >C10-C12 (w)	0.3	WHO	mg/l	2 of 5	0	0.0062	0.012		0.012	0.008	<0.005	<0.005	<0.001
Ali >C12-C16 (w)	0.3	WHO	mg/l	2 of 5	2	0.0066	3.319		3.319	1.173	<0.005	<0.005	<0.001
Ali >C16-C21 (w)	-	mg/l	No GAC	-	-	0.0088	0.024		0.024	0.009	0.005	<0.005	<0.001
Ali >C21-C35 (w)	-	mg/l	No GAC	-	-	0.057	0.139		0.071	0.039	0.139	0.035	<0.001
Ali >C35-C44 (w)	-	mg/l	No GAC	-	-	0.0048	0.008		<0.005	<0.005	0.008	<0.005	<0.001
Ali >C5-C6 (w)	15	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.001	<0.0001
Ali >C6-C8 (w)	15	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.001	<0.0001
Ali >C8-C10 (w)	0.3	WHO	mg/l	0 of 5	0	0.00402	<0.005		<0.005	<0.005	<0.005	<0.005	<0.0001
Aliphatics >C5-35	-	mg/l	No GAC	-	-	#DIV/0!							
Total Aliphatics (w)	-	mg/l	No GAC	-	-	1.21175	3.43		3.43	1.23	0.152	0.035	
Aro >C10-C12 (w)	0.09	WHO	mg/l	3 of 5	1	0.0306	0.11		0.11	0.027	0.01	<0.005	<0.001
Aro >C12-C16 (w)	0.09	WHO	mg/l	4 of 5	2	0.0316	1.349		1.349	0.436	0.012	0.01	<0.001
Aro >C16-C21 (w)	0.09	WHO	mg/l	4 of 5	0	0.013	0.018		0.018	0.016	0.012	0.018	<0.001
Aro >C21-C35 (w)	0.09	WHO	mg/l	2 of 5	0	0.0088	0.012		0.011	<0.01	0.012	<0.01	<0.001
Aro >C35-C44 (w)	-	mg/l	No GAC	-	-	0.0042	<0.005		<0.005	<0.005	<0.005	<0.005	<0.001
Aro >C5-C7 (w)	0.01	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.001	<0.0001
Aro >C7-C8 (w)	0.7	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.001	<0.0001
Aro >C8-C10 (w)	0.3	WHO	mg/l	1 of 5	0	0.00442	0.007		<0.005	<0.005	0.007	<0.005	<0.0001
Aromatics >C10-44	-	mg/l	No GAC	-	-	1.49	1.49		1.49	0.479	0.053	0.028	
Total Aromatics (w)	-	mg/l	No GAC	-	-	0.5125	1.49						
TPH (Ali & Aro >C5-C44) (w)	-	mg/l	No GAC	-	-	1.722	4.91		4.91	1.71	0.205	0.063	
Total Aliphatics and Aromatics C10-C44	-	mg/l	No GAC	-	-	#DIV/0!							
Total Aliphatics and Aromatics C5-C35	-	mg/l	No GAC	-	-	#DIV/0!							
Total Aromatics C5-C35	-	mg/l	No GAC	-	-	#DIV/0!							
PAH													
Acenaphthene	2	USEPA	mg/l	3 of 5	0	0.000227	0.0017		<0.00001	<0.00001	0.00002	0.00009	0.0017
Dibenz-a-h-anthracene	-	mg/l	No GAC	-	-	0.000255	0.0004		<0.00001	<0.00001	0.00004	<0.00001	<0.00001
Fluoranthene	6.30E-06	EQS	mg/l	4 of 5	4	0.000193	0.00031		0.00004	<0.00001	0.00031	0.00002	0.00006
Fluorene	-	mg/l	No GAC	-	-	0.000218	0.00042		<0.00001	<0.00001	0.00003	0.00005	0.00042
Indeno(1,2,3-cd)pyrene	-	mg/l	No GAC	-	-	0.0000964	0.0002		0.00002	<0.00001	0.00002	<0.00001	<0.00001
Phenanthrene	-	mg/l	No GAC	-	-	0.0000964	0.00024		0.00001	<0.00001	0.00015	<0.00001	0.00024
Pyrene	-	mg/l	No GAC	-	-	0.0002509	0.00066		0.00007	0.00002	0.00066	0.00005	0.00009
Naphthalene (w)	0.002	EQS	mg/l	1 of 5	1	0.00001	0.0085		<0.00001	<0.00001	<0.00001	<0.00001	0.0085
Total PAH 16MS (w)	-	mg/l	No GAC	-	-	0.0013773	0.012		0.00025	0.00002	0.00295	0.00021	0.012
PAH Total	-	mg/l	No GAC	-	-	#DIV/0!							
Acenaphthylene	-	mg/l	No GAC	-	-	0.0000209	0.0004		<0.00001	<0.00001	0.00007	<0.00001	0.0004
Anthracene	0.0001	EQS	mg/l	2 of 5	1	0.0000409	0.00012		<0.00001	<0.00001	0.00006	<0.00001	0.00012
Benzo(a)anthracene	-	mg/l	No GAC	-	-	0.0001118	0.00019		0.00002	<0.00001	0.00019	<0.00001	<0.00001

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max	Hole Ref	BH310	BH310	GEO_BH203	GEO_BH203	BH203
								Sample Ref	3WBH-BH310 4.3	3WBH-BH310 4.3	GWBH-BH203 12.30	GWBH-BH203 12.30	100
Easting								384838.09	384838.09	384838.09	384845.747	384845.747	
Northing								399638.18	399638.18	399638.18	399748.863	399748.863	
Hole Elevation (mOD)								32.6	32.6	32.6	41.891	41.891	
Sample Depth (mbgl)								4.3	4.3	4.3	12.3	12.4	
Piezometer top (mbgl)								8	8	8	18	18	
Piezometer base (mbgl)								16	16	16	24	24	
Sample Date								26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021	
Investigation								326R	326R	326R	NW1604	NW1604	
Response zone								Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone
St Catherine's Wood													
Benzo (g,h,i) perylene	1.7E-07	-	mg/l	No GAC	-	0.0001009	0.00028		0.00003	<0.00001	0.00028	<0.00001	<0.00001
Benzo(a)pyrene		EQS	mg/l	2 of 5	2	0.0001373	0.0003		0.00002	<0.00001	0.0003	<0.00001	<0.00001
Benzo(b)fluoranthene		-	mg/l	No GAC	-	0.0001482	0.00029		0.00002	<0.00001	0.00029	<0.00001	<0.00001
Benzo(k)fluoranthene		-	mg/l	No GAC	-	0.0000527	0.0001		<0.00001	<0.00001	0.0001	<0.00001	<0.00001
Chrysene		-	mg/l	No GAC	-	0.0001336	0.00025		0.00002	<0.00001	0.00025	<0.00001	0.00002
#DIV/0!													
BTEX - Benzene (w)	0.01	EQS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
BTEX - Toluene (w)	0.074	EQS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
BTEX - Ethyl Benzene (w)	0.02	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
BTEX - m & p Xylene (w)	0.03	EQS*	mg/l	0 of 4	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
BTEX - o Xylene (w)	0.03	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Xylene	0.03	EQS*	mg/l	0 of 1	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
#DIV/0!													
VOC													
1,1,1,2-Tetrachloroethane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,1,1-Trichloroethane	0.1	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2,2-Tetrachloroethane	0.14	EQS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,1,2-Trichloroethane	0.4	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethene	0.05	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloropropene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,2,3 Trichlorobenzene	0.0004	EQS	mg/l	0 of 5	0	0.0026	<0.003		<0.003	<0.003	<0.003	<0.003	<0.001
1,2,3-Trichloropropane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,2,4-Trichlorobenzene	0.0004	EQS	mg/l	0 of 5	0	0.0026	<0.003		<0.003	<0.003	<0.003	<0.003	<0.001
1,2,4-Trimethylbenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dibromo-3-Chloropropane	0.001	WHO	mg/l	0 of 5	0	0.0018	<0.002		<0.002	<0.002	<0.002	<0.002	<0.001
1,2-Dibromoethane	0.0004	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichlorobenzene	0.02	EQS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,2-Dichloroethane	0.01	EQS	mg/l	0 of 5	0	0.0018	<0.002		<0.002	<0.002	<0.002	<0.002	<0.001
1,2-Dichloropropane	0.04	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,3,5-Trimethylbenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,3-Dichlorobenzene	0.02	EQS*	mg/l	0 of 5	0	0.0012	<0.002		<0.001	<0.001	<0.001	<0.001	<0.002
1,3-Dichloropropane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	0.02	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2,2-Dichloropropane			mg/l	No GAC	-	0.0012	<0.002		<0.001	<0.001	<0.001	<0.001	<0.002
2-Chlorotoluene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
4-Chlorotoluene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
4-Isopropyltoluene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Bromobenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Bromochloromethane			mg/l	No GAC	-	0.0048	<0.005		<0.005	<0.005	<0.005	<0.005	<0.004
Bromodichloromethane	0.06	WHO	mg/l	0 of 5	0	0.0088	<0.01		<0.01	<0.01	<0.01	<0.01	<0.004
Bromoform	0.1	WHO	mg/l	0 of 4	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Bromomethane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Carbon Disulphide			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Carbon Tetrachloride	0.012	EQS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Chlorobenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Chloroethane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Chloroethene	0.0005	DWS	mg/l	0 of 4	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	0.0025	EQS	mg/l	1 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	0.001
Chloromethane			mg/l	No GAC	-	0.0082	<0.01		<0.01	<0.01	<0.01	<0.01	<0.001
Dibromochloromethane	0.1	WHO	mg/l	0 of 5	0	0.0026	<0.003		<0.003	<0.003	<0.003	<0.003	<0.001
Dibromomethane	0.02	EQS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Dichlorodifluoromethane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Dichloromethane	0.02	EQS	mg/l	0 of 4	0	<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.001
Hexachlorobutadiene	0.0006	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Isopropylbenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
MTBE (w)	0.015	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Sec-Butylbenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Styrene	0.05	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Tert-Butylbenzene			mg/l	No GAC	-	0.0018	<0.002		<0.002	<0.002	<0.002	<0.002	<0.001
Tetrachloroethene	0.01	DWS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Trichloroethene	0.01	DWS	mg/l	0 of 4	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
Trichlorofluoromethane			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
cis 1,2-Dichloroethene	0.05	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
cis 1,3-Dichloropropene	0.02	WHO	mg/l	0 of 4	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
n-Butylbenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
n-propylbenzene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
trans 1,2-Dichloroethene	0.05	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
trans 1,3-Dichloropropene	0.02	WHO	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
#DIV/0!													
SVOC													
2,4,5-Trichlorophenol			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2,4,6-Trichlorophenol			mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dichlorophenol	0.0042	EQS	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dimethylphenol	0.1	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2,4-Dinitrotoluene	0.1	USEPA	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2,6-Dinitrotoluene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2-Chloronaphthalene			mg/l	No GAC	-	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001
2-Chlorophenol	0.05	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max	St Catherine's	St Catherine's	St Catherine's	St Catherine's	St Catherine's
4-Bromophenyl Phenyl Ether	0.04	EQS*	mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Chloro-3-Methylphenol			mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
4-Nitrophenol			mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bis(2-chloroethoxy)methane			mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bis(2-chloroethyl)ether	0.0013	EQS	mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bis(2-ethylhexyl)phthalate			mg/l	1 of 5	1	0.00904	<0.01	<0.01	<0.01	<0.01	<0.01	0.0052
Butylbenzyl phthalate			mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Carbazole			mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Di-N-Butyl Phthalate	0.008	EQS*	mg/l	2 of 5	0	0.0015	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
Di-N-Octyl Phthalate	0.02	EQS*	mg/l	0 of 5	0	0.0082	<0.01	<0.01	<0.01	0.003	<0.001	0.0015
Dibenzofuran	0.2	EQS*	mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Diethyl phthalate			mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Dimethyl phthalate			mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorobenzene			mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachlorocyclopentadiene	0.05	USEPA	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hexachloroethane	0.04	USEPA	mg/l	0 of 4	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Isophorone	7	USEPA	mg/l	0 of 4	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nitrobenzene	0.0004	EQS	mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PCP; (Pentachlorophenol) (w)			mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
n-Nitroso-n-dipropylamine			mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Herbicides							#DIV/0!					
Ametryne (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Atraton (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Atrazine (w)	0.0006	EQS	mg/l	0 of 0	0	#DIV/0!						
Prometon (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Prometryn (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Propazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Simazine (w)	0.001	EQS	mg/l	0 of 0	0	#DIV/0!						
Simetryn (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Terbutylazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
2,3,6-TBA (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
2,4,5-T (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
2,4,5-TP; (Fenoprop); (Silvex) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
2,4-D (w)	0.0003	EQS	mg/l	0 of 0	0	#DIV/0!						
2,4-DB (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
2,4-DP; (Dichloroprop)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
4-CPA (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Benazolin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Bentazone (w)	0.5	EQS*	mg/l	0 of 0	0	#DIV/0!						
Bromoxynil (w)	0.1	EQS*	mg/l	0 of 0	0	#DIV/0!						
Clopyralid (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Dicamba (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Diclofop (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Flamprop (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Flamprop-isopropyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
loxynil (w)	0.01	EQS*	mg/l	0 of 0	0	#DIV/0!						
MCPA (w)	0.012	EQS*	mg/l	0 of 0	0	#DIV/0!						
MCPB (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
MCPP; (Mecoprop) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Picloram (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Triclopyr (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Bromacil (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Carbetamide (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Chlorbufam (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Chlorpropham (w)	0.01	EQS*	mg/l	0 of 0	0	#DIV/0!						
Chlortoluron (w)	0.002	EQS*	mg/l	0 of 0	0	#DIV/0!						
Cyanazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Diuron (w)	0.0002	EQS	mg/l	0 of 0	0	#DIV/0!						
Isoproturon (w)	0.0003	EQS	mg/l	0 of 0	0	#DIV/0!						
Linuron (w)	0.0005	EQS	mg/l	0 of 0	0	#DIV/0!						
Monuron (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Pimicarb (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!						
Propham (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Cyfluthrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Cypermethrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Deltamethrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Fenvalerate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Permethrin (w)	1E-06	EQS	mg/l	0 of 0	0	#DIV/0!						
Pesticides						#DIV/0!						
Aldrin (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!						
Chlorothalonil (w)	3.5E-05	EQS	mg/l	0 of 0	0	#DIV/0!						
Dichlobenil (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Dieldrin (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!						
Endosulphan I (Alpha) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Endosulphan II (Beta) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Endosulphan Sulphate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Endrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						
Heptachlor (w)	0	EQS	mg/l	0 of 0	0	#DIV/0!						
Heptachlor epoxide (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!						
Isodrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!						

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	BH310	BH310	GEO_BH203	GEO_BH203	BH203
Sample Ref	3WBH-BH310 4.3		GW/BH-BH203 12.30		100
Easting	384838.09	384838.09	384845.747	384845.747	
Northing	399638.18	399638.18	399748.863	399748.863	
Hole Elevation (mOD)	32.6	32.6	41.891	41.891	
Sample Depth (mbgl)	4.3	4.43	12.3	12.4	
Piezometer top (mbgl)	8	8	18	18	
Piezometer base (mbgl)	16	16	24	24	
Sample Date	26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021
Investigation	326R	326R	NW1604	NW1604	
Response zone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone St Catherine's Wood

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max
Pendimethalin (w)	1E-06	EQS	mg/l	0 of 0	0	#DIV/0!	
Permethrin II (trans) (w)	1E-06	EQS	mg/l	0 of 0	0	#DIV/0!	
Quintozene (PCNB) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Tecnazene (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Triadimefon (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Triallate (w)	0.00025	EQS*	mg/l	0 of 0	0	#DIV/0!	
Trifluralin (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!	
alpha-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
beta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
cis-Chlordane (Alpha) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
delta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
gamma-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDD (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDE (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDT (2,4) (w)	2.5E-05	EQS	mg/l	0 of 0	0	#DIV/0!	
o,p-Methoxychlor (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
p,p-DDE (4,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
p,p-DDT (4,4) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!	
trans-Chlordane (Gamma) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Azinphos-ethyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Azinphos-methyl (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Carbophenothion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorfenviphos (w)	0.0001	EQS	mg/l	0 of 0	0	#DIV/0!	
Chlorpyrifos (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!	
Chlorpyrifos-methyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Coumaphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!	
Diazinon (Dimpylate) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!	
Dichlorvos (w)	1E-06	EQS	mg/l	0 of 0	0	#DIV/0!	
Dimethoate (w)	0.00048	EQS	mg/l	0 of 0	0	#DIV/0!	
Disulfoton (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Ethion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Fenitrothion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Fenthion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Malathion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Methyl Parathion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Mevinphos (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Parathion (Ethyl Parathion) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Phorate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Phosalone (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Primiphos-methyl (w)	1.5E-05	EQS*	mg/l	0 of 0	0	#DIV/0!	
Propetamphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!	
Triazophos (w)	5E-06	EQS*	mg/l	0 of 0	0	#DIV/0!	
Other						#DIV/0!	
2,3,4,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!	
2,3,5,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!	
2-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
3+4-Methylphenol			mg/l	No GAC	-	<0.001	<0.001
3-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
4-Chlorophenyl Phenyl Ether			mg/l	No GAC	-	#DIV/0!	
4-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
Aliphatics >C10-44			mg/l	No GAC	-	#DIV/0!	
Alkalinity (total) (w) Colorimetry			mg/l CaCO3	No GAC	-	#DIV/0!	
Aluminium (dissolved)	15	EQS*	mg/l	0 of 0	0	#DIV/0!	
Aniline			mg/l	No GAC	-	#DIV/0!	
Azobenzene			mg/l	No GAC	-	#DIV/0!	
Benzyl Alcohol			mg/l	No GAC	-	#DIV/0!	
Bis(2-chloroisopropyl)ether			mg/l	No GAC	-	<0.001	<0.001
Bis(2-ethylhexyl) adipate			mg/l	No GAC	-	#DIV/0!	
Cobalt (dissolved)	3	EQS*	mg/l	2 of 2	0	0.008	0.014
Cyhalothrin-lambda (w)			mg/l	No GAC	-	#DIV/0!	
Demeton-S (w)			mg/l	No GAC	-	#DIV/0!	
Diflubenzuron (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Diphenylamine			mg/l	No GAC	-	#DIV/0!	
E.coli (Faecal Coliforms) (w)	0	EUDWS	cfu/100ml	0 of 0	0	#DIV/0!	
Endrin Aldehyde (w)			mg/l	No GAC	-	#DIV/0!	
Endrin Ketone (w)			mg/l	No GAC	-	#DIV/0!	
Fensulphothion (w)			mg/l	No GAC	-	#DIV/0!	
Fluroxypyr (w)			mg/l	No GAC	-	#DIV/0!	
Intestinal Enterococci (Faecal Streptococci/Faecal Enterococci)			cfu/100ml	No GAC	-	#DIV/0!	
Iron (Soluble)			mg/l	No GAC	-	#DIV/0!	
M-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!	
Methabenzthiazuron (w)			mg/l	No GAC	-	#DIV/0!	
Monolinuron (w)			mg/l	No GAC	-	#DIV/0!	
Naphthalene1-methyl-			mg/l	No GAC	-	#DIV/0!	
Naphthols (2-Naphthalenesulfonic acid, 1-hydroxy-)			mg/l	No GAC	-	#DIV/0!	
P-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!	
Perylene			mg/l	No GAC	-	<0.001	<0.001
Resorcinol			mg/l	No GAC	-	#DIV/0!	
Silver (dissolved)	0.05	EQS*	mg/l	0 of 0	0	#DIV/0!	
Telodrin (w)			mg/l	No GAC	-	#DIV/0!	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	BH310	BH310	GEO_BH203	GEO_BH203	BH203
Sample Ref	3WBH-BH310 4.3		GW/BH-BH203 12.30		100
Easting	384838.09	384838.09	384845.747	384845.747	
Northing	399638.18	399638.18	399748.863	399748.863	
Hole Elevation (mOD)	32.6	32.6	41.891	41.891	
Sample Depth (mbgl)	4.3	4.43	12.3	12.4	
Piezometer top (mbgl)	8	8	18	18	
Piezometer base (mbgl)	16	16	24	24	
Sample Date	26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021
Investigation	326R	326R	NW1604	NW1604	
Response zone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone St Catherine's Wood

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max
Terbutryn (w)	0.065	EQS	mg/l	0 of 0	0	#DIV/0!	
Tin (dissolved)	25	EQS*	mg/l	0 of 0	0	#DIV/0!	
Trichloronate (w)			mg/l	No GAC	-	#DIV/0!	
Trimethylphenol			mg/l	No GAC	-	#DIV/0!	
Xylenols & Ethylphenols			mg/l	No GAC	-	#DIV/0!	
Chloroxuron (w)			mg/l	No GAC	-	#DIV/0!	
Demeton-O (w)			mg/l	No GAC	-	#DIV/0!	
Dimeturon (w)			mg/l	No GAC	-	#DIV/0!	
Ethionecarb (w)			mg/l	No GAC	-	#DIV/0!	
Metoxuron (w)			mg/l	No GAC	-	#DIV/0!	
Pencyuron (w)			mg/l	No GAC	-	#DIV/0!	
Permethrin I (cis) (w)			mg/l	No GAC	-	#DIV/0!	
Phenmedipham (w)			mg/l	No GAC	-	#DIV/0!	
Prothiofos (Tokuthion) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-DDD (4,4) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-Methoxychlor (w)			mg/l	No GAC	-	#DIV/0!	
cis1,3-Dichloropropene			mg/l	No GAC	-	#DIV/0!	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Concentration exceeds GAC				100.00				Hole Ref	GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
Limit of Detection value exceeds GAC				<0.1				Sample Ref	200	100		100	1	
								Easting	384479.67	384479.67	384487.32		384476.006	384476.006
								Northing	399554.7	399554.7	399426.078		399396.975	399396.975
								Hole Elevation (mOD)	40.45	40.45	30.377		30.168	30.168
								Sample Depth (mbgl)	10.8	10.8	3.48		3.08	3.55
								Piezometer top (mbgl)	14	14	5.5		5.5	5.5
								Piezometer base (mbgl)	19.6	19.6	9		10	10
								Sample Date	10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
								Investigation	NW1604	NW1604	NW1604		River Works 2021/	iver Works 2021/2
								Response zone	Chester	Chester	Chester	Chester	Chester	Chester
								Formation	Formation	Formation	Formation	Formation	Formation	Formation
Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max							
Metal														
Antimony	0.005	DWS	mg/l	6 of 6	1	0.0029841666666667	0.0059	0.002005	0.002	0.005	0.0059	0.002	0.001	
Arsenic	0.05	EQS	mg/l	6 of 6	0	0.009954	0.039	0.001124	0.0026	0.039	0.014	0.001	0.002	
Beryllium	0.004	USEPA	mg/l	1 of 6	0	0.0007166666666667	0.002	<0.0001	<0.0001	0.002	<0.0001	<0.001	<0.001	
Cadmium	0.00015	EQS	mg/l	2 of 6	2	0.0007416666666667	0.0038	<0.00003	<0.00003	0.0038	0.00019	<0.0002	<0.0002	
Calcium	-	-	mg/l	No GAC	-	173.333333333333	227	120	100	215	170	208	227	
Chromium	0.0047	EQS	mg/l	5 of 6	1	0.0083005	0.045	0.000643	0.00026	0.045	0.0019	<0.001	0.001	
Copper	0.03375	EQS	mg/l	6 of 6	1	0.0169886666666667	0.078	0.003132	0.0022	0.078	0.0046	0.003	0.011	
Iron (dissolved)	1	EQS	mg/l	3 of 3	2	0.99	1.65		1.1		0.22	1.65		
Lead	0.00958	EQS	mg/l	4 of 6	2	0.155793333333333	0.866	<0.00009	0.00024	0.866	0.00043	<0.001	0.067	
Magnesium	-	-	mg/l	No GAC	-	22.5	28	27	28		11	24		
Manganese	0.226	-	mg/l	6 of 6	5	0.717123666666667	1.01	0.746742	0.85	0.79	0.023	0.883	1.01	
Mercury	0.001	DWS	mg/l	0 of 6	0	0.000055	<0.0001	<0.00001	<0.00001	<0.00001	<0.00001	<0.0001	<0.0001	
Nickel	0.01607	EQS	mg/l	6 of 6	1	0.0068431666666667	0.024	0.001259	0.0021	0.024	0.0027	0.005	0.006	
Potassium	-	-	mg/l	No GAC	-	8.575	12	7.1	7.6		7.6	12		
Selenium	0.01	DWS	mg/l	6 of 6	0	0.0028045	0.0069	0.000387	0.00054	0.005	0.0069	0.002	0.002	
Sodium	200	EUDWS	mg/l	4 of 4	0	26	38	38	13		16	37		
Titanium (dissolved)	-	-	mg/l	No GAC	-	#DIV/0!								
Vanadium	0.02	EQS*	mg/l	3 of 6	1	0.0061666666666667	0.03	<0.0006	<0.0006	0.03	0.0028	<0.001	0.002	
Zinc	0.03728	EQS	mg/l	6 of 6	1	0.163774	0.923	0.003744	0.0039	0.923	0.022	0.005	0.025	
Inorganic														
pH	<6 - >9	EQS*	pH Units	No GAC	-	7.12333333333333	7.22	7	7.2	7.03	7.2	7.22	7.09	
Cyanide	0.001	EQS	mg/l	4 of 6	4	0.949166666666667	5.246	<0.04	<0.04	5.246	0.29	0.038	0.041	
Complex Cyanide	-	EQS	mg/l	No GAC	-	1.83266666666667	5.112			5.112	0.36		0.026	
Cyanide (free) (w)	0.001	EQS	mg/l	3 of 3	3	0.136333333333333	0.26			0.134	0.26		0.015	
Thiocyanate	-	EQS	mg/l	No GAC	-	0.34	0.7			0.7	<0.02		0.3	
Chloride	250	EQS*	mg/l	6 of 6	0	28.3333333333333	42	22	28	14	23	41	42	
Ammoniacal Nitrogen as N	0.6	EQS	mg/l	3 of 6	2	1.68083333333333	7.4	2.5	7.4	<0.02	<0.015	0.13	<0.02	
DOC (w)	-	-	mg/l	No GAC	-	3.23333333333333	3.7	3.5	3.3	3.5	<2	3.4	3.7	
BOD (settled, 5 day)	-	-	mg/l	No GAC	-	#DIV/0!								
Hardness Total	-	mg/l CaCO3	No GAC	-	-	549.8	670			617	475	617	670	
Total hardness	-	-	mg/l	No GAC	-	410	410	410	370					
Nitrate (w)	50	DWS	mg/l	2 of 4	0	5.025	13	<0.5	<0.1		13	6.5		
Nitrite (w)	0.5	DWS	mg/l	0 of 4	0	0.2	<0.5	<0.5	<0.1		<0.1	<0.1		
Sulphate (w)	400	EQS*	mg/l	4 of 4	0	175.5	325	98	79		200	325		
Sulphide	-	-	mg/l	No GAC	-	0.1552765	0.5	0.018106	0.073		0.03	0.5		
Total Alkalinity as CaCO3	-	-	mg/l	No GAC	-	340	390	390	380		250			
Phenol and mineral oils														
Phenol	0.0077	EQS	mg/l	0 of 1	0	<0.001	<0.001					<0.001		
Phenol (Monohydric)	0.0077	EQS	mg/l	0 of 6	0	0.055	<0.1	<0.1	<0.1	<0.01	<0.1	<0.01	<0.01	
Phenols, Total	-	-	mg/l	No GAC	-	#DIV/0!								
Cresols	-	-	mg/l	No GAC	-	#DIV/0!								
TPH														
Ali >C10-C12 (w)	0.3	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005	
Ali >C12-C16 (w)	0.3	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005	
Ali >C16-C21 (w)	-	-	mg/l	No GAC	-	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005	
Ali >C21-C35 (w)	-	-	mg/l	No GAC	-	0.0054	0.015	<0.001		0.015	<0.001	<0.005	<0.005	
Ali >C35-C44 (w)	-	-	mg/l	No GAC	-	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005	
Ali >C5-C6 (w)	15	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001	
Ali >C6-C8 (w)	15	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001	
Ali >C8-C10 (w)	0.3	WHO	mg/l	0 of 5	0	0.00304	<0.005	<0.0001		<0.005	<0.0001	<0.005	<0.005	
Aliphatics >C5-35	-	-	mg/l	No GAC	-	#DIV/0!								
Total Aliphatics (w)	-	-	mg/l	No GAC	-	0.00833333333333333	0.015			0.015		<0.005	<0.005	
Aro >C10-C12 (w)	0.09	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005	
Aro >C12-C16 (w)	0.09	WHO	mg/l	0 of 5	0	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005	
Aro >C16-C21 (w)	0.09	WHO	mg/l	1 of 5	0	0.0034	<0.005	<0.001		0.005	<0.001	<0.005	<0.005	
Aro >C21-C35 (w)	0.09	WHO	mg/l	0 of 5	0	0.0064	<0.01	<0.001		<0.01	<0.001	<0.01	<0.01	
Aro >C35-C44 (w)	-	-	mg/l	No GAC	-	0.0034	<0.005	<0.001		<0.005	<0.001	<0.005	<0.005	
Aro >C5-C7 (w)	0.01	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001	
Aro >C7-C8 (w)	0.7	WHO	mg/l	0 of 5	0	0.00064	<0.001	<0.0001		<0.001	<0.0001	<0.001	<0.001	
Aro >C8-C10 (w)	0.3	WHO	mg/l	0 of 5	0	0.00304	<0.005	<0.0001		<0.005	<0.0001	<0.005	<0.005	
Aromatics >C10-44	-	-	mg/l	No GAC	-	<0.001	<0.001	<0.001		<0.001	<0.001			
Total Aromatics (w)	-	-	mg/l	No GAC	-	<0.01	<0.01			<0.01	<0.001	<0.01	<0.01	
TPH (Ali & Aro >C5-C44) (w)	-	-	mg/l	No GAC	-	0.0133333333333333	0.02			0.02		<0.01	<0.01	
Total Aliphatics and Aromatics C10-C44	-	-	mg/l	No GAC	-	#DIV/0!								
Total Aliphatics and Aromatics C5-C35	-	-	mg/l	No GAC	-	#DIV/0!								
Total Aromatics C5-C35	-	-	mg/l	No GAC	-	#DIV/0!								
PAH														
Acenaphthene	2	USEPA	mg/l	2 of 5	0	0.0000227	0.00011		0.00002	<0.00001	0.00011	<0.00001	<0.00001	
Dibenz-a-h-anthracene	-	-	mg/l	No GAC	-	0.0000255	<0.00001	<0.00001		<0.00001	<0.00001	<0.00001	<0.00001	
Fluoranthene	6.30E-06	EQS	mg/l	4 of 5	4	0.0001973	0.00013	0.00002	0.00013	0.00001	0.00001	<0.00001	0.00006	
Fluorene	-	-	mg/l	No GAC	-	0.0000218	0.00005	0.00001	<0.00001	<0.00001	0.00005	<0.00001	<0.00001	
Indeno(1,2,3-cd)pyrene	-	-	mg/l	No GAC	-	0.0000964	0.00004	<0.00001		0.00004	<0.00001	<0.00001	0.00002	
Phenanthrene	-	-	mg/l	No GAC	-	0.0000964	0.00008	0.00001		0.00008	0.00003	<0.00001	0.00004	
Pyrene	-	-	mg/l	No GAC	-	0.0002509	0.00013	0.00001		0.00013	0.00001	0.00001	0.00007	
Naphthalene (w)	0.002	EQS	mg/l	2 of 5	0	0.00001	0.00034	<0.00005	<0.00001	<0.00001	0.00034	0.00001	<0.00001	
Total PAH 16MS (w)	-	-												

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

								Hole Ref	GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
								Sample Ref	200	100		100	1	
								Easting	384479.67	384479.67	384487.32		384476.006	384476.006
								Northing	399554.7	399554.7	399426.078		399396.975	399396.975
								Hole Elevation (mOD)	40.45	40.45	30.377		30.168	30.168
								Sample Depth (mbgl)	10.8	10.8	3.48		3.08	3.55
								Piezometer top (mbgl)	14	14	5.5		5.5	5.5
								Piezometer base (mbgl)	19.6	19.6	9		10	10
								Sample Date	10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
								Investigation	NW1604	NW1604	NW1604		River Works 2021/iver Works 2021/2	
								Response zone	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation
Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max							
BTEX - Ethyl Benzene (w)	0.02	EQS*	mg/l	0 of 5	0	<0.001	<0.001		<0.001			<0.001	<0.001	<0.001
BTEX - m & p Xylene (w)	0.03	EQS*	mg/l	0 of 3	0	<0.001	<0.001				<0.001		<0.001	<0.001
BTEX - o Xylene (w)	0.03	EQS*	mg/l	0 of 3	0	<0.001	<0.001				<0.001		<0.001	<0.001
Xylene	0.03	EQS*	mg/l	0 of 2	0	<0.001	<0.001		<0.001			<0.001		<0.001
VOC						#DIV/0!								
1,1,1,2-Tetrachloroethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,1,1-Trichloroethane	0.1	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1,2,2-Tetrachloroethane	0.14	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1,2-Trichloroethane	0.4	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1-Dichloroethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,1-Dichloroethene	0.05	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,1-Dichloropropene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,2,3 Trichlorobenzene	0.0004	EQS	mg/l	0 of 1	0	<0.003	<0.003						<0.003	
1,2,3-Trichloropropane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,2,4-Trichlorobenzene	0.0004	EQS	mg/l	0 of 1	0	<0.003	<0.003						<0.003	
1,2,4-Trimethylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,2-Dibromo-3-Chloropropane	0.001	WHO	mg/l	0 of 1	0	<0.002	<0.002						<0.002	
1,2-Dibromoethane	0.0004	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,2-Dichlorobenzene	0.02	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,2-Dichloroethane	0.01	EQS	mg/l	0 of 1	0	<0.002	<0.002						<0.002	
1,2-Dichloropropane	0.04	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,3,5-Trimethylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,3-Dichlorobenzene	0.02	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
1,3-Dichloropropane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
1,4-Dichlorobenzene	0.02	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,2-Dichloropropane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Chlorotoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Chlorotoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Isopropyltoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bromobenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bromochloromethane			mg/l	No GAC	-	<0.005	<0.005						<0.005	
Bromodichloromethane	0.06	WHO	mg/l	0 of 1	0	<0.01	<0.01						<0.01	
Bromoforn	0.1	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Bromomethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Carbon Disulphide			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Carbon Tetrachloride	0.012	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Chlorobenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Chloroethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Chloroethene	0.0005	DWS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Chloroform	0.0025	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Chloromethane			mg/l	No GAC	-	<0.01	<0.01						<0.01	
Dibromochloromethane	0.1	WHO	mg/l	0 of 1	0	<0.003	<0.003						<0.003	
Dibromomethane	0.02	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Dichlorodifluoromethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Dichloromethane	0.02	EQS	mg/l	0 of 1	0	<0.005	<0.005						<0.005	
Hexachlorobutadiene	0.0006	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Isopropylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
MTBE (w)	0.015	WHO	mg/l	0 of 3	0	<0.001	<0.001				<0.001		<0.001	<0.001
Sec-Butylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Styrene	0.05	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Tert-Butylbenzene			mg/l	No GAC	-	<0.002	<0.002						<0.002	
Tetrachloroethene	0.01	DWS	mg/l	1 of 1	0	0.003	0.003						0.003	
Trichloroethene	0.01	DWS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Trichlorofluoromethane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
cis 1,2-Dichloroethene	0.05	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
cis 1,3-Dichloropropene	0.02	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
n-Butylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
n-propylbenzene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
trans 1,2-Dichloroethene	0.05	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
trans 1,3-Dichloropropene	0.02	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
SVOC						#DIV/0!								
2,4,5-Trichlorophenol			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2,4,6-Trichlorophenol	0.2	WHO	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,4-Dichlorophenol	0.0042	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,4-Dimethylphenol	0.1	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,4-Dinitrotoluene	0.1	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2,6-Dinitrotoluene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Chloronaphthalene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Chlorophenol	0.05	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2-Methylnaphthalene			mg/l	No GAC	-	<0.001	<0.001						<0.001	
2-Methylphenol	0.1	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
2-Nitrophenol			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Bromophenyl Phenyl Ether			mg/l	No GAC	-	<0.001	<0.001						<0.001	
4-Chloro-3-Methylphenol	0.04	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
4-Nitrophenol			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bis(2-chloroethoxy)methane			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bis(2-chloroethyl)ether			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Bis(2-ethylhexyl)phthalate	0.0013	EQS	mg/l	0 of 1	0	<0.01	<0.01						<0.01	
Butylbenzyl phthalate	0.0075	EQS	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Carbazole			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Di-N-Butyl Phthalate	0.008	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Di-N-Octyl Phthalate	0.02	EQS*	mg/l	0 of 1	0	<0.01	<0.01						<0.01	
Dibenzofuran			mg/l	No GAC	-	<0.001	<0.001						<0.001	
Diethyl phthalate	0.2	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Dimethyl phthalate	0.8	EQS*	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Hexachlorobenzene	0.001	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Hexachlorocyclopentadiene	0.05	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Hexachloroethane	0.04	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	
Isophorone	7	USEPA	mg/l	0 of 1	0	<0.001	<0.001						<0.001	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
Sample Ref	200	100		100	1	
Easting	384479.67	384479.67	384487.32		384476.006	384476.006
Northing	399554.7	399554.7	399426.078		399396.975	399396.975
Hole Elevation (mOD)	40.45	40.45	30.377		30.168	30.168
Sample Depth (mbgl)	10.8	10.8	3.48		3.08	3.55
Piezometer top (mbgl)	14	14	5.5		5.5	5.5
Piezometer base (mbgl)	19.6	19.6	9		10	10
Sample Date	10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
Investigation	NW1604	NW1604	NW1604		River Works 2021/iver Works 2021/2	
Response zone	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max
Nitrobenzene	0.0004	EQS	mg/l	No GAC	-	<0.001	<0.001
PCP; (Pentachlorophenol) (w)			mg/l	0 of 1	0	<0.001	<0.001
n-Nitroso-n-dipropylamine			mg/l	No GAC	-	<0.001	<0.001
Herbicides						#DIV/0!	
Ametryne (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Atraton (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Atrazine (w)	0.0006	EQS	mg/l	0 of 0	0	#DIV/0!	
Prometon (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Prometryn (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Propazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Simazine (w)	0.001	EQS	mg/l	0 of 0	0	#DIV/0!	
Simetryn (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Terbutylazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,3,6-TBA (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4,5-T (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4,5-TP; (Fenoprop); (Silvex) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4-D (w)	0.0003	EQS	mg/l	0 of 0	0	#DIV/0!	
2,4-DB (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
2,4-DP; (Dichlorprop)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
4-CPA (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Benazolin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Bentazone (w)	0.5	EQS*	mg/l	0 of 0	0	#DIV/0!	
Bromoxynil (w)	0.1	EQS*	mg/l	0 of 0	0	#DIV/0!	
Clopyralid (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Dicamba (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Diclofop (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Flamprop (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Flamprop-isopropyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Ioxynil (w)	0.01	EQS*	mg/l	0 of 0	0	#DIV/0!	
MCPA (w)	0.012	EQS*	mg/l	0 of 0	0	#DIV/0!	
MCPB (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
MCPP; (Mecoprop) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Picloram (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Triclopyr (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Bromacil (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Carbetamide (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorbufam (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorpropham (w)	0.01	EQS*	mg/l	0 of 0	0	#DIV/0!	
Chlortoluron (w)	0.002	EQS*	mg/l	0 of 0	0	#DIV/0!	
Cyanazine (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Diuron (w)	0.0002	EQS	mg/l	0 of 0	0	#DIV/0!	
Isoproturon (w)	0.0003	EQS	mg/l	0 of 0	0	#DIV/0!	
Linuron (w)	0.0005	EQS	mg/l	0 of 0	0	#DIV/0!	
Monuron (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Pirimicarb (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Propham (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Cyfluthrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Cypermethrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Deltamethrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Fenvalerate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Permethrin (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Pesticides						#DIV/0!	
Aldrin (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorothalonil (w)	0.000035	EQS	mg/l	0 of 0	0	#DIV/0!	
Dichlobenil (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Dieldrin (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!	
Endosulphan I (Alpha) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Endosulphan II (Beta) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Endosulphan Sulphate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Endrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Heptachlor (w)	0	EQS	mg/l	0 of 0	0	#DIV/0!	
Heptachlor epoxide (w)	0.00003	DWS	mg/l	0 of 0	0	#DIV/0!	
Isodrin (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Pendimethalin (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Permethrin II (trans) (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Quintozene (PCNB) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Tecnazene (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Triadimefon (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Triallate (w)	0.00025	EQS*	mg/l	0 of 0	0	#DIV/0!	
Trifluralin (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!	
alpha-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
beta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
cis-Chlordane (Alpha) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
delta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
gamma-Hexachlorocyclohexane (HCH) / L	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDD (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDE (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
o,p-DDT (2,4) (w)	0.000025	EQS	mg/l	0 of 0	0	#DIV/0!	
o,p-Methoxychlor (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
p,p-DDE (4,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
p,p-DDT (4,4) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!	
trans-Chlordane (Gamma) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Azinphos-ethyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Azinphos-methyl (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Carbophenothion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Chlorfenvinphos (w)	0.0001	EQS	mg/l	0 of 0	0	#DIV/0!	
Chlorpyrifos (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!	
Chlorpyrifos-methyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Coumaphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	GEO_BH210	BH210	GEO_BH212	BH212	RE15	RE15
Sample Ref	200	100		100	1	
Easting	384479.67	384479.67	384487.32		384476.006	384476.006
Northing	399554.7	399554.7	399426.078		399396.975	399396.975
Hole Elevation (mOD)	40.45	40.45	30.377		30.168	30.168
Sample Depth (mbgl)	10.8	10.8	3.48		3.08	3.55
Piezometer top (mbgl)	14	14	5.5		5.5	5.5
Piezometer base (mbgl)	19.6	19.6	9		10	10
Sample Date	10/08/21	27/05/2021	05/07/22	01/06/2021	15/02/22	05/07/22
Investigation	NW1604	NW1604	NW1604		River Works 2021/iver Works 2021/2	
Response zone	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation	Chester Formation

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max
Diazinon (Dimpylate) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!	
Dichlorvos (w)	0.000001	EQS	mg/l	0 of 0	0	#DIV/0!	
Dimethoate (w)	0.00048	EQS	mg/l	0 of 0	0	#DIV/0!	
Disulfoton (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Ethion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Fenitrothion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Fenthion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Malathion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Methyl Parathion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Mevinphos (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Parathion (Ethyl Parathion) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Phorate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Phosalone (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!	
Pirimiphos-methyl (w)	0.000015	EQS*	mg/l	0 of 0	0	#DIV/0!	
Propetamphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!	
Triazophos (w)	0.000005	EQS*	mg/l	0 of 0	0	#DIV/0!	
Other						#DIV/0!	
2,3,4,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!	
2,3,5,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!	
2-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
3+4-Methylphenol			mg/l	No GAC	-	<0.001	<0.001
3-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
4-Chlorophenyl Phenyl Ether			mg/l	No GAC	-	#DIV/0!	
4-Nitroaniline			mg/l	No GAC	-	#DIV/0!	
Aliphatics >C10-44			mg/l	No GAC	-	#DIV/0!	
Alkalinity (total) (w) Colorimetry			mg/l CaCO3	No GAC	-	294	294
Aluminium (dissolved)	15	EQS*	mg/l	0 of 0	0	#DIV/0!	
Aniline			mg/l	No GAC	-	#DIV/0!	
Azobenzene			mg/l	No GAC	-	#DIV/0!	
Benzyl Alcohol			mg/l	No GAC	-	#DIV/0!	
Bis(2-chloroisopropyl)ether			mg/l	No GAC	-	<0.001	<0.001
Bis(2-ethylhexyl) adipate			mg/l	No GAC	-	#DIV/0!	
Cobalt (dissolved)	3	EQS*	mg/l	0 of 0	0	#DIV/0!	
Cyhalothrin-lambda (w)			mg/l	No GAC	-	#DIV/0!	
Demeton-S (w)			mg/l	No GAC	-	#DIV/0!	
Diiflubenzuron (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!	
Diphenylamine			mg/l	No GAC	-	#DIV/0!	
Ecoli (Faecal Coliforms) (w)	0	EUDWS	cfu/100ml	0 of 1	0	<1	<1
Endrin Aldehyde (w)			mg/l	No GAC	-	#DIV/0!	
Endrin Ketone (w)			mg/l	No GAC	-	#DIV/0!	
Fensulphothion (w)			mg/l	No GAC	-	#DIV/0!	
Fluroxypyr (w)			mg/l	No GAC	-	#DIV/0!	
Intestinal Enterococci (Faecal Streptococci/Faecal Enterococci)			cfu/100ml	No GAC	-	5	5
Iron (Soluble)			mg/l	No GAC	-	0.24	0.24
M-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!	
Methabenzthiazuron (w)			mg/l	No GAC	-	#DIV/0!	
Monolinuron (w)			mg/l	No GAC	-	#DIV/0!	
Naphthalene1-methyl-			mg/l	No GAC	-	#DIV/0!	
Naphthols (2-Naphthalenesulfonic acid, 1-hydroxy-)			mg/l	No GAC	-	#DIV/0!	
P-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!	
Perylene			mg/l	No GAC	-	<0.001	<0.001
Resorcinol			mg/l	No GAC	-	#DIV/0!	
Silver (dissolved)	0.05	EQS*	mg/l	0 of 0	0	#DIV/0!	
Telodrin (w)			mg/l	No GAC	-	#DIV/0!	
Terbutryn (w)	0.065	EQS	mg/l	0 of 0	0	#DIV/0!	
Tin (dissolved)	25	EQS*	mg/l	0 of 0	0	#DIV/0!	
Trichloronate (w)			mg/l	No GAC	-	#DIV/0!	
Trimethylphenol			mg/l	No GAC	-	#DIV/0!	
Xylenols & Ethylphenols			mg/l	No GAC	-	#DIV/0!	
Chloroxuron (w)			mg/l	No GAC	-	#DIV/0!	
Demeton-O (w)			mg/l	No GAC	-	#DIV/0!	
Dimefuron (w)			mg/l	No GAC	-	#DIV/0!	
Ethiofencarb (w)			mg/l	No GAC	-	#DIV/0!	
Metoxuron (w)			mg/l	No GAC	-	#DIV/0!	
Pencycuron (w)			mg/l	No GAC	-	#DIV/0!	
Permethrin I (cis) (w)			mg/l	No GAC	-	#DIV/0!	
Phenmedipham (w)			mg/l	No GAC	-	#DIV/0!	
Prothiofos (Tokuthion) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-DDD (4,4) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-Methoxychlor (w)			mg/l	No GAC	-	#DIV/0!	
cis1,3-Dichloropropene			mg/l	No GAC	-	#DIV/0!	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Concentration exceeds GAC						100.00	Hole Ref Sample Ref Easting Northing Hole Elevation (mOD) Sample Depth (mbgl) Piezometer top (mbgl) Piezometer base (mbgl) Sample Date Investigation Response zone	BH310	BH310	GEO_BH203	GEO_BH203	BH203	
Limit of Detection value exceeds GAC						<0.1		3WBH-BH310 4.3	384838.09	384838.09	384845.747	384845.747	100
								399638.18	399638.18	399748.863	399748.863		
								32.6	32.6	41.891	41.891		
								4.3	4.43	12.3	12.4		
								8	8	18	18		
								16	16	24	24		
								26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021	
								326R	326R	NW1604	NW1604		
								Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone St Catherine's Wood	
Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max						
Metal													
Antimony	0.005	DWS	mg/l	1 of 5	0	0.000902	<0.001		<0.001	<0.001	<0.001	0.00051	
Arsenic	0.05	EQS	mg/l	5 of 5	0	0.00638	0.011		0.007	0.007	0.011	0.003	
Beryllium	0.004	USEPA	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.0001	
Cadmium	0.00015	EQS	mg/l	2 of 5	2	0.000186	0.0003		<0.0002	<0.0002	0.0002	0.0003	
Calcium	-	-	mg/l	No GAC	-	235	834		834	70	91	95	
Chromium	0.0047	EQS	mg/l	3 of 5	0	0.001656	0.004		0.002	<0.001	0.004	<0.001	
Copper	0.03375	EQS	mg/l	5 of 5	1	0.01352	0.043		0.013	0.004	0.043	0.007	
Iron (dissolved)	1	EQS	mg/l	1 of 1	0	0.018	0.018						
Lead	0.00958	EQS	mg/l	5 of 5	2	0.025182	0.088		0.025	0.008	0.088	0.004	
Magnesium	-	-	mg/l	No GAC	-	45	45						
Manganese	0.226	EQS	mg/l	5 of 5	5	1.0842	1.92		1.92	1.31	0.722	0.809	
Mercury	0.001	DWS	mg/l	1 of 5	0	0.000094	<0.0001		<0.0001	<0.0001	<0.0001	<0.0007	
Nickel	0.01607	EQS	mg/l	5 of 5	1	0.00604	0.02		0.005	0.002	0.02	0.002	
Potassium	-	-	mg/l	No GAC	-	4.1	4.1						
Selenium	0.01	DWS	mg/l	1 of 5	0	0.000874	<0.001		<0.001	<0.001	<0.001	<0.00037	
Sodium	200	EUDWS	mg/l	1 of 1	0	18	18						
Titanium (dissolved)	-	-	mg/l	No GAC	-	#DIV/0!							
Vanadium	0.02	EQS*	mg/l	2 of 5	0	0.00172	0.004		0.002	<0.001	0.004	<0.001	
Zinc	0.03728	EQS	mg/l	5 of 5	3	0.05166	0.137		0.038	0.024	0.137	0.055	
Inorganic													
pH	<6 ->9	EQS*	pH Units	No GAC	-	7.384	7.84		7.4	7.5	7.84	7.08	
Cyanide	0.001	EQS	mg/l	2 of 5	2	0.0138	<0.04		0.01	0.009	<0.005	<0.005	
Complex Cyanide	-	EQS	mg/l	No GAC	-	0.005025	0.009			0.009	<0.005	<0.005	
Cyanide (free) (w)	0.001	EQS	mg/l	0 of 4	0	0.00875	<0.02			<0.005	<0.005	<0.005	
Thiocyanate	-	EQS	mg/l	No GAC	-	0.43	1.5			0.1	1.5	0.1	
Chloride	250	EQS*	mg/l	5 of 5	0	37	39		37	39	35	38	
Ammoniacal Nitrogen as N	0.6	EQS	mg/l	5 of 5	5	2.628	4.04		2.27	1.22	3.81	4.04	
DOC (w)	-	-	mg/l	No GAC	-	3.12	4.3		2.4	<2	4.3	3.6	
BOD (settled, 5 day)	-	-	mg/l	No GAC	-	#DIV/0!							
Hardness Total	-	-	mg/l CaCO3	No GAC	-	747	2463		2463	262	345	358	
Total hardness	-	-	mg/l	No GAC	-	#DIV/0!							
Nitrate (w)	50	DWS	mg/l	0 of 1	0	<0.1	<0.1					<0.1	
Nitrite (w)	0.5	DWS	mg/l	0 of 1	0	<0.1	<0.1					<0.1	
Sulphate (w)	400	EQS*	mg/l	2 of 2	0	27.5	38		17				
Sulphide	-	-	mg/l	No GAC	-	0.021	0.021						
Total Alkalinity as CaCO3	-	-	mg/l	No GAC	-	290	290						
Phenol and mineral oils													
Phenol	0.0077	EQS	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.0001	
Phenol (Monohydric)	0.0077	EQS	mg/l	0 of 5	0	0.028	<0.1		<0.01	<0.01	<0.01	<0.1	
Phenols, Total	-	-	mg/l	No GAC	-	<0.002	<0.002					<0.002	
Cresols	-	-	mg/l	No GAC	-	<0.0001	<0.0001					<0.0001	
TPH													
Ali >C10-C12 (w)	0.3	WHO	mg/l	2 of 5	0	0.0062	0.012		0.012	0.008	<0.005	<0.005	
Ali >C12-C16 (w)	0.3	WHO	mg/l	2 of 5	2	0.0062	3.319		3.319	1.173	<0.005	<0.005	
Ali >C16-C21 (w)	-	-	mg/l	No GAC	-	0.0088	0.024		0.024	0.009	0.005	<0.005	
Ali >C21-C35 (w)	-	-	mg/l	No GAC	-	0.057	0.139		0.071	0.039	0.139	0.035	
Ali >C35-C44 (w)	-	-	mg/l	No GAC	-	0.0048	0.008		<0.005	<0.005	0.008	<0.005	
Ali >C5-C6 (w)	15	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.0001	
Ali >C6-C8 (w)	15	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.0001	
Ali >C8-C10 (w)	0.3	WHO	mg/l	0 of 5	0	0.00402	<0.005		<0.005	<0.005	<0.005	<0.0001	
Aliphatics >C5-35	-	-	mg/l	No GAC	-	#DIV/0!							
Total Aliphatics (w)	-	-	mg/l	No GAC	-	1.21175	3.43		3.43	1.23	0.152	0.035	
Aro >C10-C12 (w)	0.09	WHO	mg/l	3 of 5	1	0.0306	0.11		0.11	0.027	0.01	<0.005	
Aro >C12-C16 (w)	0.09	WHO	mg/l	4 of 5	2	0.0316	1.349		1.349	0.436	0.012	0.01	
Aro >C16-C21 (w)	0.09	WHO	mg/l	4 of 5	0	0.013	0.018		0.018	0.016	0.012	0.018	
Aro >C21-C35 (w)	0.09	WHO	mg/l	2 of 5	0	0.0088	0.012		0.011	<0.01	0.012	<0.01	
Aro >C35-C44 (w)	-	-	mg/l	No GAC	-	0.0042	<0.005		<0.005	<0.005	<0.005	<0.0001	
Aro >C5-C7 (w)	0.01	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.0001	
Aro >C7-C8 (w)	0.7	WHO	mg/l	0 of 5	0	0.00082	<0.001		<0.001	<0.001	<0.001	<0.0001	
Aro >C8-C10 (w)	0.3	WHO	mg/l	1 of 5	0	0.00442	0.007		<0.005	<0.005	0.007	<0.005	
Aromatics >C10-44	-	-	mg/l	No GAC	-	<0.001	<0.001					<0.001	
Total Aromatics (w)	-	-	mg/l	No GAC	-	0.5125	1.49		1.49	0.479	0.053	0.028	
TPH (Ali & Aro >C5-C44) (w)	-	-	mg/l	No GAC	-	1.722	4.91		4.91	1.71	0.205	0.063	
Total Aliphatics and Aromatics C10-C44	-	-	mg/l	No GAC	-	#DIV/0!							
Total Aliphatics and Aromatics C5-C35	-	-	mg/l	No GAC	-	#DIV/0!							
Total Aromatics C5-C35	-	-	mg/l	No GAC	-	#DIV/0!							
PAH													
Acenaphthene	2	USEPA	mg/l	3 of 5	0	0.000227	0.0017		<0.00001	<0.00001	0.00002	0.00009	
Dibenz-a-h-anthracene	-	-	mg/l	No GAC	-	0.000255	0.00004		<0.00001	<0.00001	0.00004	<0.00001	
Fluoranthene	6.30E-06	EQS	mg/l	4 of 5	4	0.0001973	0.00031		0.00004	<0.00001	0.00031	0.00002	
Fluorene	-	-	mg/l	No GAC	-	0.000218	0.00042		<0.00001	<0.00001	0.00003	0.00005	
Indeno(1,2,3-cd)pyrene	-	-	mg/l	No GAC	-	0.0000964	0.0002		0.00002	<0.00001	0.0002	<0.00001	
Phenanthrene	-	-	mg/l	No GAC	-	0.0000964	0.00024		0.00001	<0.00001	0.00015	<0.00001	
Pyrene	-	-	mg/l	No GAC	-	0.0002509	0.00066		0.00007	0.00002	0.00066	0.00005	
Naphthalene (w)	0.002	EQS	mg/l	1 of 5	1	0.00001	0.0085		<0.00001	<0.00001	<0.00001	0.0085	
Total PAH 16MS (w)	-	-	mg/l	No GAC	-	0.0013773	0.012		0.00025	0.00002	0.00295	0.00021	
PAH Total	-	-	mg/l	No GAC	-	#DIV/0!							
Acenaphthylene	-	-	mg/l	No GAC	-	0.0000209	0.0004		<0.00001	<0.00001	0.00007	<0.00001	
Anthracene	0.0001	EQS	mg/l	2 of 5	1	0.0000409	0.00012		<0.00001	<0.00001	0.00006	<0.00001	
Benzo(a)anthracene	-	-	mg/l	No GAC	-	0.0001118	0.00019		0.00002	<0.00001	0.00019	<0.00001	

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Concentration exceeds GAC		100.00						Hole Ref Sample Ref Easting Northing Hole Elevation (mOD) Sample Depth (mbgl) Piezometer top (mbgl) Piezometer base (mbgl) Sample Date Investigation Response zone	BH310	BH310	GEO_BH203	GEO_BH203	BH203	
Limit of Detection value exceeds GAC		<0.1							3WBH-BH310 4.3	384838.09	384838.09	384845.747	384845.747	100
									399638.18	399638.18	399748.863	399748.863		
									32.6	32.6	41.891	41.891		
									4.3	4.3	12.3	12.4		
									8	8	18	18		
									16	16	24	24		
									26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021	
									326R	326R	NW1604	NW1604		
									Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	
													St Catherine's Wood	
									0.00003	<0.00001	0.00028	<0.00001	<0.00001	
								0.00002	<0.00001	0.0003	<0.00001	<0.00001		
								0.00002	<0.00001	0.00029	<0.00001	<0.00001		
								<0.00001	<0.00001	0.0001	<0.00001	<0.00001		
								0.00002	<0.00001	0.00025	<0.00001	0.00002		
								#DIV/0!						
BTEX - Benzene (w)		0.01	EQS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
BTEX - Toluene (w)		0.074	EQS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
BTEX - Ethyl Benzene (w)		0.02	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
BTEX - m & p Xylene (w)		0.03	EQS*	mg/l	0 of 4	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
BTEX - o Xylene (w)		0.03	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Xylene		0.03	EQS*	mg/l	0 of 1	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
VOC							#DIV/0!						<0.001	
1,1,1,2-Tetrachloroethane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,1,1-Trichloroethane		0.1	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,1,2,2-Tetrachloroethane		0.14	EQS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,1,2-Trichloroethane		0.4	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,1-Dichloroethane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,1-Dichloroethene		0.05	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,1-Dichloropropene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,2,3 Trichlorobenzene		0.0004	EQS	mg/l	0 of 5	0	0.0026	<0.003	<0.003	<0.003	<0.003	<0.003	<0.001	
1,2,3-Trichloropropane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,2,4-Trichlorobenzene		0.0004	EQS	mg/l	0 of 5	0	0.0026	<0.003	<0.003	<0.003	<0.003	<0.003	<0.001	
1,2,4-Trimethylbenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,2-Dibromo-3-Chloropropane		0.001	WHO	mg/l	0 of 5	0	0.0018	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	
1,2-Dibromoethane		0.0004	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,2-Dichlorobenzene		0.02	EQS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,2-Dichloroethane		0.01	EQS	mg/l	0 of 5	0	0.0018	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	
1,2-Dichloropropane		0.04	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,3,5-Trimethylbenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,3-Dichlorobenzene		0.02	EQS*	mg/l	0 of 5	0	0.0012	<0.002	<0.002	<0.001	<0.001	<0.001	<0.002	
1,3-Dichloropropane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
1,4-Dichlorobenzene		0.02	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2,2-Dichloropropane				mg/l	No GAC	-	0.0012	<0.002	<0.001	<0.001	<0.001	<0.001	<0.002	
2-Chlorotoluene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
4-Chlorotoluene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
4-Isopropyltoluene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Bromobenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Bromochloromethane				mg/l	No GAC	-	0.0048	<0.005	<0.005	<0.005	<0.005	<0.005	<0.004	
Bromodichloromethane		0.06	WHO	mg/l	0 of 5	0	0.0088	<0.01	<0.01	<0.01	<0.01	<0.01	<0.004	
Bromoform		0.1	WHO	mg/l	0 of 4	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Bromomethane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Carbon Disulphide				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Carbon Tetrachloride		0.012	EQS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Chlorobenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Chloroethane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Chloroethene		0.0005	DWS	mg/l	0 of 4	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Chloroform		0.0025	EQS	mg/l	1 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Chloromethane				mg/l	No GAC	-	0.0082	<0.01	<0.01	<0.01	<0.01	<0.01	<0.001	
Dibromochloromethane		0.1	WHO	mg/l	0 of 5	0	0.0026	<0.003	<0.003	<0.003	<0.003	<0.003	<0.001	
Dibromomethane		0.02	EQS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Dichlorodifluoromethane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Dichloromethane		0.02	EQS	mg/l	0 of 4	0	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	
Hexachlorobutadiene		0.0006	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Isopropylbenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
MTBE (w)		0.015	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Sec-Butylbenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Styrene		0.05	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Tert-Butylbenzene				mg/l	No GAC	-	0.0018	<0.002	<0.002	<0.002	<0.002	<0.002	<0.001	
Tetrachloroethene		0.01	DWS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Trichloroethene		0.01	DWS	mg/l	0 of 4	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Trichlorofluoromethane				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
cis 1,2-Dichloroethene		0.05	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
cis 1,3-Dichloropropene		0.02	WHO	mg/l	0 of 4	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
n-Butylbenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
n-propylbenzene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
trans 1,2-Dichloroethene		0.05	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
trans 1,3-Dichloropropene		0.02	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
								#DIV/0!						
SVOC														
2,4,5-Trichlorophenol				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2,4,6-Trichlorophenol		0.2	WHO	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2,4-Dichlorophenol		0.0042	EQS	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2,4-Dimethylphenol		0.1	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2,4-Dinitrotoluene		0.1	USEPA	mg/l	0 of 5	0	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2,6-Dinitrotoluene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2-Chloronaphthalene				mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
2-Chlorophenol		0.05	EQS*	mg/l	0 of 5	0	<0.001	<0.001	<0.001					

Page 3 of 5

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	BH310	BH310	GEO_BH203	GEO_BH203	BH203
Sample Ref	3WBH-BH310 4.3		GWBH-BH203 12.30		100
Easting	384838.09	384838.09	384845.747	384845.747	
Northing	399638.18	399638.18	399748.863	399748.863	
Hole Elevation (mOD)	32.6	32.6	41.891	41.891	
Sample Depth (mbgl)	4.3	4.43	12.3	12.4	
Piezometer top (mbgl)	8	8	18	18	
Piezometer base (mbgl)	16	16	24	24	
Sample Date	26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021
Investigation	326R	326R	NW1604	NW1604	
Response zone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone St Catherine's Wood

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max				
Pendimethalin (w)	1E-06	EQS	mg/l	0 of 0	0	#DIV/0!					
Permethrin II (trans) (w)	1E-06	EQS	mg/l	0 of 0	0	#DIV/0!					
Quintozene (PCNB) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Tecnazene (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!					
Triadimefon (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Triallate (w)	0.00025	EQS*	mg/l	0 of 0	0	#DIV/0!					
Trifluralin (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!					
alpha-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
beta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
cis-Chlordane (Alpha) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
delta-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
gamma-Hexachlorocyclohexane (HCH) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
o,p-DDD (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
o,p-DDE (2,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
o,p-DDT (2,4) (w)	2.5E-05	EQS	mg/l	0 of 0	0	#DIV/0!					
o,p-Methoxychlor (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
p,p-DDE (4,4) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
p,p-DDT (4,4) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!					
trans-Chlordane (Gamma) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Azinphos-ethyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Azinphos-methyl (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!					
Carbophenothion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Chlorfenvinphos (w)	0.0001	EQS	mg/l	0 of 0	0	#DIV/0!					
Chlorpyrifos (w)	0.00003	EQS	mg/l	0 of 0	0	#DIV/0!					
Chlorpyrifos-methyl (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Coumaphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!					
Diazinon (Dimpylate) (w)	0.00001	EQS	mg/l	0 of 0	0	#DIV/0!					
Dichlorvos (w)	1E-06	EQS	mg/l	0 of 0	0	#DIV/0!					
Dimethoate (w)	0.00048	EQS	mg/l	0 of 0	0	#DIV/0!					
Disulfoton (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Ethion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Fenitrothion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!					
Fenthion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Malathion (w)	0.00001	EQS*	mg/l	0 of 0	0	#DIV/0!					
Methyl Parathion (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Mevinphos (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Parathion (Ethyl Parathion) (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Phorate (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Phosalone (w)	0.0001	DWS	mg/l	0 of 0	0	#DIV/0!					
Primiphos-methyl (w)	1.5E-05	EQS*	mg/l	0 of 0	0	#DIV/0!					
Propetamphos (w)	0.00003	EQS*	mg/l	0 of 0	0	#DIV/0!					
Triazophos (w)	5E-06	EQS*	mg/l	0 of 0	0	#DIV/0!					
Other						#DIV/0!					
2,3,4,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!					
2,3,5,6-Tetrachlorophenol			mg/l	No GAC	-	#DIV/0!					
2-Nitroaniline			mg/l	No GAC	-	#DIV/0!					
3+4-Methylphenol			mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3-Nitroaniline			mg/l	No GAC	-	#DIV/0!					
4-Chlorophenyl Phenyl Ether			mg/l	No GAC	-	#DIV/0!					
4-Nitroaniline			mg/l	No GAC	-	#DIV/0!					
Aliphatics >C10-44			mg/l	No GAC	-	#DIV/0!					
Alkalinity (total) (w) Colorimetry			mg/l CaCO3	No GAC	-	#DIV/0!					
Aluminium (dissolved)	15	EQS*	mg/l	0 of 0	0	#DIV/0!					
Aniline			mg/l	No GAC	-	#DIV/0!					
Azobenzene			mg/l	No GAC	-	#DIV/0!					
Benzyl Alcohol			mg/l	No GAC	-	#DIV/0!					
Bis(2-chloroisopropyl)ether			mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bis(2-ethylhexyl) adipate			mg/l	No GAC	-	#DIV/0!					
Cobalt (dissolved)	3	EQS*	mg/l	2 of 2	0	0.008	0.014	0.014	0.002		
Cyhalothrin-lambda (w)			mg/l	No GAC	-	#DIV/0!					
Demeton-S (w)			mg/l	No GAC	-	#DIV/0!					
Diflubenzuron (w)	0.001	EQS*	mg/l	0 of 0	0	#DIV/0!					
Diphenylamine			mg/l	No GAC	-	#DIV/0!					
E.coli (Faecal Coliforms) (w)	0	EUDWS	cfu/100ml	0 of 0	0	#DIV/0!					
Endrin Aldehyde (w)			mg/l	No GAC	-	#DIV/0!					
Endrin Ketone (w)			mg/l	No GAC	-	#DIV/0!					
Fensulphothion (w)			mg/l	No GAC	-	#DIV/0!					
Fluroxypyr (w)			mg/l	No GAC	-	#DIV/0!					
Intestinal Enterococci (Faecal Streptococci/Faecal Enterococci)			cfu/100ml	No GAC	-	#DIV/0!					
Iron (Soluble)			mg/l	No GAC	-	#DIV/0!					
M-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!					
Methabenzthiazuron (w)			mg/l	No GAC	-	#DIV/0!					
Monolinuron (w)			mg/l	No GAC	-	#DIV/0!					
Naphthalene1-methyl-			mg/l	No GAC	-	#DIV/0!					
Naphthols (2-Naphthalenesulfonic acid, 1-hydroxy-)			mg/l	No GAC	-	#DIV/0!					
P-Dinitrobenzene			mg/l	No GAC	-	#DIV/0!					
Perylene			mg/l	No GAC	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Resorcinol			mg/l	No GAC	-	#DIV/0!					
Silver (dissolved)	0.05	EQS*	mg/l	0 of 0	0	#DIV/0!					
Telodrin (w)			mg/l	No GAC	-	#DIV/0!					

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Hole Ref	BH310	BH310	GEO_BH203	GEO_BH203	BH203
Sample Ref	3WBH-BH310 4.3		GW/BH-BH203 12.30		100
Easting	384838.09	384838.09	384845.747	384845.747	
Northing	399638.18	399638.18	399748.863	399748.863	
Hole Elevation (mOD)	32.6	32.6	41.891	41.891	
Sample Depth (mbgl)	4.3	4.43	12.3	12.4	
Piezometer top (mbgl)	8	8	18	18	
Piezometer base (mbgl)	16	16	24	24	
Sample Date	26/05/22	05/07/22	26/05/22	05/07/22	26/05/2021
Investigation	326R	326R	NW1604	NW1604	
Response zone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone	Collyhurst Sandstone St Catherine's Wood

Contaminant Name	GAC	GAC Source	Units	Total > LOD	Total > GAC	Average	Max
Terbutryn (w)	0.065	EQS	mg/l	0 of 0	0	#DIV/0!	
Tin (dissolved)	25	EQS*	mg/l	0 of 0	0	#DIV/0!	
Trichloronate (w)			mg/l	No GAC	-	#DIV/0!	
Trimethylphenol			mg/l	No GAC	-	#DIV/0!	
Xylenols & Ethylphenols			mg/l	No GAC	-	#DIV/0!	
Chloroxuron (w)			mg/l	No GAC	-	#DIV/0!	
Demeton-O (w)			mg/l	No GAC	-	#DIV/0!	
Dimeturon (w)			mg/l	No GAC	-	#DIV/0!	
Ethioncarb (w)			mg/l	No GAC	-	#DIV/0!	
Metoxuron (w)			mg/l	No GAC	-	#DIV/0!	
Pencyuron (w)			mg/l	No GAC	-	#DIV/0!	
Permethrin I (cis) (w)			mg/l	No GAC	-	#DIV/0!	
Phenmedipham (w)			mg/l	No GAC	-	#DIV/0!	
Prothiofos (Tokuthion) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-DDD (4,4) (w)			mg/l	No GAC	-	#DIV/0!	
p,p-Methoxychlor (w)			mg/l	No GAC	-	#DIV/0!	
cis1,3-Dichloropropene			mg/l	No GAC	-	#DIV/0!	

Page 2 of 2

16:12 20/08/2023 [Controlled Waters Risk Assessment_Aug 2023.xlsm Surface water]

Concentration exceeds GAC	100.00
Limit of Detection value exceeds GAC	<0.1

Concentration exceeds GAC				100.00		Hole Ref Sample Ref Easting Northing Hole Elevation (mOD) Sample Depth (mbgl) Piezometer top (mbgl) Piezometer base (mbgl) Sample Date Investigation Aquifer			Surface water 1	Surface water 2	SWS01	SWS01	SWS01	SWS02	SWS02	SWS02	SWS02	SWS03	SWS03	SWS03			
Limit of Detection value exceeds GAC				<0.1					326R.SWS01.EW	6R.SWS01.EW	6R.SWS01.EW	26R.SWS02.EW	26R.SWS02.EW	26R.SWS02.EW	26R.SWS02.EW	26R.SWS02.EW	26R.SWS03.EW	26R.SWS03.EW	26R.SWS03.EW	26R.SWS03.EW	26R.SWS03.EW	26R.SWS03.EW	



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	Anthracene		
Target Concentration (C _T)	1.00E-04	mg/l	Origin of C _T : EQS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

Anthracene
0.0001 mg/l

Input Parameters

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction
Air filled soil porosity θ_a 8.90E-02 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 1.84E-04 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 5.62E+03 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species $K_{oc,n}$

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

pH value pH pH units

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 3.26E+02 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target 3.26E-02 mg/kg (for comparison with soil analyses)
or
0.0001 mg/l (for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Anthracene
0.0001 mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
9.53E+02

m/d
m²

Estimated based on 10% infiltration
Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

5.20E+01
3.00E+02
4.00E-01
3.20E-02
2.20E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Measurement of source zone
Literature value for Collyhurst Sandstone
Literature value
Site measurement
Site measurement

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
6.48E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

7.64E-04
or
2.49E-01

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Anthracene		from Level 1
Target Concentration	Ct	0.0001	mg/l	from Level 1
Dilution Factor	DF	7.64E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
--------------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	t _{1/2}	4.60E+02	days
Calculated decay rate	λ	1.51E-03	days ⁻¹
Width of plume in aquifer at source	Sz	2.20E+01	m
Plume thickness in aquifer at source	Sy	6.48E+00	m
Bulk density of aquifer materials	ρ	2.24E+00	g/cm ³
Effective porosity of aquifer	n	2.50E-01	fraction
Hydraulic gradient	i	3.68E-02	fraction
Hydraulic conductivity of saturated aquifer	K	4.00E-01	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	1.00E+99	days
<i>Parameters values determined from options</i>			
Partition coefficient	Kd	8.43E+00	l/kg
Longitudinal dispersivity	ax	5.000	m
Transverse dispersivity	az	0.500	m
Vertical dispersivity	ay	0.050	m

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	5.89E-02
Retardation factor	Rf	7.65E+01
Decay rate used	λ	1.97E-05
Hydraulic gradient used in aquifer flow down-gradient	i	3.68E-02
Rate of contaminant flow due to retardation	u	7.70E-04
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	2.78E-01
Attenuation factor (C ₀ /C _{CP})	AF	3.59E+00

Remedial Targets

Level 3 Remedial Target	2.78E-03	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	2.78E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

ax

Transverse dispersivity az

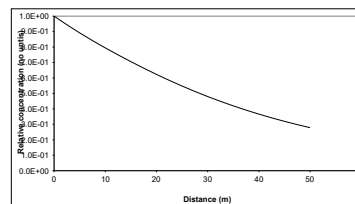
Vertical dispersivity ay

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.44E-01
5.0	8.92E-01
7.5	8.42E-01
10.0	7.95E-01
12.5	7.49E-01
15.0	7.06E-01
17.5	6.64E-01
20.0	6.23E-01
22.5	5.85E-01
25.0	5.48E-01
27.5	5.13E-01
30.0	4.80E-01
32.5	4.49E-01
35.0	4.19E-01
37.5	3.92E-01
40.0	3.66E-01
42.5	3.42E-01
45.0	3.19E-01
47.5	2.98E-01
50.0	2.78E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	2
Contaminant	TPH - Aromatic C8-C10		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

TPH - Aromatic C8-C10
0.3 mg/l

Input Parameters

Standard entry

Water filled soil porosity
Air filled soil porosity
Bulk density of soil zone material
Henry's Law constant

Variable
 θ_w
 θ_a
 ρ
H

Value
2.28E-01
8.90E-02
1.90E+00
4.90E-01

Unit
fraction
fraction
g/cm³
dimensionless

Source of parameter value

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

foc

fraction

Site measurement for made ground

Organic carbon partition coefficient

K_{oc}

l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

foc

fraction

Soil water partition coefficient used in Level Assessment

K_d

9.28E+01

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target
2.79E+01 mg/kg
or
0.3 mg/l

(for comparison with soil analyses)

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T TPH - Aromatic C8-C10
0.3 mg/l from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

2.40E-04

m/d

Estimated based on 10% infiltration

Area of contaminant source

A

9.53E+02

m²

Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

5.20E+01

m

Measurement of source zone

Saturated aquifer thickness

da

3.00E+02

m

Literature value for Collyhurst Sandstone

Hydraulic Conductivity of aquifer in which dilution occurs

K

4.00E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.20E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

2.20E+01

m

Site measurement

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

6.48E+00

m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

2.29E+00

mg/l

or

2.13E+02

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C8-C10		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	2.94E+02	days	Howard, 1991
Calculated decay rate	2.36E-03	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of gasworks
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.40E+00	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	5.89E-02 m/d
Retardation factor	Rf	2.25E+01
Decay rate used	λ	1.05E-04 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	3.68E-02
Rate of contaminant flow due to retardation	u	2.62E-03 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.59E-01
Attenuation factor (C ₀ /C _{CP})	AF	6.30E+00

Remedial Targets

Level 3 Remedial Target	1.44E+01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.59E-01	fraction 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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

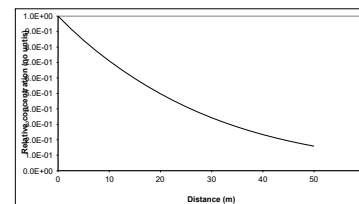
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.18E-01
5.0	8.43E-01
7.5	7.74E-01
10.0	7.10E-01
12.5	6.51E-01
15.0	5.96E-01
17.5	5.45E-01
20.0	4.98E-01
22.5	4.54E-01
25.0	4.14E-01
27.5	3.77E-01
30.0	3.43E-01
32.5	3.11E-01
35.0	2.83E-01
37.5	2.57E-01
40.0	2.34E-01
42.5	2.12E-01
45.0	1.93E-01
47.5	1.75E-01
50.0	1.59E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	2
Contaminant	TPH - Aromatic C10-C12		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration C_T TPH - Aromatic C10-C12
0.09 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ _w	2.28E-01	fraction	Calculated	This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient. The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.
Air filled soil porosity	θ _a	8.90E-02	fraction	Calculated	
Bulk density of soil zone material	ρ	1.90E+00	g/cm ³	Site measurement for made ground	
Henry's Law constant	H	1.40E-01	dimensionless	Literature value	

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction Site measurement for made ground
Organic carbon partition coefficient K_{oc} 2.50E+03 l/kg Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n} l/kg
Sorption coefficient for ionised species K_{oc,i} l/kg
pH value pH units
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 1.45E+02 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	1.31E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C10-C12
0.09 mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
9.53E+02

m/d
m²

Estimated based on 10% infiltration
Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

5.20E+01
3.00E+02
4.00E-01
3.20E-02
2.20E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Measurement of source zone
Literature value for Collyhurst Sandstone
Literature value
Site measurement
Site measurement

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
6.48E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

6.88E-01
or
9.98E+01

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C10-C12		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	2.58E+02	days	Howard, 1991
Calculated decay rate	2.69E-03	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of gasworks
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	3.75E+00	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	3.46E+01	fraction
Decay rate used	7.76E-05	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	1.70E-03	m/d
Ratio of Compliance Point to Source Concentration	1.29E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	7.73E+00	fraction

Remedial Targets

Level 3 Remedial Target	5.32E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	7.72E+02	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	1.29E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

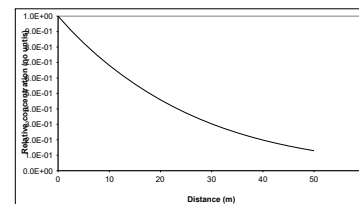
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.09E-01
5.0	8.26E-01
7.5	7.50E-01
10.0	6.82E-01
12.5	6.19E-01
15.0	5.61E-01
17.5	5.07E-01
20.0	4.59E-01
22.5	4.14E-01
25.0	3.73E-01
27.5	3.36E-01
30.0	3.03E-01
32.5	2.73E-01
35.0	2.45E-01
37.5	2.21E-01
40.0	1.98E-01
42.5	1.78E-01
45.0	1.60E-01
47.5	1.44E-01
50.0	1.29E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	2
Contaminant	TPH - Aromatic C12-C16		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

TPH - Aromatic C12-C16
0.09 mg/l

Input Parameters
Variable **Value** **Unit** **Source of parameter value**

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction
Air filled soil porosity θ_a 8.90E-02 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 5.40E-02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 5.00E+03 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n} l/kg

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

pH value pH pH units

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 2.90E+02 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	2.61E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C12-C16
0.09

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
9.53E+02

m/d
m²

Estimated based on 10% infiltration
Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

5.20E+01
3.00E+02
4.00E-01
3.20E-02
2.20E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Measurement of source zone
Literature value for Collyhurst Sandstone
Literature value
Site measurement
Site measurement

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
6.48E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

6.88E-01
or
2.00E+02

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C12-C16		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	1.62E+02	days	Howard, 1991
Calculated decay rate	4.28E-03	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of site
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	7.50E+00	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	6.82E+01	fraction
Decay rate used	6.27E-05	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	8.64E-04	m/d
Ratio of Compliance Point to Source Concentration	5.17E-02	fraction
Attenuation factor (C ₀ /C ₁₀)	1.93E+01	fraction

Remedial Targets

Level 3 Remedial Target	1.33E+01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	3.86E+03	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	5.17E-02	fraction	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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

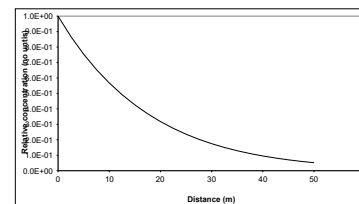
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	5.00E+00	2.98E+00
Transverse dispersivity	az	5.00E-01	2.98E-01
Vertical dispersivity	ay	5.00E-02	2.98E-02

Note: values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	8.68E-01
5.0	7.53E-01
7.5	6.54E-01
10.0	5.67E-01
12.5	4.92E-01
15.0	4.26E-01
17.5	3.68E-01
20.0	3.18E-01
22.5	2.74E-01
25.0	2.36E-01
27.5	2.03E-01
30.0	1.75E-01
32.5	1.50E-01
35.0	1.29E-01
37.5	1.11E-01
40.0	9.53E-02
42.5	8.18E-02
45.0	7.02E-02
47.5	6.03E-02
50.0	5.17E-02

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	2
Contaminant	TPH - Aromatic C16-C21		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aromatic C16-C21
0.09 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction
Air filled soil porosity θ_a 8.90E-02 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 1.30E-02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 1.60E+04 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 9.28E+02 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	8.35E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T TPH - Aromatic C16-C21
0.09 mg/l from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable	Value	Unit	Source of parameter value
Infiltration	2.40E-04	m/d	Estimated based on 10% infiltration
Area of contaminant source	9.53E+02	m ²	Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	5.20E+01	m	Measurement of source zone
Saturated aquifer thickness	da	3.00E+02	m	Literature value for Collyhurst Sandstone
Hydraulic Conductivity of aquifer in which dilution occurs	K	4.00E-01	m/d	Literature value
Hydraulic gradient of water table	i	3.20E-02	fraction	Site measurement
Width of contaminant source perpendicular to groundwater flow	w	2.20E+01	m	Site measurement
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	Not used in calculation
		Calculate		
Enter mixing zone thickness	Mz		m	
Calculated mixing zone thickness	Mz	6.48E+00	m	

Calculated Parameters

Dilution Factor	DF	7.64E+00
Level 2 Remedial Target		6.88E-01 mg/l or 6.38E+02 mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C16-C21		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.31E+03	days	Howard, 1991
Calculated decay rate	5.29E-04	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of gasworks
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	2.40E+01	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	2.16E+02	fraction
Decay rate used	2.45E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	2.73E-04	m/d
Ratio of Compliance Point to Source Concentration	5.70E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.75E+00	fraction

Remedial Targets

Level 3 Remedial Target	1.21E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	1.12E+03	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	5.70E-01	fraction	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

Entry if specify partition coefficient (option)

Soil water partition coefficient

Kd

l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer

foc

fraction

Organic carbon partition coefficient

Koc

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

K_{oc,L}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

Acid dissociation constant

pKa

Fraction of organic carbon in aquifer

foc

fraction

Soil water partition coefficient

Kd

l/kg

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

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

Longitudinal dispersivity

ax

m

Transverse dispersivity

az

m

Vertical dispersivity

ay

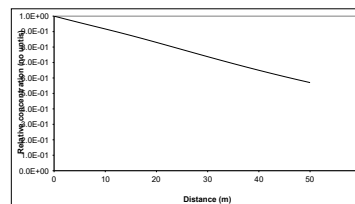
m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.79E-01
5.0	9.58E-01
7.5	9.37E-01
10.0	9.17E-01
12.5	8.96E-01
15.0	8.75E-01
17.5	8.53E-01
20.0	8.30E-01
22.5	8.07E-01
25.0	7.84E-01
27.5	7.61E-01
30.0	7.38E-01
32.5	7.15E-01
35.0	6.93E-01
37.5	6.71E-01
40.0	6.50E-01
42.5	6.29E-01
45.0	6.09E-01
47.5	5.89E-01
50.0	5.70E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	TPH - Aromatic C21-C35		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration C_T TPH - Aromatic C21-C35
0.09 mg/l

Input Parameters Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction Calculated
Air filled soil porosity θ_a 8.90E-02 fraction Calculated
Bulk density of soil zone material ρ 1.90E+00 g/cm³ Site measurement for made ground
Henry's Law constant H 6.80E-04 dimensionless Literature value

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction Site measurement for made ground

Organic carbon partition coefficient K_{oc} 1.30E+05 l/kg Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n} l/kg

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

pH value pH units

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 7.54E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	6.79E+02	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C21-C35
0.09 mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
9.53E+02

m/d
m²

Estimated based on 10% infiltration
Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

5.20E+01
3.00E+02
4.00E-01
3.20E-02
2.20E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Measurement of source zone
Literature value for Collyhurst Sandstone
Literature value
Site measurement
Site measurement

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
6.48E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

6.88E-01
or
5.19E+03

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C21-C35		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.81E+03	days	Howard, 1991
Calculated decay rate	3.82E-04	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of site
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	1.95E+02	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	1.75E+03	fraction
Decay rate used	2.19E-07	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	3.37E-05	m/d
Ratio of Compliance Point to Source Concentration	6.40E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.56E+00	fraction

Remedial Targets

Level 3 Remedial Target	1.07E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	8.10E+03	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	6.40E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

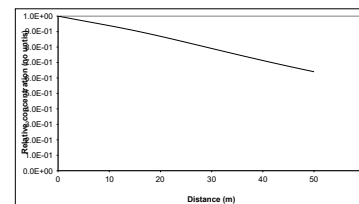
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.84E-01
5.0	9.69E-01
7.5	9.54E-01
10.0	9.39E-01
12.5	9.23E-01
15.0	9.06E-01
17.5	8.88E-01
20.0	8.69E-01
22.5	8.50E-01
25.0	8.31E-01
27.5	8.11E-01
30.0	7.91E-01
32.5	7.71E-01
35.0	7.51E-01
37.5	7.32E-01
40.0	7.13E-01
42.5	6.94E-01
45.0	6.75E-01
47.5	6.58E-01
50.0	6.40E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	Benzo(a)Pyrene		
Target Concentration (C _T)	1.00E-05	mg/l	Origin of C _T : Background concentration in Irk

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
Benzo(a)Pyrene
0.00001 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ_w	2.28E-01	fraction	Calculated	This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient. The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.
Air filled soil porosity	θ_a	8.90E-02	fraction	Calculated	
Bulk density of soil zone material	ρ	1.90E+00	g/cm ³	Site measurement for made ground	
Henry's Law constant	H	1.92E-05	dimensionless	Literature value	

Entry if specify partition coefficient (option)

Soil water partition coefficient
Kd
I/kg
Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)
foc
5.80E-02
fraction
Site measurement for made ground

Organic carbon partition coefficient
Koc
1.30E+05
I/kg
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species
K_{oc,n}
I/kg

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

pH value
pH
pH units

Acid dissociation constant
pKa

Fraction of organic carbon (in soil)
foc
fraction

Soil water partition coefficient used in Level Assessment
Kd
7.54E+03
I/kg
Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	7.54E-02	mg/kg	(for comparison with soil analyses)
	or		
	0.00001	mg/l	(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Benzo(a)Pyrene
0.00001

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

2.40E-04

m/d

Estimated based on 10% infiltration

Area of contaminant source

A

9.53E+02

m²

Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

5.20E+01

m

Measurement of source zone

Saturated aquifer thickness

da

3.00E+02

m

Literature value for Collyhurst Sandstone

Hydraulic Conductivity of aquifer in which dilution occurs

K

4.00E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.20E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

2.20E+01

m

Site measurement

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

6.48E+00

m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

7.64E-05

mg/l

or

5.76E-01

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Benzo(a)Pyrene		from Level 1
Target Concentration	Ct	0.00001	mg/l	from Level 1
Dilution Factor	DF	7.64E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.24E+02	days	Howard, 1991
Calculated decay rate	2.36E-03	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of gasworks
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	1.95E+02	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	1.75E+03	fraction
Decay rate used	1.35E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	3.37E-05	m/d
Ratio of Compliance Point to Source Concentration	1.59E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	6.30E+00	fraction

Remedial Targets

Level 3 Remedial Target	4.81E-04	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	3.63E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	1.59E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

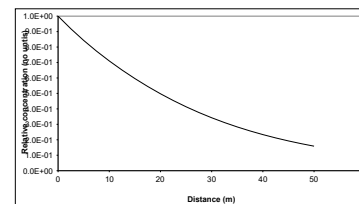
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.18E-01
5.0	8.43E-01
7.5	7.74E-01
10.0	7.10E-01
12.5	6.51E-01
15.0	5.96E-01
17.5	5.45E-01
20.0	4.98E-01
22.5	4.54E-01
25.0	4.14E-01
27.5	3.77E-01
30.0	3.43E-01
32.5	3.11E-01
35.0	2.83E-01
37.5	2.57E-01
40.0	2.34E-01
42.5	2.12E-01
45.0	1.93E-01
47.5	1.75E-01
50.0	1.59E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Aug-23	Version:	1
Contaminant	Zinc		
Target Concentration (C_T)	0.1115	mg/l	Origin of C_T : Normal Background Concentration

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

User specified value for partition coefficient

Contaminant
Target concentration
C_T

Zinc
0.1115 mg/l

Input Parameters
Variable **Value** **Unit** **Source of parameter value**

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction
Air filled soil porosity θ_a 8.90E-02 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 0.00E+00 dimensionless

Calculated
Calculated
Site measurement for made ground
N/A

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d 5.01E+02 l/kg

Literature value from Buss (EA)

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc}
Organic carbon partition coefficient K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 5.01E+02 l/kg Specified value

Level 1 Remedial Target

Level 1 Remedial Target	5.59E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.1115	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Aug-23
Version:	1

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Zinc
0.1115 mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
9.53E+02

m/d
m²

Estimated based on 10% infiltration
Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

5.20E+01
1.50E+02
4.00E-01
3.20E-02
2.20E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Measurement of source zone
Literature value for Collyhurst Sandstone
Literature value
Site measurement
Site measurement

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
6.48E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

8.52E-01
or
4.27E+02

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Aug-23
Version: 1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Zinc		from Level 1
Target Concentration	Ct	0.1115	mg/l	from Level 1
Dilution Factor	DF	7.64E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	t _{1/2}	9.00E+99	days
Calculated decay rate	λ	7.70E-101	days ⁻¹
Width of plume in aquifer at source	Sz	2.20E+01	m
Plume thickness in aquifer at source	Sy	6.48E+00	m
Bulk density of aquifer materials	ρ	2.24E+00	g/cm ³
Effective porosity of aquifer	n	2.50E-01	fraction
Hydraulic gradient	i	3.68E-02	fraction
Hydraulic conductivity of saturated aquifer	K	4.00E-01	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	1.00E+99	days
Parameters values determined from options			
Partition coefficient	Kd	5.01E+02	l/kg
Longitudinal dispersivity	ax	5.000	m
Transverse dispersivity	az	0.500	m
Vertical dispersivity	ay	0.050	m

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	5.89E-02 m/d
Retardation factor	Rf	4.49E+03
Decay rate used	λ	1.72E-104 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	3.68E-02
Rate of contaminant flow due to retardation	u	1.31E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.77E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.14E+00

Remedial Targets

Level 3 Remedial Target	9.72E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	4.87E+02	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.77E-01	fraction

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

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.01E+02 l/kg

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd 5.01E+02 l/kg

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

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

Longitudinal dispersivity

ax 0.00E+00 5.00E+00 2.50E+00 m

Transverse dispersivity az 0.00E+00 5.00E-01 2.50E-01 m

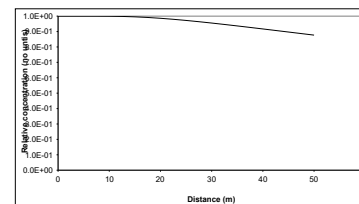
Vertical dispersivity ay 0.00E+00 5.00E-02 2.50E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	0.99E-01
12.5	9.98E-01
15.0	9.95E-01
17.5	9.91E-01
20.0	9.86E-01
22.5	9.80E-01
25.0	9.72E-01
27.5	9.64E-01
30.0	9.55E-01
32.5	9.46E-01
35.0	9.37E-01
37.5	9.27E-01
40.0	9.17E-01
42.5	9.07E-01
45.0	8.97E-01
47.5	8.87E-01
50.0	8.77E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	13-Jul-23	Version:	1
Contaminant	PFOA		
Target Concentration (C _T)	6.50E-07	mg/l	Origin of C _T : EQS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

PFOA
0.00000065 mg/l

Input Parameters
Standard entry

Standard entry

Water filled soil porosity

θ_w

2.28E-01

fraction

Calculated

Air filled soil porosity

θ_a

8.90E-02

fraction

Calculated

Bulk density of soil zone material

ρ

1.90E+00

g/cm³

Site measurement for made ground

Henry's Law constant

H

3.63E-05

dimensionless

CONCAWE, 2016

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

5.80E-02

fraction

Site measurement for made ground

Organic carbon partition coefficient

K_{oc}

9.33E+01

l/kg

Mid-point literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

5.41E+00

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target

3.60E-06

mg/kg

or

0.00000065

mg/l

(for comparison with soil analyses)

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works

Completed by: DH

Date: 13-Jul-23

Version: 1

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

PFOA
0.00000065

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
2.80E+03

m/d
m²

Estimated based on 10% infiltration
Estimated area of PFAS soil contamination

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

4.00E+01
3.00E+02
4.00E-01
3.20E-02
7.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Estimated measurement of source zone
Literature value for Collyhurst Sandstone
Literature value
Site measurement
Site measurement

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
4.98E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

4.97E-06
or
2.75E-05

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 13-Jul-23
Version: 1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	PFOA		from Level 1
Target Concentration	0.00000065	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	7.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.98E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from PFAS source zone
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	1.40E-01	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	2.25E+00	fraction
Decay rate used	3.42E-101	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	2.61E-02	m/d
Ratio of Compliance Point to Source Concentration	9.74E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.03E+00	fraction

Remedial Targets

Level 3 Remedial Target	5.10E-06	mg/l	For comparison with measured pore water concentration.
Ogata Banks	2.82E-05	mg/kg	This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	9.74E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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 1.50E-03 fraction

Organic carbon partition coefficient Koc 9.33E+01 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L} l/kgSorption 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 1.40E-01 l/kg

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

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

Longitudinal dispersivity

ax 0.00E+00 5.00E+00 2.50E+00 m

Transverse dispersivity az 0.00E+00 5.00E-01 2.50E-01 m

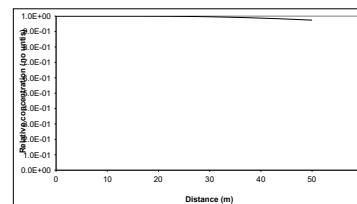
Vertical dispersivity ay 0.00E+00 5.00E-02 2.50E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	1.00E+00
12.5	1.00E+00
15.0	1.00E+00
17.5	1.00E+00
20.0	1.00E+00
22.5	9.99E-01
25.0	9.98E-01
27.5	9.97E-01
30.0	9.96E-01
32.5	9.94E-01
35.0	9.92E-01
37.5	9.90E-01
40.0	9.87E-01
42.5	9.84E-01
45.0	9.81E-01
47.5	9.78E-01
50.0	9.74E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	TP422/423		
Completed by:	DH		
Date:	13-Jul-23	Version:	1
Contaminant	PFOS		
Target Concentration (C_T)	6.50E-07	mg/l	Origin of C_T: EQS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

PFOS
0.00000065 mg/l

Input Parameters
Standard entry

Variable	Value	Unit
Water filled soil porosity	2.28E-01	fraction
Air filled soil porosity	8.90E-02	fraction
Bulk density of soil zone material	1.90E+00	g/cm ³
Henry's Law constant	1.29E-07	dimensionless

Source of parameter value
Calculated
Calculated
Site measurement for made ground
Environment Agency, 2004

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient
K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)
foc

Site measurement for made ground

Organic carbon partition coefficient
K_{oc}

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species
K_{oc,n}

Sorption coefficient for ionised species
K_{oc,i}

pH value
pH

Acid dissociation constant
pK_a

Fraction of organic carbon (in soil)
foc

Soil water partition coefficient used in Level Assessment
K_d 3.66E+01 I/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	2.39E-05	mg/kg	(for comparison with soil analyses)
	or		
	0.00000065	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	13-Jul-23
Version:	1

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T PFOS 0.00000065 mg/l from Level 1 from Level 1

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

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

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

2.40E-04

m/d

Estimated based on 10% infiltration

Area of contaminant source

A

2.80E+03

m²

Estimated area of PFAS soil contamination

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

4.00E+01

m

Estimated measurement of source zone

Saturated aquifer thickness

da

3.00E+02

m

Literature value for Collyhurst Sandstone

Hydraulic Conductivity of aquifer in which dilution occurs

K

4.00E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.20E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

7.00E+01

m

Site measurement

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.98E+00

m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

4.97E-06

mg/l

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

or

1.82E-04

mg/kg

For comparison with measured soil concentration. This assumes Level 1

Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 13-Jul-23
Version: 1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		PFOS		from Level 1
Target Concentration	Ct	0.00000065	mg/l	from Level 1
Dilution Factor	DF	7.64E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	7.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.98E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from PFAS source zone
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	9.46E-01	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	9.48E+00	fraction
Decay rate used	8.12E-102	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	6.21E-03	m/d
Ratio of Compliance Point to Source Concentration	9.74E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.03E+00	fraction

Remedial Targets

Level 3 Remedial Target	5.10E-06	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.87E-04	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	9.74E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

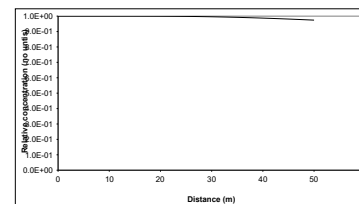
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	1.00E+00
12.5	1.00E+00
15.0	1.00E+00
17.5	1.00E+00
20.0	1.00E+00
22.5	9.99E-01
25.0	9.98E-01
27.5	9.97E-01
30.0	9.96E-01
32.5	9.94E-01
35.0	9.92E-01
37.5	9.90E-01
40.0	9.87E-01
42.5	9.84E-01
45.0	9.81E-01
47.5	9.78E-01
50.0	9.74E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	20-Oct-22	Version:	1
Contaminant	TPH - Aliphatic C8-C10		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C8-C10
0.3 mg/l

Input Parameters
Variable **Value** **Unit** **Source of parameter value**

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction
Air filled soil porosity θ_a 8.90E-02 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 8.20E+01 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 3.20E+04 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 1.86E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	5.58E+02	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 1

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aliphatic C8-C10
0.3

mg/l
from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

2.40E-04

m/d

Estimated based on 10% infiltration

Area of contaminant source

A

9.53E+02

m²

Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

5.20E+01

m

Measurement of source zone

Saturated aquifer thickness

da

3.00E+02

m

Literature value for Collyhurst Sandstone

Hydraulic Conductivity of aquifer in which dilution occurs

K

4.00E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.20E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

2.20E+01

m

Site measurement

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

6.48E+00

m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

2.29E+00

mg/l

or

4.26E+03

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C8-C10		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of site
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	4.80E+01	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	4.31E+02	fraction
Decay rate used	1.79E-103	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	1.37E-04	m/d
Ratio of Compliance Point to Source Concentration	8.77E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.14E+00	fraction

Remedial Targets

Level 3 Remedial Target	2.61E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	4.86E+03	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	8.77E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

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Soil water partition coefficient Kd

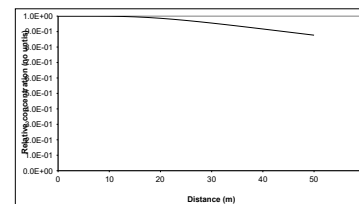
Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	0.99E-01
12.5	9.98E-01
15.0	9.95E-01
17.5	9.91E-01
20.0	9.86E-01
22.5	9.80E-01
25.0	9.72E-01
27.5	9.64E-01
30.0	9.55E-01
32.5	9.46E-01
35.0	9.37E-01
37.5	9.27E-01
40.0	9.17E-01
42.5	9.07E-01
45.0	8.97E-01
47.5	8.87E-01
50.0	8.77E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	20-Oct-22	Version:	1
Contaminant	TPH - Aliphatic C10-C12		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C10-C12
0.3 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction
Air filled soil porosity θ_a 8.90E-02 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 1.30E+02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 2.50E+05 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 1.45E+04 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	4.35E+03	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 1

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aliphatic C10-C12
0.3

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
9.53E+02

m/d
m²

Estimated based on 10% infiltration
Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

5.20E+01
3.00E+02
4.00E-01
3.20E-02
2.20E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Measurement of source zone
Literature value for Collyhurst Sandstone
Literature value
Site measurement
Site measurement

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
6.48E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

2.29E+00
or
3.33E+04

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C10-C12		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of site
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	3.75E+02	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	5.89E-02 m/d
Retardation factor	Rf	3.36E+03
Decay rate used	λ	2.29E-104 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	3.68E-02
Rate of contaminant flow due to retardation	u	1.75E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.77E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.14E+00

Remedial Targets

Level 3 Remedial Target	2.61E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	3.79E+04	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.77E-01	fraction 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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

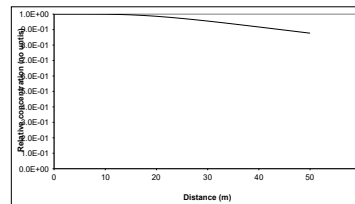
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	9.99E-01
12.5	9.98E-01
15.0	9.95E-01
17.5	9.91E-01
20.0	9.86E-01
22.5	9.80E-01
25.0	9.72E-01
27.5	9.64E-01
30.0	9.55E-01
32.5	9.46E-01
35.0	9.37E-01
37.5	9.27E-01
40.0	9.17E-01
42.5	9.07E-01
45.0	8.97E-01
47.5	8.87E-01
50.0	8.77E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	1



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	TPH - Aliphatic C12-C16		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C12-C16
0.3 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 2.28E-01 fraction
Air filled soil porosity θ_a 8.90E-02 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 5.40E+02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 5.00E+06 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 2.90E+05 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	8.70E+04	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	20-Oct-22
Version:	2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aliphatic C12-C16
0.3

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

2.40E-04
9.53E+02

m/d
m²

Estimated based on 10% infiltration

Measurement based on mapping/observation

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

5.20E+01
3.00E+02
4.00E-01
3.20E-02
2.20E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Measurement of source zone

Literature value for Collyhurst Sandstone

Literature value

Site measurement

Site measurement

Not used in calculation

Calculate

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

6.48E+00

m
m

Calculated Parameters

Dilution Factor

DF

7.64E+00

Level 2 Remedial Target

2.29E+00
or
6.65E+05

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C12-C16		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of gasworks
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	7.50E+03	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	6.72E+04	fraction
Decay rate used	1.15E-105	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	8.77E-07	m/d
Ratio of Compliance Point to Source Concentration	8.77E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.14E+00	fraction

Remedial Targets

Level 3 Remedial Target	2.61E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	7.58E+05	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	8.77E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

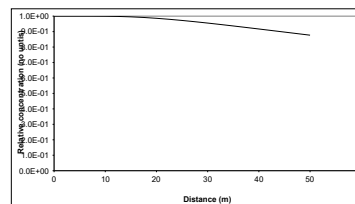
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	0.99E-01
12.5	9.98E-01
15.0	9.95E-01
17.5	9.91E-01
20.0	9.86E-01
22.5	9.80E-01
25.0	9.72E-01
27.5	9.64E-01
30.0	9.55E-01
32.5	9.46E-01
35.0	9.37E-01
37.5	9.27E-01
40.0	9.17E-01
42.5	9.07E-01
45.0	8.97E-01
47.5	8.87E-01
50.0	8.77E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Gasworks area		
Completed by:	DH		
Date:	01-Nov-22	Version:	2
Contaminant	Ammoniacal nitrogen (ammonium)		
Target Concentration (C _T)	0.6	mg/l	Origin of C _T : EQS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

User specified value for partition coefficient

Contaminant
Target concentration
 C_T
Ammoniacal nitrogen (ammonia)
0.6 mg/l

Input Parameters
Standard entry
Variable Value Unit Source of parameter value

Water filled soil porosity θ_w 2.28E-01 fraction Calculated
Air filled soil porosity θ_a 8.90E-02 fraction Calculated
Bulk density of soil zone material ρ 1.90E+00 g/cm³ Site measurement for made ground
Henry's Law constant H 0.00E+00 dimensionless N/A

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 4.00E-01 l/kg Literature value from Buss (EA)

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) foc
Organic carbon partition coefficient Koc

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species $K_{oc,n}$
Sorption coefficient for ionised species $K_{oc,i}$
pH value pH
Acid dissociation constant pKa
Fraction of organic carbon (in soil) foc

Soil water partition coefficient used in Level Assessment Kd 4.00E-01 l/kg Specified value

Level 1 Remedial Target

Level 1 Remedial Target	3.12E-01	mg/kg	(for comparison with soil analyses)
	or		
	0.6	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T Ammoniacal nitrogen (ammor 0.6 mg/l from Level 1 from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Infiltration	Inf	2.40E-04	m/d	Estimated based on 10% infiltration	
Area of contaminant source	A	9.53E+02	m ²	Measurement based on mapping/observation	Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	5.20E+01	m	Measurement of source zone	
Saturated aquifer thickness	da	1.50E+02	m	Literature value for Collyhurst Sandstone	
Hydraulic Conductivity of aquifer in which dilution occurs	K	4.00E-01	m/d	Literature value	
Hydraulic gradient of water table	i	3.20E-02	fraction	Site measurement	
Width of contaminant source perpendicular to groundwater flow	w	2.20E+01	m	Site measurement	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l		
		Calculate			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	6.48E+00	m		

Calculated Parameters

Dilution Factor	DF	7.64E+00		
Level 2 Remedial Target		4.58E+00 or 2.38E+00	mg/l mg/kg	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration. For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	Ammoniacal nitrogen (ammol)		from Level 1
Target Concentration	0.6	mg/l	from Level 1
Dilution Factor	7.64E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.10E+03	days	Buss et al 2004
Calculated decay rate	8.33E-04	days ⁻¹	calculated
Width of plume in aquifer at source	2.20E+01	m	from Level 2
Plume thickness in aquifer at source	6.48E+00	m	from Level 2
Bulk density of aquifer materials	2.24E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.50E-01	fraction	Literature value
Hydraulic gradient	3.68E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	4.00E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Distance to river from centre of gasworks area
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	4.00E-01	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	5.89E-02	m/d
Retardation factor	4.58E+00	fraction
Decay rate used	1.38E-04	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	3.68E-02	fraction
Rate of contaminant flow due to retardation	1.29E-02	m/d
Ratio of Compliance Point to Source Concentration	5.26E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.90E+00	fraction

Remedial Targets

Level 3 Remedial Target	8.72E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	4.53E+00	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	5.26E-01	fraction

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

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

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 4.00E-01 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,L} l/kgSorption coefficient for ionised species K_{oc,I} l/kg

pH value pH fraction

Acid dissociation constant pKa fraction

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 4.00E-01 l/kg

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

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

Longitudinal dispersivity

ax 0.00E+00 5.00E+00 2.50E+00 m

Transverse dispersivity az 0.00E+00 5.00E-01 2.50E-01 m

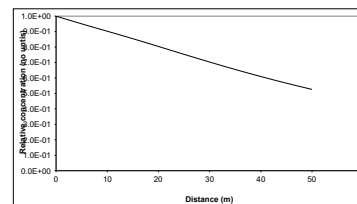
Vertical dispersivity ay 0.00E+00 5.00E-02 2.50E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	9.75E-01
5.0	9.50E-01
7.5	9.26E-01
10.0	9.02E-01
12.5	8.78E-01
15.0	8.54E-01
17.5	8.29E-01
20.0	8.04E-01
22.5	7.78E-01
25.0	7.53E-01
27.5	7.28E-01
30.0	7.03E-01
32.5	6.79E-01
35.0	6.55E-01
37.5	6.32E-01
40.0	6.09E-01
42.5	5.87E-01
45.0	5.65E-01
47.5	5.46E-01
50.0	5.26E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	TPH - Aliphatic C8-C10		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C8-C10
0.3 mg/l

Input Parameters
Variable **Value** **Unit** **Source of parameter value**

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 8.20E+01 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 3.20E+04 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 1.86E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	5.59E+02	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	20-Oct-22
Version:	2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aliphatic C8-C10
0.3

mg/l
from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median of fill in zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median of fill in zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value for Chester Pebble Beds

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill in zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

1.03E+00

mg/l

or

1.91E+03

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C8-C10		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	3.42E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	4.80E+01	l/kg	see options
Longitudinal dispersivity	2.500	m	see options
Transverse dispersivity	0.250	m	see options
Vertical dispersivity	0.025	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	4.39E+02	fraction
Decay rate used	1.75E-103	g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.81E-02	fraction
Rate of contaminant flow due to retardation	2.71E-04	m/d
Ratio of Compliance Point to Source Concentration	1.00E+00	fraction
Attenuation factor (C ₀ /C ₁₀)	1.00E+00	fraction

Remedial Targets

Level 3 Remedial Target	1.03E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	1.91E+03	mg/kg	For comparison with measured soil concentration. This
	25	m	assumes Level 1 Remedial Target calculated from soil-water
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	1.00E+00	partitioning equation.
		fraction	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

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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity ax

Transverse dispersivity az

Vertical dispersivity ay

Note values of dispersivity must be > 0

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

Note

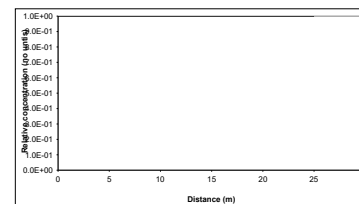
This worksheet should be used if pollutant transport and

degradation is best described by a first order reaction. If

degradation is best described by an electron limited

degradation such as oxidation by O₂, NO₃, SO₄ etc than an

alternative solution should be used



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance

Relative concentration

(No units)

0 1.0E+00

1.3 1.00E+00

2.5 1.00E+00

3.8 1.00E+00

5.0 1.00E+00

6.3 1.00E+00

7.5 1.00E+00

8.8 1.00E+00

10.0 1.00E+00

11.3 1.00E+00

12.5 1.00E+00

13.8 1.00E+00

15.0 1.00E+00

16.3 1.00E+00

17.5 1.00E+00

18.8 1.00E+00

20.0 1.00E+00

21.3 1.00E+00

22.5 1.00E+00

23.8 1.00E+00

25.0 1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	TPH - Aliphatic C10-C12		
Target Concentration (C_T)	3.00E-01	mg/l	Origin of C_T: WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C10-C12
0.3 mg/l

Input Parameters
Variable **Value** **Unit** **Source of parameter value**

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 1.30E+02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 2.50E+05 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 1.45E+04 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	4.35E+03	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aliphatic C10-C12
0.3

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median of fill areas in Zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median of fill areas in Zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value for Chester Pebble Beds

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill areas in Zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

1.03E+00

mg/l

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

or

1.49E+04

mg/kg

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C10-C12		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	3.42E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance in Zone
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	3.75E+02	l/kg see options
Longitudinal dispersivity	ax	1.863	m see options
Transverse dispersivity	az	0.186	m see options
Vertical dispersivity	ay	0.019	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	3.42E+03
Decay rate used	λ	2.25E-104 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	3.48E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	1.03E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	25	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction 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

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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

Dispersivity based on Xu & Eckstein (1995)

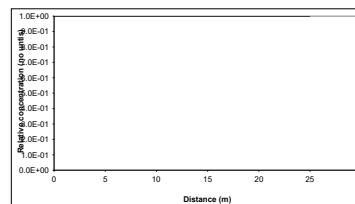
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	2.50E+00 1.86E+00 m
Transverse dispersivity	az	0.00E+00	2.50E+01 1.86E-01 m
Vertical dispersivity	ay	0.00E+00	2.50E-02 1.86E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	1.00E+00
2.5	1.00E+00
3.8	1.00E+00
5.0	1.00E+00
6.3	1.00E+00
7.5	1.00E+00
8.8	1.00E+00
10.0	1.00E+00
11.3	1.00E+00
12.5	1.00E+00
13.8	1.00E+00
15.0	1.00E+00
16.3	1.00E+00
17.5	1.00E+00
18.8	1.00E+00
20.0	1.00E+00
21.3	1.00E+00
22.5	1.00E+00
23.8	1.00E+00
25.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	TPH - Aliphatic C12-C16		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C12-C16
0.3 mg/l

Input Parameters
Variable **Value** **Unit** **Source of parameter value**

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 5.40E+02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 5.00E+06 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 2.90E+05 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	8.70E+04	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	20-Oct-22
Version:	2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aliphatic C12-C16
0.3

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Estimate based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median of fill areas in Zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median of fill areas in Zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value for Chester Pebble Beds

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill areas in Zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

1.03E+00

mg/l

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

or

2.97E+05

mg/kg

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C12-C16		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	3.42E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance in Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	7.50E+03	l/kg	see options
Longitudinal dispersivity	2.500	m	see options
Transverse dispersivity	0.250	m	see options
Vertical dispersivity	0.025	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	6.85E+04	fraction
Decay rate used	1.12E-105	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.81E-02	fraction
Rate of contaminant flow due to retardation	1.74E-06	m/d
Ratio of Compliance Point to Source Concentration	1.00E+00	fraction
Attenuation factor (C ₀ /C ₁₀)	1.00E+00	fraction

Remedial Targets

Level 3 Remedial Target	1.03E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	25	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	1.00E+00	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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 foc 1.50E-03 fraction

Organic carbon partition coefficient K_{oc} 5.00E+06 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L} l/kgSorption 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 K_d 7.50E+03 l/kg

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

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

Longitudinal dispersivity

ax 0.00E+00 2.50E+00 1.00E+00 m

Transverse dispersivity az 0.00E+00 2.50E-01 1.00E-01 m

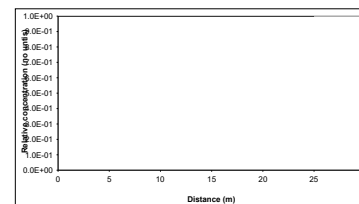
Vertical dispersivity ay 0.00E+00 2.50E-02 1.00E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
1.3	1.00E+00
2.5	1.00E+00
3.8	1.00E+00
5.0	1.00E+00
6.3	1.00E+00
7.5	1.00E+00
8.8	1.00E+00
10.0	1.00E+00
11.3	1.00E+00
12.5	1.00E+00
13.8	1.00E+00
15.0	1.00E+00
16.3	1.00E+00
17.5	1.00E+00
18.8	1.00E+00
20.0	1.00E+00
21.3	1.00E+00
22.5	1.00E+00
23.8	1.00E+00
25.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	Anthracene		
Target Concentration (C _T)	1.00E-04	mg/l	Origin of C _T : EQS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

Anthracene
0.0001 mg/l

Input Parameters

Standard entry

Water filled soil porosity
Air filled soil porosity
Bulk density of soil zone material
Henry's Law constant

Variable
Value
Unit
θ_w 3.12E-01 fraction
θ_a 1.52E-01 fraction
ρ 1.80E+00 g/cm³
H 1.81E-04 dimensionless

Source of parameter value
Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient
K_d

Value
Unit
I/kg

Source of parameter value
Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)
Organic carbon partition coefficient

Variable
Value
Unit
f_{oc} 5.80E-02 fraction
K_{oc} 5.62E+03 I/kg

Source of parameter value
Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species
Sorption coefficient for ionised species
pH value
Acid dissociation constant
Fraction of organic carbon (in soil)

Variable
Value
Unit
K_{oc,n} I/kg
K_{oc,i} I/kg
pH pH units
pK_a
f_{oc} fraction

Source of parameter value

Soil water partition coefficient used in Level Assessment
K_d 3.26E+02 I/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target 3.26E-02 mg/kg (for comparison with soil analyses)
or
0.0001 mg/l (for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T **Anthracene** from Level 1
0.0001 mg/l from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.40E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median of fill in zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median of fill in zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill in zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.44E+00

m

Calculated Parameters

Dilution Factor

DF

3.46E+00

Level 2 Remedial Target

3.46E-04

mg/l

or

1.13E-01

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Anthracene		from Level 1
Target Concentration	Ct	0.0001	mg/l	from Level 1
Dilution Factor	DF	3.46E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	4.60E+02	days	Howard, 1991
Calculated decay rate	1.51E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.44E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.78E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median of Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.73E+01	l/kg see options
Longitudinal dispersivity	ax	2.500	m see options
Transverse dispersivity	az	0.250	m see options
Vertical dispersivity	ay	0.025	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	2.50E+02	fraction
Decay rate used	6.02E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.78E-02	fraction
Rate of contaminant flow due to retardation	4.74E-04	m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	7.35E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.36E+00

Remedial Targets

Level 3 Remedial Target	4.71E-04	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.54E-01	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	25	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	7.35E-01	fraction 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

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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

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Soil water partition coefficient Kd

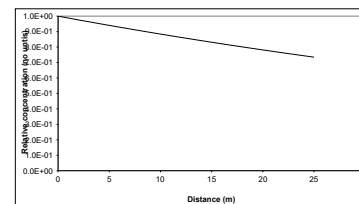
Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks	Relative concentration
From calculation sheet	(No units)
Distance	0
	1.3
	2.5
	3.8
	5.0
	6.3
	7.5
	8.8
	10.0
	11.3
	12.5
	13.8
	15.0
	16.3
	17.5
	18.8
	20.0
	21.3
	22.5
	23.8
	25.0

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9.9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	TPH - Aromatic C8-C10		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aromatic C8-C10
0.3 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 4.90E-01 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 1.60E+03 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 9.28E+01 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	2.79E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C8-C10
0.3

mg/l
from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median of fill areas in Zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median of fill areas in Zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Median of fill areas in Zone 1

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Site measurement

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

1.03E+00

mg/l

or

9.54E+01

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C8-C10		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	3.42E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	2.94E+02	days	Howard, 1991
Calculated decay rate	2.36E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median within Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.40E+00	l/kg see options
Longitudinal dispersivity	ax	2.500	m see options
Transverse dispersivity	az	0.250	m see options
Vertical dispersivity	ay	0.025	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	2.29E+01
Decay rate used	λ	1.03E-04 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	5.20E-03 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	6.23E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.60E+00

Remedial Targets

Level 3 Remedial Target	1.64E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	1.53E+02	mg/kg	For comparison with measured soil concentration. This
	25	m	assumes Level 1 Remedial Target calculated from soil-water
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	6.23E-01	partitioning equation.
			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

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_{oc,L}Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

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Soil water partition coefficient Kd

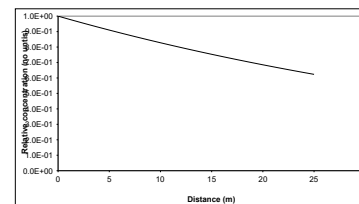
Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd

Soil water partition coefficient Kd



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
0	1.0E+00
1.3	9.77E-01
2.5	9.54E-01
3.8	9.32E-01
5.0	9.10E-01
6.3	8.89E-01
7.5	8.68E-01
8.8	8.48E-01
10.0	8.28E-01
11.3	8.08E-01
12.5	7.90E-01
13.8	7.71E-01
15.0	7.53E-01
16.3	7.36E-01
17.5	7.18E-01
18.8	7.02E-01
20.0	6.85E-01
21.3	6.69E-01
22.5	6.54E-01
23.8	6.38E-01
25.0	6.23E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	TPH - Aromatic C10-C12		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

TPH - Aromatic C10-C12
0.09 mg/l

Input Parameters
Standard entry

Variable Value Unit Source of parameter value
Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 1.40E-01 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 2.50E+03 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 1.45E+02 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	1.31E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T TPH - Aromatic C10-C12
0.09 mg/l from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Infiltration	Inf	1.44E-03	m/d	Estimated based on 60% infiltration	
Area of contaminant source	A	1.33E+03	m ²	Median of fill within Zone 1	Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	2.50E+01	m	Median of fill within Zone 1	
Saturated aquifer thickness	da	1.50E+02	m	Literature value for Chester Pebble Beds	
Hydraulic Conductivity of aquifer in which dilution occurs	K	5.70E-01	m/d	Literature value	
Hydraulic gradient of water table	i	3.40E-02	fraction	Site measurement	
Width of contaminant source perpendicular to groundwater flow	w	5.00E+01	m	Median of fill within Zone 1	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l		
		Calculate			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	4.49E+00	m		

Calculated Parameters

Dilution Factor	DF	3.42E+00		
Level 2 Remedial Target		3.08E-01 or 4.47E+01	mg/l mg/kg	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration. For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C10-C12		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.42E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	2.58E+02	days	Howard, 1991
Calculated decay rate	2.69E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance within Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	3.75E+00	l/kg see options
Longitudinal dispersivity	ax	2.500	m see options
Transverse dispersivity	az	0.250	m see options
Vertical dispersivity	ay	0.025	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	3.52E+01
Decay rate used	λ	7.62E-05 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	3.38E-03 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	5.85E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.71E+00

Remedial Targets

Level 3 Remedial Target	5.26E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	25	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	5.85E-01	fraction 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

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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

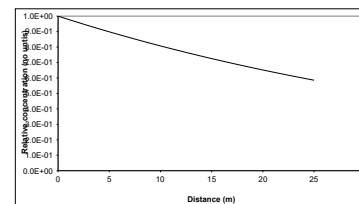
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	9.74E-01
2.5	9.48E-01
3.8	9.23E-01
5.0	8.98E-01
6.3	8.75E-01
7.5	8.52E-01
8.8	8.29E-01
10.0	8.07E-01
11.3	7.86E-01
12.5	7.65E-01
13.8	7.45E-01
15.0	7.25E-01
16.3	7.06E-01
17.5	6.88E-01
18.8	6.69E-01
20.0	6.52E-01
21.3	6.34E-01
22.5	6.18E-01
23.8	6.01E-01
25.0	5.85E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	TPH - Aromatic C12-C16		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration C_T TPH - Aromatic C12-C16
0.09 mg/l

Input Parameters Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction Calculated
Air filled soil porosity θ_a 1.52E-01 fraction Calculated
Bulk density of soil zone material ρ 1.80E+00 g/cm³ Site measurement for made ground
Henry's Law constant H 5.40E-02 dimensionless Literature value

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction Site measurement for made ground

Organic carbon partition coefficient K_{oc} 5.00E+03 l/kg Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n} l/kg

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

pH value pH units

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 2.90E+02 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	2.61E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T TPH - Aromatic C12-C16
0.09 mg/l from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.40E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median of fill areas within Zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median of fill areas within Zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill areas within Zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.44E+00

m

Calculated Parameters

Dilution Factor

DF

3.46E+00

Level 2 Remedial Target

3.11E-01

mg/l

or

9.03E+01

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C12-C16		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.46E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	1.62E+02	days	Howard, 1991
Calculated decay rate	4.28E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.44E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.78E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance within Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	7.50E+00	l/kg	see options
Longitudinal dispersivity	ax	2.500	m	see options
Transverse dispersivity	az	0.250	m	see options
Vertical dispersivity	ay	0.025	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Groundwater flow velocity	v	1.19E-01	m/d
Retardation factor	Rf	6.95E+01	fraction
Decay rate used	λ	6.16E-05	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.78E-02	fraction
Rate of contaminant flow due to retardation	u	1.71E-03	m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	4.35E-01	fraction
Attenuation factor (C ₀ /C _{CP})	AF	2.30E+00	fraction

Remedial Targets

Level 3 Remedial Target	7.16E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	2.08E+02	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	4.35E-01	fraction

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

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

Fraction of organic carbon in aquifer

Soil water partition coefficient

Kd

foc

K_{oc}K_{oc,L}K_{oc,I}

pH

pKa

foc

Kd

7.50E+00

l/kg

fraction

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

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

Longitudinal dispersivity

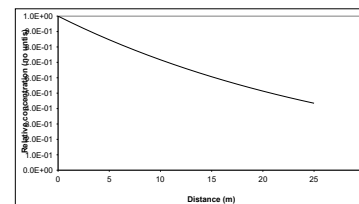
Transverse dispersivity

Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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

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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	9.59E-01
2.5	9.20E-01
3.8	8.83E-01
5.0	8.47E-01
6.3	8.12E-01
7.5	7.79E-01
8.8	7.47E-01
10.0	7.17E-01
11.3	6.87E-01
12.5	6.59E-01
13.8	6.32E-01
15.0	6.07E-01
16.3	5.82E-01
17.5	5.58E-01
18.8	5.35E-01
20.0	5.14E-01
21.3	4.93E-01
22.5	4.72E-01
23.8	4.53E-01
25.0	4.35E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	TPH - Aromatic C16-C21		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

TPH - Aromatic C16-C21
0.09 mg/l

Input Parameters
Standard entry

Water filled soil porosity
Air filled soil porosity
Bulk density of soil zone material
Henry's Law constant

Variable
θ_w
θ_a
ρ
H

Value
3.12E-01
1.52E-01
1.80E+00
1.30E-02

Unit
fraction
fraction
g/cm³
dimensionless

Source of parameter value

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

foc

fraction

Site measurement for made ground

Organic carbon partition coefficient

K_{oc}

l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

foc

fraction

Soil water partition coefficient used in Level Assessment

K_d

9.28E+02

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target
8.35E+01 mg/kg
or
0.09 mg/l

(for comparison with soil analyses)

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C16-C21
0.09

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.40E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median value for fill in Zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median value for fill in Zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median value for fill in Zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.44E+00

m

Calculated Parameters

Dilution Factor

DF

3.46E+00

Level 2 Remedial Target

3.11E-01

mg/l

or

2.89E+02

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C16-C21		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.46E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	1.31E+03	days	Howard 1991
Calculated decay rate	5.29E-04	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.44E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.78E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance in Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.40E+01	l/kg see options
Longitudinal dispersivity	ax	2.500	m see options
Transverse dispersivity	az	0.250	m see options
Vertical dispersivity	ay	0.025	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	2.20E+02
Decay rate used	λ	2.40E-06 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.78E-02
Rate of contaminant flow due to retardation	u	5.38E-04 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.95E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.12E+00

Remedial Targets

Level 3 Remedial Target	3.48E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	25	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.95E-01	fraction 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

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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

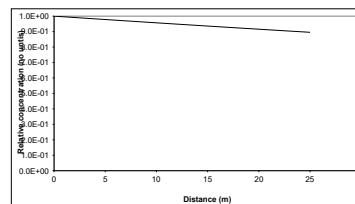
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
1.3	9.94E-01
2.5	9.89E-01
3.8	9.84E-01
5.0	9.78E-01
6.3	9.73E-01
7.5	9.67E-01
8.8	9.62E-01
10.0	9.57E-01
11.3	9.52E-01
12.5	9.46E-01
13.8	9.41E-01
15.0	9.36E-01
16.3	9.31E-01
17.5	9.26E-01
18.8	9.21E-01
20.0	9.15E-01
21.3	9.10E-01
22.5	9.05E-01
23.8	9.00E-01
25.0	8.95E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	TPH - Aromatic C21-C35		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aromatic C21-C35
0.09 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 6.80E-04 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 1.30E+05 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 7.54E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	6.79E+02	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C21-C35
0.09

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

1.40E-03
1.33E+03

m/d
m²

Estimated based on 60% infiltration
Median of fill within Zone 1

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

2.50E+01
1.50E+02
5.70E-01
3.40E-02
5.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Median of fill within Zone 1
Literature value for Chester Pebble Beds
Literature value
Site measurement
Median of fill within Zone 1

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
4.44E+00

m
m

Calculated Parameters

Dilution Factor

DF

3.46E+00

Level 2 Remedial Target

3.11E-01
or
2.35E+03

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C21-C35		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.46E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.81E+03	days	Howard, 1991
Calculated decay rate	3.82E-04	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.44E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.78E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance within zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	1.95E+02	l/kg	see options
Longitudinal dispersivity	2.500	m	see options
Transverse dispersivity	0.250	m	see options
Vertical dispersivity	0.025	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	1.78E+03	fraction
Decay rate used	2.15E-07	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.78E-02	fraction
Rate of contaminant flow due to retardation	6.65E-05	m/d
Ratio of Compliance Point to Source Concentration	9.23E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.08E+00	fraction

Remedial Targets

Level 3 Remedial Target	3.37E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	2.54E+03	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	9.23E-01	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

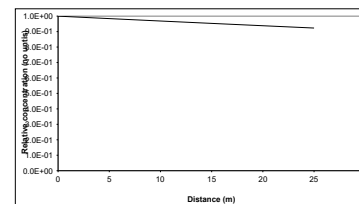
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	9.96E-01
2.5	9.92E-01
3.8	9.88E-01
5.0	9.84E-01
6.3	9.80E-01
7.5	9.76E-01
8.8	9.72E-01
10.0	9.69E-01
11.3	9.65E-01
12.5	9.61E-01
13.8	9.57E-01
15.0	9.53E-01
16.3	9.49E-01
17.5	9.46E-01
18.8	9.42E-01
20.0	9.38E-01
21.3	9.34E-01
22.5	9.31E-01
23.8	9.27E-01
25.0	9.23E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	Benzo(a)Pyrene		
Target Concentration (C _T)	1.00E-05	mg/l	Origin of C _T : Background concentration in Irk

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration C_T Benzo(a)Pyrene
0.00001 mg/l

Input Parameters Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction Calculated
Air filled soil porosity θ_a 1.52E-01 fraction Calculated
Bulk density of soil zone material ρ 1.80E+00 g/cm³ Site measurement for made ground
Henry's Law constant H 1.92E-05 dimensionless Literature value
This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction Site measurement for made ground

Organic carbon partition coefficient K_{oc} 1.30E+05 l/kg Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species $K_{oc,n}$ l/kg

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

pH value pH units

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 7.54E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target 7.54E-02 mg/kg (for comparison with soil analyses)
or
0.00001 mg/l (for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Benzo(a)Pyrene
0.00001

mg/l

from Level 1
from Level 1

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

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

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

1.44E-03

m/d

Calculated assuming 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median area of fill in zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median length of fill areas zone 1

Saturated aquifer thickness

da

1.50E+02

m

Minimum thickness of Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Geometric mean for Chester Formation

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median width of fill in zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

3.42E-05

mg/l

or

2.58E-01

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Benzo(a)Pyrene		from Level 1
Target Concentration	Ct	0.00001	mg/l	from Level 1
Dilution Factor	DF	3.42E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.29E+02	days	Howard, 1991
Calculated decay rate	2.36E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.12E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.32E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance within Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	1.95E+02	l/kg	see options
Longitudinal dispersivity	1.863	m	see options
Transverse dispersivity	0.186	m	see options
Vertical dispersivity	0.019	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.18E-01	m/d
Retardation factor	1.78E+03	fraction
Decay rate used	1.32E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.81E-02	fraction
Rate of contaminant flow due to retardation	6.62E-05	m/d
Ratio of Compliance Point to Source Concentration	6.18E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.62E+00	fraction

Remedial Targets

Level 3 Remedial Target	5.53E-05	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	4.17E-01	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	6.18E-01	fraction

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

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

K_{oc}

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species

K_{oc,L}

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

1.95E+02 l/kg

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

Dispersivity based on Xu & Eckstein (1995)

Longitudinal dispersivity

ax

0.00E+00 2.50E+00 1.86E+00 m

Transverse dispersivity

az

0.00E+00 2.50E+01 1.86E-01 m

Vertical dispersivity

ay

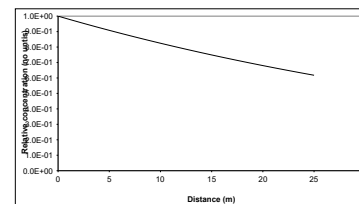
0.00E+00 2.50E-02 1.86E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	9.76E-01
2.5	9.53E-01
3.8	9.30E-01
5.0	9.08E-01
6.3	8.87E-01
7.5	8.65E-01
8.8	8.45E-01
10.0	8.25E-01
11.3	8.05E-01
12.5	7.86E-01
13.8	7.67E-01
15.0	7.49E-01
16.3	7.31E-01
17.5	7.14E-01
18.8	6.97E-01
20.0	6.80E-01
21.3	6.64E-01
22.5	6.48E-01
23.8	6.33E-01
25.0	6.18E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	Fluoranthene		
Target Concentration (C _T)	6.00E-06	mg/l	Origin of C _T : EQS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
Fluoranthene
0.000006 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ_w	3.12E-01	fraction	Calculated	This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient. The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.
Air filled soil porosity	θ_a	1.52E-01	fraction	Calculated	
Bulk density of soil zone material	ρ	1.80E+00	g/cm ³	Site measurement for made ground	
Henry's Law constant	H	6.29E-05	dimensionless	Literature value	

Entry if specify partition coefficient (option)

Soil water partition coefficient
Kd
I/kg
Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)
foc
5.80E-02
fraction
Site measurement for made ground
Organic carbon partition coefficient
Koc
1.82E+04
I/kg
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species
K_{oc,n}
I/kg
Sorption coefficient for ionised species
K_{oc,i}
I/kg
pH value
pH
pH units
Acid dissociation constant
pKa
Fraction of organic carbon (in soil)
foc
fraction

Soil water partition coefficient used in Level Assessment
Kd
1.06E+03
I/kg
Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	6.33E-03	mg/kg	(for comparison with soil analyses)
	or		
	0.000006	mg/l	(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Fluoranthene
0.000006 mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

1.40E-03
1.33E+03

m/d
m²

Estimated based on 60% infiltration
Median of fill areas in Zone 1

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

2.50E+01
1.50E+02
5.70E-01
3.40E-02
5.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Median of fill areas in Zone 1
Literature value for Chester Pebble Beds
Literature value
Site measurement
Median of fill areas in Zone 1

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
4.44E+00

m
m

Calculated Parameters

Dilution Factor

DF

3.46E+00

Level 2 Remedial Target

2.08E-05
or
2.19E-02

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	Fluoranthene		from Level 1
Target Concentration	0.000006	mg/l	from Level 1
Dilution Factor	3.46E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	2.90E+02	days	Howard, 1991
Calculated decay rate	2.39E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.44E+00	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.78E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance within Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.73E+01	l/kg see options
Longitudinal dispersivity	ax	2.500	m see options
Transverse dispersivity	az	0.250	m see options
Vertical dispersivity	ay	0.025	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	2.50E+02
Decay rate used	λ	9.55E-06 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.78E-02
Rate of contaminant flow due to retardation	u	4.74E-04 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	6.18E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.62E+00

Remedial Targets

Level 3 Remedial Target	3.36E-05	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	25	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	6.18E-01	fraction 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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

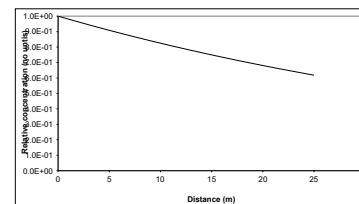
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	9.76E-01
2.5	9.53E-01
3.8	9.30E-01
5.0	9.08E-01
6.3	8.87E-01
7.5	8.66E-01
8.8	8.45E-01
10.0	8.25E-01
11.3	8.05E-01
12.5	7.86E-01
13.8	7.68E-01
15.0	7.49E-01
16.3	7.32E-01
17.5	7.14E-01
18.8	6.97E-01
20.0	6.81E-01
21.3	6.64E-01
22.5	6.49E-01
23.8	6.33E-01
25.0	6.18E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	Nickel		
Target Concentration (C_T)	0.0153	mg/l	Origin of C_T: BGS background concentration, 95%ile

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

User specified value for partition coefficient

Contaminant
Target concentration

C_T

Nickel
0.0153 mg/l

Input Parameters

Standard entry

Water filled soil porosity

θ_w

3.12E-01

fraction

Calculated

Air filled soil porosity

θ_a

1.52E-01

fraction

Calculated

Bulk density of soil zone material

ρ

1.80E+00

g/cm³

Site measurement for made ground

Henry's Law constant

H

0.00E+00

dimensionless

N/A

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

5.00E+02

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

fraction

Organic carbon partition coefficient

K_{oc}

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

5.00E+02

l/kg

Specified value

Level 1 Remedial Target

Level 1 Remedial Target

7.65E+00

mg/kg

or

0.0153

mg/l

(for comparison with soil analyses)

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works

Completed by: DH

Date: 20-Oct-22

Version: 2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T Nickel
0.0153 mg/l from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

1.40E-03
1.33E+03

m/d
m²

Estimated based on 60% infiltration
Median area of fill in Zone 1

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

2.50E+01
1.50E+02
5.70E-01
3.40E-02
5.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Median of fill in Zone 1
Literature value for Chester Pebble Beds
Literature value
Site measurement
Median of fill in Zone 1

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
4.44E+00

m
m

Calculated Parameters

Dilution Factor

DF

3.46E+00

Level 2 Remedial Target

5.29E-02
or
2.65E+01

mg/l
mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Nickel		from Level 1
Target Concentration	Ct	0.0153	mg/l	from Level 1
Dilution Factor	DF	3.46E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	t _{1/2}	9.00E+99	days
Calculated decay rate	λ	7.70E-101	days ⁻¹
Width of plume in aquifer at source	Sz	5.00E+01	m
Plume thickness in aquifer at source	Sy	4.44E+00	m
Bulk density of aquifer materials	ρ	2.10E+00	g/cm ³
Effective porosity of aquifer	n	2.30E-01	fraction
Hydraulic gradient	i	4.78E-02	fraction
Hydraulic conductivity of saturated aquifer	K	5.70E-01	m/d
Distance to compliance point	x	2.50E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	1.00E+99	days
Parameters values determined from options			
Partition coefficient	Kd	5.00E+02	l/kg
Longitudinal dispersivity	ax	2.500	m
Transverse dispersivity	az	0.250	m
Vertical dispersivity	ay	0.025	m

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	4.57E+03
Decay rate used	λ	1.69E-104 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.78E-02
Rate of contaminant flow due to retardation	u	2.60E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	5.29E-02	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	25	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction

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

Enter method of defining partition co-efficient (using pull down list)
User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.00E+02 l/kg

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_{oc,L}Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd 5.00E+02 l/kg

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

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

Longitudinal dispersivity

ax 0.00E+00 2.50E+00 1.00E+00 m

Transverse dispersivity az 0.00E+00 2.50E-01 1.00E-01 m

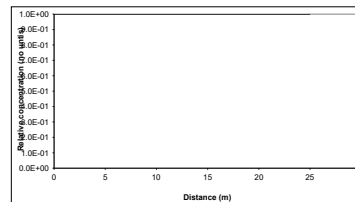
Vertical dispersivity ay 0.00E+00 2.50E-02 1.00E-02 m

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
1.3	1.00E+00
2.5	1.00E+00
3.8	1.00E+00
5.0	1.00E+00
6.3	1.00E+00
7.5	1.00E+00
8.8	1.00E+00
10.0	1.00E+00
11.3	1.00E+00
12.5	1.00E+00
13.8	1.00E+00
15.0	1.00E+00
16.3	1.00E+00
17.5	1.00E+00
18.8	1.00E+00
20.0	1.00E+00
21.3	1.00E+00
22.5	1.00E+00
23.8	1.00E+00
25.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	18-Jul-23	Version:	3
Contaminant	PFOA		
Target Concentration (C_T)	6.50E-07	mg/l	Origin of C_T : EQS for PFOS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

PFOA
0.00000065 mg/l

Input Parameters
Standard entry

Variable Value Unit
Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 3.65E-05 dimensionless

Source of parameter value
Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 9.33E+01 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 5.41E+00 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target 3.63E-06 mg/kg (for comparison with soil analyses)
or
0.00000065 mg/l (for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 18-Jul-23
Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T PFOA 0.00000065 mg/l from Level 1 from Level 1

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

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

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

1.44E-03

m/d

Calculated assuming 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median area of fill in zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median length of fill areas zone 1

Saturated aquifer thickness

da

1.50E+02

m

Minimum thickness of Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Geometric mean for Chester Formation

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median width of fill in zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

2.22E-06

mg/l

or

1.24E-05

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 18-Jul-23
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		PFOA		from Level 1
Target Concentration	Ct	0.00000065	mg/l	from Level 1
Dilution Factor	DF	3.42E+00		from Level 2

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

Ogata Banks Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.00E+99	days	None
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.12E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.32E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance within Zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.40E-01	l/kg see options
Longitudinal dispersivity	ax	1.863	m see options
Transverse dispersivity	az	0.186	m see options
Vertical dispersivity	ay	0.019	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.18E-01	m/d
Retardation factor	2.28E+00	fraction
Decay rate used	3.38E-101	g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.81E-02	fraction
Rate of contaminant flow due to retardation	5.18E-02	m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	2.22E-06	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or	1.24E-05	This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	25	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction 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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

Dispersivity based on Xu & Eckstein (1995)

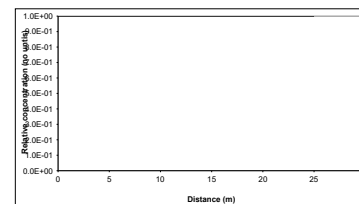
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	2.50E+00
Transverse dispersivity	az	0.00E+00	2.50E+01
Vertical dispersivity	ay	0.00E+00	2.50E-02

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	1.00E+00
2.5	1.00E+00
3.8	1.00E+00
5.0	1.00E+00
6.3	1.00E+00
7.5	1.00E+00
8.8	1.00E+00
10.0	1.00E+00
11.3	1.00E+00
12.5	1.00E+00
13.8	1.00E+00
15.0	1.00E+00
16.3	1.00E+00
17.5	1.00E+00
18.8	1.00E+00
20.0	1.00E+00
21.3	1.00E+00
22.5	1.00E+00
23.8	1.00E+00
25.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	18-Jul-23	Version:	3
Contaminant	PFOS		
Target Concentration (C_T)	6.50E-07	mg/l	Origin of C_T : EQS for PFOS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

PFOS
0.00000065 mg/l

Input Parameters
Standard entry

Variable	Value	Unit
Water filled soil porosity θ _w	3.12E-01	fraction
Air filled soil porosity θ _a	1.52E-01	fraction
Bulk density of soil zone material ρ	1.80E+00	g/cm ³
Henry's Law constant H	1.29E-07	dimensionless

Source of parameter value
Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc}

Site measurement for made ground

Organic carbon partition coefficient K_{oc}

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 3.66E+01 I/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	2.39E-05	mg/kg	(for comparison with soil analyses)
	or		
	0.00000065	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	18-Jul-23
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T PFOS 0.00000065 mg/l from Level 1 from Level 1

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

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

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

1.44E-03

m/d

Calculated assuming 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Median area of fill in zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Median length of fill areas zone 1

Saturated aquifer thickness

da

1.50E+02

m

Minimum thickness of Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Geometric mean for Chester Formation

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median width of fill in zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

2.22E-06

mg/l

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

or

8.17E-05

mg/kg

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 18-Jul-23
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	PFOS		from Level 1
Target Concentration	0.00000065	mg/l	from Level 1
Dilution Factor	3.42E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			

Half life for degradation of contaminant in water	102	9.00E+99	days	None
Calculated decay rate	λ	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	4.49E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.12E+00	g/cm ³	Site measurement
Effective porosity of aquifer	i	2.32E-01	fraction	Literature value
Hydraulic gradient	i	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	5.70E-01	m/d	from Level 2
Distance to compliance point	x	2.50E+01	m	Median distance within Zone 1
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	time variant options only
Parameters values determined from options				
Partition coefficient	Kd	9.47E-01	l/kg	see options
Longitudinal dispersivity	ax	1.863	m	see options
Transverse dispersivity	az	0.186	m	see options
Vertical dispersivity	ay	0.019	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.18E-01 m/d
Retardation factor	Rf	9.65E+00
Decay rate used	λ	7.98E-102 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	1.22E-02 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	2.22E-06	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	8.17E-05	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	25	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction

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

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

Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

Dispersivity based on Xu & Eckstein (1995)

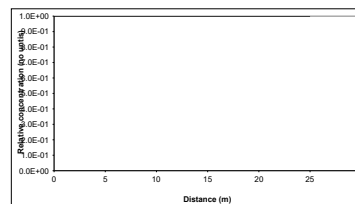
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	2.50E+00
Transverse dispersivity	az	0.00E+00	2.50E+01
Vertical dispersivity	ay	0.00E+00	2.50E-02

Note: values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
1.3	1.00E+00
2.5	1.00E+00
3.8	1.00E+00
5.0	1.00E+00
6.3	1.00E+00
7.5	1.00E+00
8.8	1.00E+00
10.0	1.00E+00
11.3	1.00E+00
12.5	1.00E+00
13.8	1.00E+00
15.0	1.00E+00
16.3	1.00E+00
17.5	1.00E+00
18.8	1.00E+00
20.0	1.00E+00
21.3	1.00E+00
22.5	1.00E+00
23.8	1.00E+00
25.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 1		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	Zinc		
Target Concentration (C_T)	0.1115	mg/l	Origin of C_T: BGS Baseline quality 95%ile

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

User specified value for partition coefficient

Contaminant
Target concentration

C_T

Zinc
0.1115 mg/l

Input Parameters

Standard entry

Water filled soil porosity

θ_w

3.12E-01

fraction

Calculated

Air filled soil porosity

θ_a

1.52E-01

fraction

Calculated

Bulk density of soil zone material

ρ

1.80E+00

g/cm³

Site measurement for made ground

Henry's Law constant

H

0.00E+00

dimensionless

N/A

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

5.01E+02

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

fraction

Organic carbon partition coefficient

K_{oc}

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

5.01E+02

l/kg

Specified value

Level 1 Remedial Target

Level 1 Remedial Target

5.59E+01

mg/kg

or

0.1115

mg/l

(for comparison with soil analyses)

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works

Completed by: DH

Date: 20-Oct-22

Version: 2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Zinc
0.1115 mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

1.33E+03

m²

Calculated median area of fill in Zone 1

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

2.50E+01

m

Calculated median length of fill in Zone 1

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Calculated median width of fill in Zone 1

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

4.49E+00

m

Calculated Parameters

Dilution Factor

DF

3.42E+00

Level 2 Remedial Target

3.81E-01

mg/l

or

1.91E+02

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Zinc		from Level 1
Target Concentration	Ct	0.1115	mg/l	from Level 1
Dilution Factor	DF	3.42E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No biodegradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	4.49E+00	m	from Level 2
Bulk density of aquifer materials	2.12E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	2.50E+01	m	Median distance for proximity zone 1
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	5.01E+02	l/kg see options
Longitudinal dispersivity	ax	1.863	m see options
Transverse dispersivity	az	0.186	m see options
Vertical dispersivity	ay	0.019	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable			
Groundwater flow velocity	v	1.19E-01	m/d
Retardation factor	Rf	4.62E+03	fraction
Decay rate used	λ	1.67E-104	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02	fraction
Rate of contaminant flow due to retardation	u	2.58E-05	m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00	fraction

Remedial Targets

Level 3 Remedial Target	3.81E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.91E+02	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	25	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction 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)
User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.01E+02 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,L} l/kgSorption coefficient for ionised species K_{oc,i} l/kg

pH value pH

Acid dissociation constant pKa fraction

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 5.01E+02 l/kg

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

Dispersivity based on Xu & Eckstein (1995)

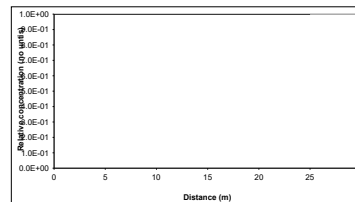
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	2.50E+01 1.86E+00 m
Transverse dispersivity	az	0.00E+00	2.50E+01 1.86E-01 m
Vertical dispersivity	ay	0.00E+00	2.50E-02 1.86E-02 m

Note: values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
1.3	1.00E+00
2.5	1.00E+00
3.8	1.00E+00
5.0	1.00E+00
6.3	1.00E+00
7.5	1.00E+00
8.8	1.00E+00
10.0	1.00E+00
11.3	1.00E+00
12.5	1.00E+00
13.8	1.00E+00
15.0	1.00E+00
16.3	1.00E+00
17.5	1.00E+00
18.8	1.00E+00
20.0	1.00E+00
21.3	1.00E+00
22.5	1.00E+00
23.8	1.00E+00
25.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	3
Contaminant	TPH - Aliphatic C8-C10		
Target Concentration (C_T)	3.00E-01	mg/l	Origin of C_T: WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C8-C10
0.3 mg/l

Input Parameters
Variable **Value** **Unit** **Source of parameter value**

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.90E+00 g/cm³
Henry's Law constant H 8.20E+01 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 3.20E+04 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n} l/kg

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

pH value pH pH units

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 1.86E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	5.59E+02	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	16-Aug-23
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T **TPH - Aliphatic C8-C10** from Level 1
0.3 mg/l from Level 1

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

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

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

1.44E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median of fill in zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median of fill in zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value for Chester Pebble Beds

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill in zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.13E+01

m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

1.02E+00

mg/l

or

1.90E+03

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 3

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		TPH - Aliphatic C8-C10		from Level 1
Target Concentration	C _T	0.3	mg/l	from Level 1
Dilution Factor	DF	3.41E+00		from Level 2

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

Ogata Banks Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

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

Entry if specify partition coefficient (option)		
Soil water partition coefficient	Kd	1.0E+01 /kg
Entry for non-polar organic chemicals (option)		
Fraction of organic carbon in aquifer	foc	1.50E-03 /fraction
Fraction of organic carbon partition coefficient	Koc	3.20E+04 /kg
Entry for ionic organic chemicals (option)		
Sorption coefficient for related species	K _{oc,n}	1.0E+01 /kg
Sorption coefficient for ionised species	K _{oc,i}	1.0E+01 /kg
pH value	pH	7.0
Acid dissociation constant	pKa	4.75
Fraction of organic carbon in aquifer	foc	1.50E-03 /fraction
Soil water partition coefficient	Kd	4.80E+01 /kg

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

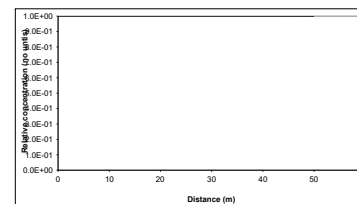
Dispersivities 10%, 1%, 0.1% of pathway length			
		Enter value	Calc value Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	2.98E+00
Transverse dispersivity	az	0.00E+00	2.98E-01
Vertical dispersivity	ay	0.00E+00	2.98E-02

Note values of dispersivity must be > 0

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

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O_2 , NO_3 , SO_4 etc than an alternative solution should be used



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Relative concentration (No units)
0	1.0E+00
2.5	1.00E+00
7.5	1.00E+00
10.0	1.00E+00
12.5	1.00E+00
15.0	1.00E+00
17.5	1.00E+00
20.0	1.00E+00
22.5	1.00E+00
25.0	1.00E+00
27.5	1.00E+00
30.0	1.00E+00
32.5	1.00E+00
35.0	1.00E+00
37.5	1.00E+00
40.0	1.00E+00
42.5	1.00E+00
45.0	1.00E+00
47.5	1.00E+00
50.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3

Remedial Targets

Remedial Targets			
Level 3 Remedial Target	1.02E+00	mg/l	For comparison with measured pore water concentration.
or			This assumes Level 1 Remedial Target is based on Target Concentration.
Ogata Banks	1.91E+03	mg/kg	For comparison with measured soil concentration. This
	50	m	assumes Level 1 Remedial Target calculated from soil-water
Distance to compliance point			partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{ED} /C _S	1.00E+00	Ogata Banks
		fraction	

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



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	3
Contaminant	TPH - Aliphatic C10-C12		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
 C_T

TPH - Aliphatic C10-C12
0.3 mg/l

Input Parameters
Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 1.30E+02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) foc 5.80E-02 fraction
Organic carbon partition coefficient Koc 2.50E+05 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species $K_{oc,n}$ l/kg
Sorption coefficient for ionised species $K_{oc,i}$ l/kg
pH value pH units
Acid dissociation constant pKa
Fraction of organic carbon (in soil) foc

Soil water partition coefficient used in Level Assessment Kd 1.45E+04 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	4.35E+03	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	16-Aug-23
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aliphatic C10-C12
0.3

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

1.44E-03
3.02E+03

m/d
m²

Based on 60% infiltration

Median of fill areas in Zone 2

Not used in calculation

Entry for groundwater flow below site

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

L
da
K
i
w
Cu

6.30E+01
1.50E+02
5.70E-01
3.40E-02
5.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Median of fill areas in Zone 2

Literature value for Chester Pebble Beds

Literature value for Chester Pebble Beds

Site measurement

Median of fill areas in Zone 2

Not used in calculation

Calculate

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

1.13E+01

m
m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

1.02E+00
or
1.48E+04

mg/l

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C10-C12		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	3.41E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.13E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Max distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	3.75E+02	l/kg see options
Longitudinal dispersivity	ax	2.984	m see options
Transverse dispersivity	az	0.298	m see options
Vertical dispersivity	ay	0.030	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	3.42E+03
Decay rate used	λ	2.25E-104 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	3.48E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	1.02E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.48E+04	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction 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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

Dispersivity based on Xu & Eckstein (1995)

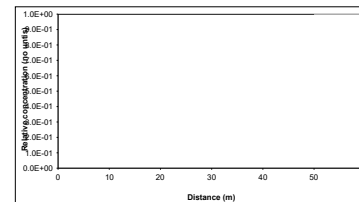
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	2.98E+00 m
Transverse dispersivity	az	0.00E+00	2.98E-01 m
Vertical dispersivity	ay	0.00E+00	2.98E-02 m

Note: values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	1.00E+00
12.5	1.00E+00
15.0	1.00E+00
17.5	1.00E+00
20.0	1.00E+00
22.5	1.00E+00
25.0	1.00E+00
27.5	1.00E+00
30.0	1.00E+00
32.5	1.00E+00
35.0	1.00E+00
37.5	1.00E+00
40.0	1.00E+00
42.5	1.00E+00
45.0	1.00E+00
47.5	1.00E+00
50.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	3
Contaminant	TPH - Aliphatic C12-C16		
Target Concentration (C_T)	3.00E-01	mg/l	Origin of C_T: WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aliphatic C12-C16
0.3 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 5.40E+02 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 5.00E+06 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 2.90E+05 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	8.70E+04	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	16-Aug-23
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T TPH - Aliphatic C12-C16
0.3 mg/l from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Infiltration	Inf	1.44E-03	m/d	Estimate based on 60% infiltration	
Area of contaminant source	A	3.02E+03	m ²	Median of fill areas in Zone 2	Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow	L	6.30E+01	m	Median of fill areas in Zone 2	
Saturated aquifer thickness	da	1.50E+02	m	Literature value for Chester Pebble Beds	
Hydraulic Conductivity of aquifer in which dilution occurs	K	5.70E-01	m/d	Literature value for Chester Pebble Beds	
Hydraulic gradient of water table	i	3.40E-02	fraction	Site measurement	
Width of contaminant source perpendicular to groundwater flow	w	5.00E+01	m	Median of fill areas in Zone 2	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l		
		Calculate			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	1.13E+01	m		

Calculated Parameters

Dilution Factor	DF	3.41E+00		
Level 2 Remedial Target		1.02E+00 or 2.97E+05	mg/l mg/kg	For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration. For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	16-Aug-23
Version:	3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aliphatic C12-C16		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	3.41E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	9.00E+99	days	No degradation assumed
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.13E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Maximum distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	7.50E+03	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	6.85E+04	fraction
Decay rate used	1.12E-105	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.81E-02	fraction
Rate of contaminant flow due to retardation	1.74E-06	m/d
Ratio of Compliance Point to Source Concentration	1.00E+00	fraction
Attenuation factor (C ₀ /C ₁₀)	1.00E+00	fraction

Remedial Targets

Level 3 Remedial Target	1.02E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or	mg/kg	This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	1.00E+00	fraction

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

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

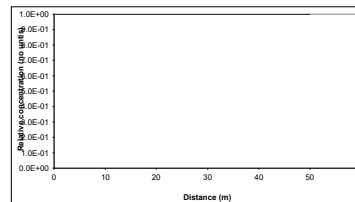
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	1.00E+00
12.5	1.00E+00
15.0	1.00E+00
17.5	1.00E+00
20.0	1.00E+00
22.5	1.00E+00
25.0	1.00E+00
27.5	1.00E+00
30.0	1.00E+00
32.5	1.00E+00
35.0	1.00E+00
37.5	1.00E+00
40.0	1.00E+00
42.5	1.00E+00
45.0	1.00E+00
47.5	1.00E+00
50.0	1.00E+00

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	3
Contaminant	Anthracene		
Target Concentration (C_T)	1.00E-04	mg/l	Origin of C_T : EQS

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

Anthracene
0.0001 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity

θ_w

3.12E-01

fraction

Calculated

Air filled soil porosity

θ_a

1.52E-01

fraction

Calculated

Bulk density of soil zone material

ρ

1.80E+00

g/cm³

Site measurement for made ground

Henry's Law constant

H

1.81E-04

dimensionless

Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

5.80E-02

fraction

Site measurement for made ground

Organic carbon partition coefficient

K_{oc}

5.62E+03

l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

3.26E+02

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target

3.26E-02

mg/kg

(for comparison with soil analyses)

or

0.0001

mg/l

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works

Completed by: DH

Date: 16-Aug-23

Version: 3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T **Anthracene** from Level 1
0.0001 mg/l from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.40E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median of fill in zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median of fill in zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill in zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.12E+01

m

Calculated Parameters

Dilution Factor

DF

3.45E+00

Level 2 Remedial Target

3.45E-04

mg/l

or

1.13E-01

mg/kg

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

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		Anthracene		from Level 1
Target Concentration	Ct	0.0001	mg/l	from Level 1
Dilution Factor	DF	3.45E+00		from Level 2

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

Ogata Banks	Equations in HRA publication
-------------	------------------------------

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			

Half life for degradation of contaminant in water	tt2	4.60E+02	days	Howard, 1991
Calculated decay rate	λ	1.51E-03	days ⁻¹	calculated
Width of plume in aquifer at source	Sz	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	1.12E+01	m	from Level 2
Bulk density of aquifer materials	ρ	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	n	2.30E-01	fraction	Literature value
Hydraulic gradient	i	4.79E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	5.70E-01	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	Maximum distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+99	days	time variant options only

Parameters values determined from options

Partition coefficient	Kd	2.73E+01	l/kg	see options
Longitudinal dispersivity	ax	5.000	m	see options
Transverse dispersivity	az	0.500	m	see options
Vertical dispersivity	ay	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable			
Groundwater flow velocity	v	1.19E-01	m/d
Retardation factor	Rf	2.50E+02	fraction
Decay rate used	λ	6.02E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.79E-02	fraction
Rate of contaminant flow due to retardation	u	4.74E-04	m/d
Ratio of Compliance Point to Source Concentration	Ccp/Cs	5.49E-01	fraction
Attenuation factor (C0/Ccp)	AF	1.82E+00	fraction

Remedial Targets

Level 3 Remedial Target	6.28E-04	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	2.05E-01	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water
Ratio of Compliance Point to Source Concentration	Ccp/Cs	5.49E-01	fraction
			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

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 Koc,n

Sorption coefficient for ionised species Koc,i

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

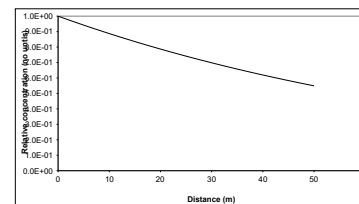
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks	
From calculation sheet	
Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	9.70E-01
5.0	9.42E-01
7.5	9.14E-01
10.0	8.87E-01
12.5	8.61E-01
15.0	8.35E-01
17.5	8.11E-01
20.0	7.87E-01
22.5	7.64E-01
25.0	7.41E-01
27.5	7.19E-01
30.0	6.98E-01
32.5	6.77E-01
35.0	6.57E-01
37.5	6.38E-01
40.0	6.19E-01
42.5	6.01E-01
45.0	5.83E-01
47.5	5.66E-01
50.0	5.49E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

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

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

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	01-Nov-22	Version:	3
Contaminant	TPH - Aromatic C8-C10		
Target Concentration (C _T)	3.00E-01	mg/l	Origin of C _T : WHO

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

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

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

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

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

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

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

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
 C_T

TPH - Aromatic C8-C10
0.3 mg/l

Input Parameters
Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 4.90E-01 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 1.60E+03 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species $K_{oc,n}$ l/kg
Sorption coefficient for ionised species $K_{oc,i}$ l/kg
pH value pH units
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 9.28E+01 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	2.79E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.3	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	01-Nov-22
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C8-C10
0.3

mg/l

from Level 1
from Level 1

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

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

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median of fill areas in Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median of fill areas in Zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill areas in Zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.13E+01

m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

1.02E+00

mg/l

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

or

9.51E+01

mg/kg

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 01-Nov-22
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C8-C10		from Level 1
Target Concentration	0.3	mg/l	from Level 1
Dilution Factor	3.41E+00		from Level 2

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

Ogata Banks

Equations in HRA publication

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

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	2.94E+02	days	Howard, 1991
Calculated decay rate	2.36E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.13E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Maximum distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	2.40E+00	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	2.29E+01
Decay rate used	λ	1.03E-04 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	5.20E-03 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	4.04E-01
Attenuation factor (C ₀ /C _{CP})	AF	2.48E+00

Remedial Targets

Level 3 Remedial Target	2.53E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	4.04E-01	fraction 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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

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

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

Longitudinal dispersivity

Transverse dispersivity

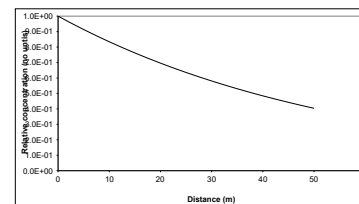
Vertical dispersivity

Note values of dispersivity must be > 0

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

Note

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



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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.56E-01
5.0	9.13E-01
7.5	8.73E-01
10.0	8.34E-01
12.5	7.97E-01
15.0	7.62E-01
17.5	7.28E-01
20.0	6.96E-01
22.5	6.65E-01
25.0	6.36E-01
27.5	6.07E-01
30.0	5.80E-01
32.5	5.55E-01
35.0	5.30E-01
37.5	5.07E-01
40.0	4.84E-01
42.5	4.63E-01
45.0	4.42E-01
47.5	4.23E-01
50.0	4.04E-01

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

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

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

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	4
Contaminant	TPH - Aromatic C10-C12		
Target Concentration (C_T)	9.00E-02	mg/l	Origin of C_T: WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T
TPH - Aromatic C10-C12
0.09 mg/l

Input Parameters
Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 1.40E-01 dimensionless

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction
Organic carbon partition coefficient K_{oc} 2.50E+03 l/kg

Site measurement for made ground
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}
Sorption coefficient for ionised species K_{oc,i}
pH value pH
Acid dissociation constant pK_a
Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 1.45E+02 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	1.31E+01	mg/kg	(for comparison with soil analyses)
	or		
	0.09	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	16-Aug-23
Version:	4

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C10-C12
0.09

mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median of fill within Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median of fill within Zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill within Zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Median of fill within Zone 2

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.13E+01

m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

3.07E-01

mg/l

or

4.45E+01

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C10-C12		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.41E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	2.58E+02	days	Howard, 1991
Calculated decay rate	2.69E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.13E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Max distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	3.75E+00	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	3.52E+01
Decay rate used	λ	7.62E-05 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	3.38E-03 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	3.60E-01
Attenuation factor (C ₀ /C _{CP})	AF	2.78E+00

Remedial Targets

Level 3 Remedial Target	8.53E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	3.60E-01	fraction 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

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 K_{oc}

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity

Transverse dispersivity

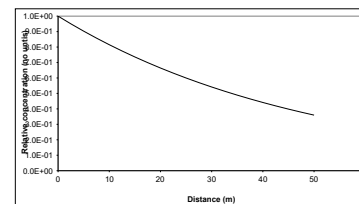
Vertical dispersivity

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log-10x)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.50E-01
5.0	9.03E-01
7.5	8.58E-01
10.0	8.15E-01
12.5	7.75E-01
15.0	7.36E-01
17.5	6.99E-01
20.0	6.64E-01
22.5	6.31E-01
25.0	6.00E-01
27.5	5.70E-01
30.0	5.42E-01
32.5	5.15E-01
35.0	4.89E-01
37.5	4.65E-01
40.0	4.41E-01
42.5	4.19E-01
45.0	3.98E-01
47.5	3.79E-01
50.0	3.60E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	4



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	4
Contaminant	TPH - Aromatic C12-C16		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

TPH - Aromatic C12-C16
0.09 mg/l

Input Parameters

Standard entry

Water filled soil porosity
Air filled soil porosity
Bulk density of soil zone material
Henry's Law constant

Variable
Value
Unit

Source of parameter value

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

foc

Site measurement for made ground

Organic carbon partition coefficient

K_{oc}

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

Sorption coefficient for ionised species

K_{oc,i}

pH value

pH

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

foc

Soil water partition coefficient used in Level Assessment
K_d 2.90E+02 I/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target 2.61E+01 mg/kg
or
0.09 mg/l
(for comparison with soil analyses)
(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C12-C16
0.09

mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.40E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median of fill areas within Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median of fill areas within Zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill areas within Zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.12E+01

m

Calculated Parameters

Dilution Factor

DF

3.45E+00

Level 2 Remedial Target

3.10E-01

mg/l

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

or

9.01E+01

mg/kg

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C12-C16		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.45E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	1.62E+02	days	Howard, 1991
Calculated decay rate	4.28E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.12E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.79E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Maximum distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	7.50E+00	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	6.95E+01	fraction
Decay rate used	6.16E-05	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.79E-02	fraction
Rate of contaminant flow due to retardation	1.71E-03	m/d
Ratio of Compliance Point to Source Concentration	2.10E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	4.76E+00	fraction

Remedial Targets

Level 3 Remedial Target	1.48E+00	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	4.29E+02	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	2.10E-01	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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

Fraction of organic carbon in aquifer

Soil water partition coefficient

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity

Transverse dispersivity

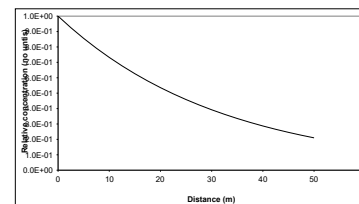
Vertical dispersivity

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	9.25E-01
5.0	8.56E-01
7.5	7.91E-01
10.0	7.32E-01
12.5	6.77E-01
15.0	6.26E-01
17.5	5.79E-01
20.0	5.36E-01
22.5	4.96E-01
25.0	4.58E-01
27.5	4.24E-01
30.0	3.92E-01
32.5	3.63E-01
35.0	3.36E-01
37.5	3.10E-01
40.0	2.87E-01
42.5	2.66E-01
45.0	2.46E-01
47.5	2.27E-01
50.0	2.10E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	4



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	4
Contaminant	TPH - Aromatic C16-C21		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

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The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

TPH - Aromatic C16-C21
0.09 mg/l

Input Parameters
Standard entry

Water filled soil porosity
Air filled soil porosity
Bulk density of soil zone material
Henry's Law constant

Variable
θ_w
θ_a
ρ
H

Value
3.12E-01
1.52E-01
1.80E+00
1.30E-02

Unit
fraction
fraction
g/cm³
dimensionless

Source of parameter value

Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

foc

fraction

Site measurement for made ground

Organic carbon partition coefficient

K_{oc}

l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

foc

fraction

Soil water partition coefficient used in Level Assessment

K_d

9.28E+02

l/kg

Calculated value

Level 1 Remedial Target

Level 1 Remedial Target
8.35E+01 mg/kg
or
0.09 mg/l

(for comparison with soil analyses)

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C16-C21
0.09

mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.40E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median value for fill in Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median value for fill in Zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median value for fill in Zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.12E+01

m

Calculated Parameters

Dilution Factor

DF

3.45E+00

Level 2 Remedial Target

3.10E-01

mg/l

or

2.88E+02

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C16-C21		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.45E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	1.31E+03	days	Howard, 1991
Calculated decay rate	5.29E-04	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.12E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.79E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Max distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Partition coefficient	2.40E+01	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	2.20E+02	fraction
Decay rate used	2.40E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.79E-02	fraction
Rate of contaminant flow due to retardation	5.39E-04	m/d
Ratio of Compliance Point to Source Concentration	8.04E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	1.24E+00	fraction

Remedial Targets

Level 3 Remedial Target	3.86E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	3.99E+02	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	8.04E-01	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity

Transverse dispersivity

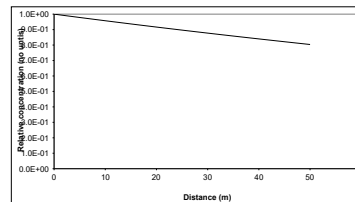
Vertical dispersivity

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	9.89E-01
5.0	9.78E-01
7.5	9.68E-01
10.0	9.57E-01
12.5	9.47E-01
15.0	9.37E-01
17.5	9.26E-01
20.0	9.16E-01
22.5	9.06E-01
25.0	8.97E-01
27.5	8.87E-01
30.0	8.77E-01
32.5	8.68E-01
35.0	8.58E-01
37.5	8.49E-01
40.0	8.40E-01
42.5	8.31E-01
45.0	8.22E-01
47.5	8.13E-01
50.0	8.04E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	4



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

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Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	4
Contaminant	TPH - Aromatic C21-C35		
Target Concentration (C _T)	9.00E-02	mg/l	Origin of C _T : WHO

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

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Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration C_T TPH - Aromatic C21-C35
0.09 mg/l

Input Parameters Variable Value Unit Source of parameter value

Standard entry

Water filled soil porosity θ_w 3.12E-01 fraction Calculated
Air filled soil porosity θ_a 1.52E-01 fraction Calculated
Bulk density of soil zone material ρ 1.80E+00 g/cm³ Site measurement for made ground
Henry's Law constant H 6.80E-04 dimensionless Literature value

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction Site measurement for made ground

Organic carbon partition coefficient K_{oc} 1.30E+05 l/kg Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n} l/kg

Sorption coefficient for ionised species K_{oc,i} l/kg

pH value pH units

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc} fraction

Soil water partition coefficient used in Level Assessment K_d 7.54E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target 6.79E+02 mg/kg (for comparison with soil analyses)
or
0.09 mg/l (for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

TPH - Aromatic C21-C35
0.09

mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

1.40E-03
3.02E+03

m/d
m²

Estimated based on 60% infiltration
Median of fill within Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow
Saturated aquifer thickness
Hydraulic Conductivity of aquifer in which dilution occurs
Hydraulic gradient of water table
Width of contaminant source perpendicular to groundwater flow
Background concentration of contaminant in groundwater beneath site

L
da
K
i
w
Cu

6.30E+01
1.50E+02
5.70E-01
3.40E-02
5.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Median of fill within Zone
Literature value for Chester Pebble Beds
Literature value
Site measurement
Median of fill within Zone 2

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
1.12E+01

m
m

Calculated Parameters

Dilution Factor

DF

3.45E+00

Level 2 Remedial Target

3.10E-01
or
2.34E+03

mg/l
mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters

Variable	Value	Unit	Source
Contaminant	TPH - Aromatic C21-C35		from Level 1
Target Concentration	0.09	mg/l	from Level 1
Dilution Factor	3.45E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	1.81E+03	days	Howard, 1991
Calculated decay rate	3.82E-04	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.12E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.79E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Maximum distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	1.95E+02	l/kg see options
Longitudinal dispersivity	ax	5.000	m see options
Transverse dispersivity	az	0.500	m see options
Vertical dispersivity	ay	0.050	m see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	1.78E+03
Decay rate used	λ	2.15E-07 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.79E-02
Rate of contaminant flow due to retardation	u	6.66E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.53E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.17E+00

Remedial Targets

Level 3 Remedial Target	3.64E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	2.74E+03	mg/kg	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	8.53E-01	fraction 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

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity

Transverse dispersivity

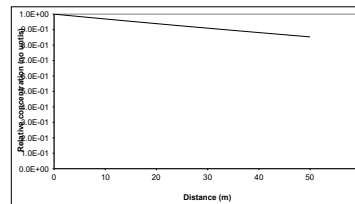
Vertical dispersivity

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	9.92E-01
5.0	9.84E-01
7.5	9.76E-01
10.0	9.69E-01
12.5	9.61E-01
15.0	9.54E-01
17.5	9.46E-01
20.0	9.39E-01
22.5	9.31E-01
25.0	9.24E-01
27.5	9.16E-01
30.0	9.09E-01
32.5	9.02E-01
35.0	8.95E-01
37.5	8.88E-01
40.0	8.81E-01
42.5	8.74E-01
45.0	8.67E-01
47.5	8.60E-01
50.0	8.53E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	4



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	4
Contaminant	Benzo(a)Pyrene		
Target Concentration (C_T)	1.00E-05	mg/l	Origin of C_T: Background concentration in Irk

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
Benzo(a)Pyrene
0.00001 mg/l

Input Parameters

Standard entry

Water filled soil porosity	θ_w	3.12E-01	fraction	Calculated	This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient. The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.
Air filled soil porosity	θ_a	1.52E-01	fraction	Calculated	
Bulk density of soil zone material	ρ	1.80E+00	g/cm ³	Site measurement for made ground	
Henry's Law constant	H	1.92E-05	dimensionless	Literature value	

Entry if specify partition coefficient (option)

Soil water partition coefficient
Kd
I/kg
Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)
foc
5.80E-02
fraction
Site measurement for made ground
Organic carbon partition coefficient
Koc
1.30E+05
I/kg
Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species
K_{oc,n}
I/kg
Sorption coefficient for ionised species
K_{oc,i}
I/kg
pH value
pH
pH units
Acid dissociation constant
pKa
Fraction of organic carbon (in soil)
foc
fraction

Soil water partition coefficient used in Level Assessment
Kd
7.54E+03
I/kg
Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	7.54E-02	mg/kg	(for comparison with soil analyses)
	or		
	0.00001	mg/l	(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

Benzo(a)Pyrene
0.00001 mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

1.44E-03

m/d

Calculated assuming 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median area of fill in zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median length of fill areas zone 2

Saturated aquifer thickness

da

1.50E+02

m

Minimum thickness of Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Geometric mean for Chester Formation

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median width of fill in zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.13E+01

m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

3.41E-05

mg/l

or

2.57E-01

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	Benzo(a)Pyrene		from Level 1
Target Concentration	0.00001	mg/l	from Level 1
Dilution Factor	3.41E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	2.94E+02	days	Howard 1991
Calculated decay rate	2.36E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.13E+01	m	from Level 2
Bulk density of aquifer materials	2.12E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.32E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Maximum distance for haz substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Partition coefficient	1.95E+02	l/kg	see options
Longitudinal dispersivity	2.984	m	see options
Transverse dispersivity	0.298	m	see options
Vertical dispersivity	0.030	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.18E-01	m/d
Retardation factor	1.78E+03	fraction
Decay rate used	1.32E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.81E-02	fraction
Rate of contaminant flow due to retardation	6.63E-05	m/d
Ratio of Compliance Point to Source Concentration	3.89E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	2.57E+00	fraction

Remedial Targets

Level 3 Remedial Target	8.76E-05	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or	mg/kg	This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	3.89E-01	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for 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 1.50E-03 fraction

Organic carbon partition coefficient Koc 1.30E+05 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L} l/kgSorption coefficient for ionised species K_{oc,I} l/kg

pH value pH pKa

Acid dissociation constant foc fraction

Fraction of organic carbon in aquifer Kd 1.95E+02 l/kg

Soil water partition coefficient

Define dispersivity (click brown cell and use pull down list)

Dispersivity based on Xu & Eckstein (1995)

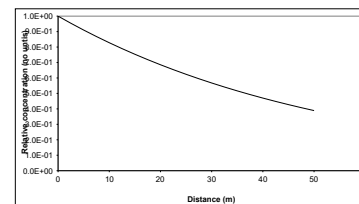
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax 0.00E+00	0.00E+00	2.98E+00 m
Transverse dispersivity	az 0.00E+00	0.00E+01	2.98E-01 m
Vertical dispersivity	ay 0.00E+00	0.00E-02	2.98E-02 m

Note: values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log-10x)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	9.54E-01
5.0	9.10E-01
7.5	8.68E-01
10.0	8.28E-01
12.5	7.90E-01
15.0	7.53E-01
17.5	7.19E-01
20.0	6.85E-01
22.5	6.54E-01
25.0	6.24E-01
27.5	5.95E-01
30.0	5.68E-01
32.5	5.41E-01
35.0	5.16E-01
37.5	4.93E-01
40.0	4.70E-01
42.5	4.48E-01
45.0	4.28E-01
47.5	4.08E-01
50.0	3.89E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	4



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	16-Aug-23	Version:	4
Contaminant	Fluoranthene		
Target Concentration (C_T)	6.00E-06	mg/l	Origin of C_T : EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

Fluoranthene
0.000006 mg/l

Input Parameters
Standard entry

Variable Value Unit
Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 6.29E-05 dimensionless

Source of parameter value
Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 1.82E+04 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 1.06E+03 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target 6.33E-03 mg/kg (for comparison with soil analyses)
or
0.000006 mg/l (for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Fluoranthene
0.000006 mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration
Area of contaminant source

Inf
A

1.40E-03
3.02E+03

m/d
m²

Estimated based on 60% infiltration
Median of fill areas in Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow
Saturated aquifer thickness
Hydraulic Conductivity of aquifer in which dilution occurs
Hydraulic gradient of water table
Width of contaminant source perpendicular to groundwater flow
Background concentration of contaminant in groundwater beneath site

L
da
K
i
w
Cu

6.30E+01
1.50E+02
5.70E-01
3.40E-02
5.00E+01
0.00E+00

m
m
m/d
fraction
m
mg/l

Median of fill areas in Zone 2
Literature value for Chester Pebble Beds
Literature value
Site measurement
Median of fill areas in Zone 2

Not used in calculation

Enter mixing zone thickness
Calculated mixing zone thickness

Mz
Mz

Calculate
1.12E+01

m
m

Calculated Parameters

Dilution Factor

DF

3.45E+00

Level 2 Remedial Target

2.07E-05
or
2.19E-02

mg/l
mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 16-Aug-23
Version: 4

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	Fluoranthene		from Level 1
Target Concentration	0.000006	mg/l	from Level 1
Dilution Factor	3.45E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	2.90E+02	days	Pubchem
Calculated decay rate	2.39E-03	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.12E+01	m	from Level 2
Bulk density of aquifer materials	2.10E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.30E-01	fraction	Literature value
Hydraulic gradient	4.79E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Maximum distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	2.73E+01	l/kg	see options
Longitudinal dispersivity	5.000	m	see options
Transverse dispersivity	0.500	m	see options
Vertical dispersivity	0.050	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.19E-01	m/d
Retardation factor	2.50E+02	fraction
Decay rate used	9.55E-06	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.79E-02	fraction
Rate of contaminant flow due to retardation	4.74E-04	m/d
Ratio of Compliance Point to Source Concentration	3.97E-01	fraction
Attenuation factor (C ₀ /C ₁₀)	2.52E+00	fraction

Remedial Targets

Level 3 Remedial Target	5.21E-05	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	5.00E-02	mg/kg	For comparison with measured soil concentration. This
Ratio of Compliance Point to Source Concentration	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C ₀ /C ₀	3.97E-01	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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

Fraction of organic carbon in aquifer

Soil water partition coefficient

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity

Transverse dispersivity

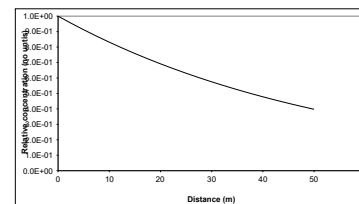
Vertical dispersivity

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	9.55E-01
5.0	9.12E-01
7.5	8.71E-01
10.0	8.32E-01
12.5	7.94E-01
15.0	7.58E-01
17.5	7.24E-01
20.0	6.92E-01
22.5	6.60E-01
25.0	6.31E-01
27.5	6.02E-01
30.0	5.75E-01
32.5	5.49E-01
35.0	5.24E-01
37.5	5.01E-01
40.0	4.78E-01
42.5	4.57E-01
45.0	4.36E-01
47.5	4.16E-01
50.0	3.97E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	4



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	Nickel		
Target Concentration (C_T)	0.0153	mg/l	Origin of C_T: BGS background concentration, 95%ile

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

User specified value for partition coefficient

Contaminant
Target concentration

C_T

Nickel
0.0153 mg/l

Input Parameters

Standard entry

Water filled soil porosity

θ_w

3.12E-01

fraction

Calculated

Air filled soil porosity

θ_a

1.52E-01

fraction

Calculated

Bulk density of soil zone material

ρ

1.80E+00

g/cm³

Site measurement for made ground

Henry's Law constant

H

0.00E+00

dimensionless

N/A

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

5.00E+02

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

fraction

Organic carbon partition coefficient

K_{oc}

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

5.00E+02

l/kg

Specified value

Level 1 Remedial Target

Level 1 Remedial Target

7.65E+00

mg/kg

or

0.0153

mg/l

(for comparison with soil analyses)

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works

Completed by: DH

Date: 20-Oct-22

Version: 2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Nickel
0.0153 mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.40E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median area of fill in Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median of fill in Zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median of fill in Zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.12E+01

m

Calculated Parameters

Dilution Factor

DF

3.45E+00

Level 2 Remedial Target

5.28E-02

mg/l

or

2.64E+01

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Nickel		from Level 1
Target Concentration	Ct	0.0153	mg/l	from Level 1
Dilution Factor	DF	3.45E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks	Equations in HRA publication
-------------	------------------------------

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	t _{1/2}	9.00E+99	days
Calculated decay rate	λ	7.70E-101	days ⁻¹
Width of plume in aquifer at source	Sz	5.00E+01	m
Plume thickness in aquifer at source	Sy	1.12E+01	m
Bulk density of aquifer materials	ρ	2.10E+00	g/cm ³
Effective porosity of aquifer	n	2.30E-01	fraction
Hydraulic gradient	i	4.79E-02	fraction
Hydraulic conductivity of saturated aquifer	K	5.70E-01	m/d
Distance to compliance point	x	9.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	1.00E+99	days
Parameters values determined from options			
Partition coefficient	Kd	5.00E+02	l/kg
Longitudinal dispersivity	ax	9.000	m
Transverse dispersivity	az	0.900	m
Vertical dispersivity	ay	0.090	m

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	4.57E+03
Decay rate used	λ	1.69E-104 d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.79E-02
Rate of contaminant flow due to retardation	u	2.60E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	9.45E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.06E+00

Remedial Targets

Level 3 Remedial Target	5.58E-02	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	2.79E+01	mg/kg	For comparison with measured soil concentration. This
	90	m	assumes Level 1 Remedial Target calculated from soil-water
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	9.45E-01	partitioning equation.
		fraction	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)
User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.00E+02 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,L} l/kgSorption coefficient for ionised species K_{oc,I} l/kg

pH value pH

Acid dissociation constant pKa fraction

Fraction of organic carbon in aquifer foc fraction

Soil water partition coefficient Kd 5.00E+02 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

Longitudinal dispersivity

ax 0.00E+00 9.00E+00 4.18E+00 m

Transverse dispersivity az 0.00E+00 9.00E-01 4.18E-01 m

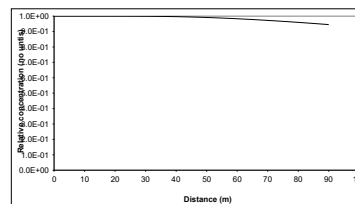
Vertical dispersivity ay 0.00E+00 9.00E-02 4.18E-02 m

Note values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log₁₀x)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
4.5	1.00E+00
9.0	1.00E+00
13.5	1.00E+00
18.0	1.00E+00
22.5	1.00E+00
27.0	1.00E+00
31.5	9.99E-01
36.0	9.98E-01
40.5	9.97E-01
45.0	9.94E-01
49.5	9.92E-01
54.0	9.88E-01
58.5	9.85E-01
63.0	9.80E-01
67.5	9.75E-01
72.0	9.70E-01
76.5	9.64E-01
81.0	9.58E-01
85.5	9.52E-01
90.0	9.45E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	18-Jul-23	Version:	3
Contaminant	PFOA		
Target Concentration (C_T)	6.50E-07	mg/l	Origin of C_T: EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

PFOA
0.00000065 mg/l

Input Parameters
Standard entry

Variable Value Unit
Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 3.63E-05 dimensionless

Source of parameter value
Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 9.33E+01 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 5.41E+00 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	3.63E-06	mg/kg	(for comparison with soil analyses)
	or		
	0.00000065	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	18-Jul-23
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T PFOA
0.00000065 mg/l from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

1.44E-03

m/d

Calculated assuming 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median area of fill in zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median length of fill areas zone 2

Saturated aquifer thickness

da

1.50E+02

m

Minimum thickness of Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Geometric mean for Chester Formation

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median width of fill in zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.13E+01

m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

2.22E-06

mg/l

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

or

1.24E-05

mg/kg

For comparison with measured soil concentration. This assumes Level 1

Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 18-Jul-23
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters

Variable	Value	Unit	Source
Contaminant	PFOA		from Level 1
Target Concentration	0.00000065	mg/l	from Level 1
Dilution Factor	3.41E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks

Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Determine remedial target based on assumed concentration

Variable	Value	Unit	Source of parameter value
Half life for degradation of contaminant in water	9.00E+99	days	None
Calculated decay rate	7.70E-101	days ⁻¹	calculated
Width of plume in aquifer at source	5.00E+01	m	from Level 2
Plume thickness in aquifer at source	1.13E+01	m	from Level 2
Bulk density of aquifer materials	2.12E+00	g/cm ³	Site measurement
Effective porosity of aquifer	2.32E-01	fraction	Literature value
Hydraulic gradient	4.81E-02	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	5.70E-01	m/d	from Level 2
Distance to compliance point	5.00E+01	m	Maximum distance for hazardous substances
Distance (lateral) to compliance point perpendicular to flow direction		m	
Distance (depth) to compliance point perpendicular to flow direction		m	
Time since pollutant entered groundwater	1.00E+99	days	time variant options only
Parameters values determined from options			
Partition coefficient	Kd	l/kg	see options
Longitudinal dispersivity	ax	m	see options
Transverse dispersivity	az	m	see options
Vertical dispersivity	ay	m	see options

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	1.18E-01	m/d
Retardation factor	2.28E+00	fraction
Decay rate used	3.38E-101	d ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	4.81E-02	fraction
Rate of contaminant flow due to retardation	5.19E-02	m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	fraction
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	2.22E-06	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or	1.24E-05	This assumes Level 1 Remedial Target is based on Target Concentration.
Distance to compliance point	50	m	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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 1.50E-03 fraction

Organic carbon partition coefficient Koc 9.33E+01 l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species K_{oc,L} l/kgSorption coefficient for ionised species K_{oc,I} l/kg

pH value pH pKa

Acid dissociation constant foc fraction

Fraction of organic carbon in aquifer Kd 1.40E-01 l/kg

Soil water partition coefficient

Define dispersivity (click brown cell and use pull down list)

Dispersivity based on Xu & Eckstein (1995)

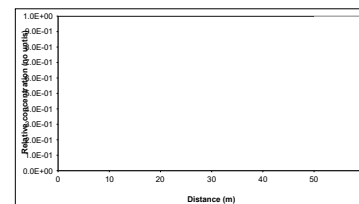
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	0.00E+00
Transverse dispersivity	az	0.00E+00	0.00E+01
Vertical dispersivity	ay	0.00E+00	0.00E-02

Note: values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration (No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	1.00E+00
12.5	1.00E+00
15.0	1.00E+00
17.5	1.00E+00
20.0	1.00E+00
22.5	1.00E+00
25.0	1.00E+00
27.5	1.00E+00
30.0	1.00E+00
32.5	1.00E+00
35.0	1.00E+00
37.5	1.00E+00
40.0	1.00E+00
42.5	1.00E+00
45.0	1.00E+00
47.5	1.00E+00
50.0	1.00E+00

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	18-Jul-23	Version:	3
Contaminant	PFOS		
Target Concentration (C_T)	6.50E-07	mg/l	Origin of C_T: EQS

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

Calculate for non-polar organic chemicals

Contaminant
Target concentration
C_T

PFOS
0.00000065 mg/l

Input Parameters
Standard entry

Variable Value Unit
Water filled soil porosity θ_w 3.12E-01 fraction
Air filled soil porosity θ_a 1.52E-01 fraction
Bulk density of soil zone material ρ 1.80E+00 g/cm³
Henry's Law constant H 1.29E-07 dimensionless

Source of parameter value
Calculated
Calculated
Site measurement for made ground
Literature value

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.
The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Entry if specify partition coefficient (option)

Soil water partition coefficient K_d

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil) f_{oc} 5.80E-02 fraction

Site measurement for made ground

Organic carbon partition coefficient K_{oc} 6.13E+02 l/kg

Literature value

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species K_{oc,n}

Sorption coefficient for ionised species K_{oc,i}

pH value pH

Acid dissociation constant pK_a

Fraction of organic carbon (in soil) f_{oc}

Soil water partition coefficient used in Level Assessment K_d 3.56E+01 l/kg Calculated value

Level 1 Remedial Target

Level 1 Remedial Target	2.32E-05	mg/kg	(for comparison with soil analyses)
	or		
	0.00000065	mg/l	(for comparison with leachate test results)

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	18-Jul-23
Version:	3

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T PFOS 0.00000065 mg/l from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Standard entry

Input Parameters

Variable

Value

Unit

Source of parameter value

Infiltration

Inf

1.44E-03

m/d

Calculated assuming 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Median area of fill in zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Median length of fill areas zone 2

Saturated aquifer thickness

da

1.50E+02

m

Minimum thickness of Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Geometric mean for Chester Formation

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Median width of fill in zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.13E+01

m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

2.22E-06

mg/l

or

7.92E-05

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 18-Jul-23
Version: 3

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note



Input Parameters	Variable	Value	Unit	Source
Contaminant		PFOS		from Level 1
Target Concentration	Ct	0.00000065	mg/l	from Level 1
Dilution Factor	DF	3.41E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks Equations in HRA publication

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	t _{1/2}	9.00E+99	days
Calculated decay rate	λ	7.70E-101	days ⁻¹
Width of plume in aquifer at source	Sz	5.00E+01	m
Plume thickness in aquifer at source	Sy	1.13E+01	m
Bulk density of aquifer materials	ρ	2.12E+00	g/cm ³
Effective porosity of aquifer	i	2.32E-01	fraction
Hydraulic gradient	K	4.81E-02	fraction
Hydraulic conductivity of saturated aquifer	K	5.70E-01	m/d
Distance to compliance point	x	5.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	1.00E+99	days
Parameters values determined from options			
Partition coefficient	Kd	9.47E-01	l/kg
Longitudinal dispersivity	ax	2.984	m
Transverse dispersivity	az	0.298	m
Vertical dispersivity	ay	0.030	m

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.18E-01 m/d
Retardation factor	Rf	9.65E+00
Decay rate used	λ	7.98E-102 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	1.23E-02 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	2.22E-06	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	7.92E-05	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	50	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	1.00E+00	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)
Calculate for 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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd

Define dispersivity (click brown cell and use pull down list)

Dispersivity based on Xu & Eckstein (1995)

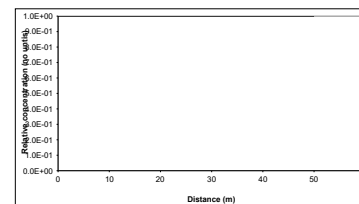
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	2.98E+00
Transverse dispersivity	az	0.00E+00	2.98E-01
Vertical dispersivity	ay	0.00E+00	2.98E-02

Note: values of dispersivity must be > 0

Xu & Eckstein (1995) report $ax = 0.83(\log_{10}x)^{2.414}$; $az = ax/10$, $ay = ax/100$ are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
2.5	1.00E+00
5.0	1.00E+00
7.5	1.00E+00
10.0	1.00E+00
12.5	1.00E+00
15.0	1.00E+00
17.5	1.00E+00
20.0	1.00E+00
22.5	1.00E+00
25.0	1.00E+00
27.5	1.00E+00
30.0	1.00E+00
32.5	1.00E+00
35.0	1.00E+00
37.5	1.00E+00
40.0	1.00E+00
42.5	1.00E+00
45.0	1.00E+00
47.5	1.00E+00
50.0	1.00E+00

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	3



Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.2

First released: 2006. Version 3.2: January 2013

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment

Site Name:	Victoria North HIF Infrastructure Works		
Site Address:	Re-use of fill in Zone 2		
Completed by:	DH		
Date:	20-Oct-22	Version:	2
Contaminant	Zinc		
Target Concentration (C_T)	0.1115	mg/l	Origin of C_T: BGS Baseline quality 95%ile

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparison with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).

Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.

Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.

Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.

Data carried forward from an earlier worksheet are identified by a light green background

It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil



Select the method of calculating the soil water
Partition Co-efficient by using the pull down menu
below

User specified value for partition coefficient

Contaminant
Target concentration

C_T

Zinc
0.1115 mg/l

Input Parameters

Standard entry

Water filled soil porosity

θ_w

3.12E-01

fraction

Calculated

Air filled soil porosity

θ_a

1.52E-01

fraction

Calculated

Bulk density of soil zone material

ρ

1.80E+00

g/cm³

Site measurement for made ground

Henry's Law constant

H

0.00E+00

dimensionless

N/A

Entry if specify partition coefficient (option)

Soil water partition coefficient

K_d

5.01E+02

l/kg

Literature value

Entry for non-polar organic chemicals (option)

Fraction of organic carbon (in soil)

f_{oc}

fraction

Organic carbon partition coefficient

K_{oc}

l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for neutral species

K_{oc,n}

l/kg

Sorption coefficient for ionised species

K_{oc,i}

l/kg

pH value

pH

pH units

Acid dissociation constant

pK_a

Fraction of organic carbon (in soil)

f_{oc}

fraction

Soil water partition coefficient used in Level Assessment

K_d

5.01E+02

l/kg

Specified value

Level 1 Remedial Target

Level 1 Remedial Target

5.59E+01

mg/kg

(for comparison with soil analyses)

or

0.1115

mg/l

(for comparison with leachate test results)

Site being assessed: Victoria North HIF Infrastructure Works

Completed by: DH

Date: 20-Oct-22

Version: 2

Remedial Targets Worksheet , Release 3.2



Level 2 - Soil

Contaminant
Target concentration

C_T

Zinc
0.1115 mg/l

from Level 1
from Level 1

This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamination' (Environment Agency 2006)

Source of parameter value

Standard entry

Input Parameters

Variable

Value

Unit

Infiltration

Inf

1.44E-03

m/d

Estimated based on 60% infiltration

Area of contaminant source

A

3.02E+03

m²

Calculated median area of fill in Zone 2

Not used in calculation

Entry for groundwater flow below site

Length of contaminant source in direction of groundwater flow

L

6.30E+01

m

Calculated median length of fill in Zone 2

Saturated aquifer thickness

da

1.50E+02

m

Literature value for Chester Pebble Beds

Hydraulic Conductivity of aquifer in which dilution occurs

K

5.70E-01

m/d

Literature value

Hydraulic gradient of water table

i

3.40E-02

fraction

Site measurement

Width of contaminant source perpendicular to groundwater flow

w

5.00E+01

m

Calculated median width of fill in Zone 2

Not used in calculation

Background concentration of contaminant in groundwater beneath site

Cu

0.00E+00

mg/l

Calculate

Enter mixing zone thickness

Mz

m

Calculated mixing zone thickness

Mz

1.13E+01

m

Calculated Parameters

Dilution Factor

DF

3.41E+00

Level 2 Remedial Target

3.80E-01

mg/l

or

1.91E+02

mg/kg

For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentration.

For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)

Cc

0.00E+00

mg/l

Calculated concentration within receptor (dilution only)

0.00E+00

mg/l

0

Site being assessed: Victoria North HIF Infrastructure Works
Completed by: DH
Date: 20-Oct-22
Version: 2

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Zinc		from Level 1
Target Concentration	Ct	0.1115	mg/l	from Level 1
Dilution Factor	DF	3.41E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks	Equations in HRA publication
-------------	------------------------------

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants:

Apply degradation rate to dissolved pollutants only

Enter source concentration

Variable	Value	Unit	Source of parameter value
Determine remedial target based on assumed concentration			
Half life for degradation of contaminant in water	t _{1/2}	9.00E+99	days
Calculated decay rate	λ	7.70E-101	days ⁻¹
Width of plume in aquifer at source	Sz	5.00E+01	m
Plume thickness in aquifer at source	Sy	1.13E+01	m
Bulk density of aquifer materials	ρ	2.12E+00	g/cm ³
Effective porosity of aquifer	i	2.30E-01	fraction
Hydraulic gradient	K	4.81E-02	fraction
Hydraulic conductivity of saturated aquifer	K	5.70E-01	m/d
Distance to compliance point	x	9.00E+01	m
Distance (lateral) to compliance point perpendicular to flow direction	z		m
Distance (depth) to compliance point perpendicular to flow direction	y		m
Time since pollutant entered groundwater	t	1.00E+99	days
Parameters values determined from options			
Partition coefficient	Kd	5.01E+02	l/kg
Longitudinal dispersivity	ax	4.183	m
Transverse dispersivity	az	0.418	m
Vertical dispersivity	ay	0.042	m

Parameter values should be checked against Level 1 and 2

Calculated Parameters

Variable	Value	Unit
Groundwater flow velocity	v	1.19E-01 m/d
Retardation factor	Rf	4.62E+03
Decay rate used	λ	1.67E-104 g ⁻¹
Hydraulic gradient used in aquifer flow down-gradient	i	4.81E-02
Rate of contaminant flow due to retardation	u	2.58E-05 m/d
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	9.96E-01
Attenuation factor (C ₀ /C _{CP})	AF	1.00E+00

Remedial Targets

Level 3 Remedial Target	3.62E-01	mg/l	For comparison with measured pore water concentration.
Ogata Banks	or		This assumes Level 1 Remedial Target is based on Target Concentration.
	1.91E+02	mg/kg	For comparison with measured soil concentration. This
Distance to compliance point	90	m	assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Ratio of Compliance Point to Source Concentration	C _{CP} /C ₀	9.96E-01	fraction

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

User specified value for partition coefficient

Entry if specify partition coefficient (option)

Soil water partition coefficient Kd 5.01E+02 l/kg

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_{oc,L}Sorption coefficient for ionised species K_{oc,I}

pH value pH

Acid dissociation constant pKa

Fraction of organic carbon in aquifer foc

Soil water partition coefficient Kd 5.01E+02 l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivity based on Xu & Eckstein (1995)

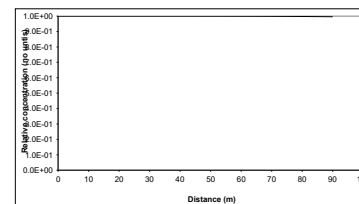
	Enter value	Calc value	Xu & Eckstein
Longitudinal dispersivity	ax	0.00E+00	0.00E+00
Transverse dispersivity	az	0.00E+00	0.00E+01
Vertical dispersivity	ay	0.00E+00	0.00E-02

Note: values of dispersivity must be > 0

Xu & Eckstein (1995) report ax = 0.83(log-ux)^{2.414}; az = ax/10, ay = ax/100 are assumed

Note

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best described by an electron limited degradation such as oxidation by O₂, NO₃, SO₄ etc than an alternative solution should be used



Note: 'Relative concentration' is the ratio of calculated concentration at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks

From calculation sheet

Distance	Relative concentration
	(No units)
0	1.0E+00
4.5	1.00E+00
9.0	1.00E+00
13.5	1.00E+00
18.0	1.00E+00
22.5	1.00E+00
27.0	1.00E+00
31.5	1.00E+00
36.0	1.00E+00
40.5	1.00E+00
45.0	1.00E+00
49.5	1.00E+00
54.0	1.00E+00
58.5	1.00E+00
63.0	9.99E-01
67.5	9.99E-01
72.0	9.99E-01
76.5	9.98E-01
81.0	9.98E-01
85.5	9.97E-01
90.0	9.96E-01

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source. Three solution methods are included, the preferred option is Ogata Banks. By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Victoria North HIF Infrastructure Works
Completed by:	DH
Date:	#####
Version:	2