Remediation Strategy & Verification Report

Aldi Wyndham Place, Egremont

Stantec

Prepared for:
Aldi Stores Ltd

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1 Introduction

1.1 Terms of reference

Stantec UK Limited (Stantec) has been commissioned by Aldi Stores Ltd. (the Client) to prepare a Remediation Strategy and Verification Plan (RSVP) for a former petrol station located off Wyndham Terrace, Egremont, CA22 2DY (the site). A Site Location Plan (Stantec Drawing 333701974-STN-XX-XX-DR-GE-1001) is presented in Appendix A.

Although some works were carried out prior to 3E being acquired by Hydrock, who in turn were acquired by Stantec, for the purpose of this report, work carried out pre- and post-acquisition is referenced as being undertaken by Stantec.

1.2 Background

A Phase 1 Geo-environmental Assessment (Desktop Study) was produced for the site in September 2021 (ref: P21-172/P1). A plan of the petrol filling station infrastructure obtained as part of this report identified two 9000-gallon tanks to the northwest of the pump islands alongside two smaller tanks (assumed to be 3000-gallon tanks).

To provide an initial assessment of potential geotechnical and environmental constraints at the site, a preliminary ground investigation was undertaken in 2023 (ref: 28850-HYD-XX-XX-RP-GE-0001).

Following submission of the above reports to Copeland Borough Council the following land contamination planning condition has been applied for planning application ref: 4/24/2044/0F1.

> **Condition 7 - No development excluding demolition shall commence until a remediation strategy to deal with the risks associated with contamination of the site in respect of the development hereby permitted, has been submitted to, and approved in writing by, the Local Planning Authority.**
>
> **This strategy will include the following components:**
>
> **1. A site investigation scheme, based on the Hydrock Ground Investigation Report to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off-site.**
>
> **2. The results of the site investigation and the detailed risk assessment referred to in (1) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.**
>
> **3. A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in the remediation strategy in (2) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.**
>
> **The scheme shall be implemented as approved.**

To aid in construction of the existing store, a ground improvement (Vibro Stone Column (VSC)) solution is the preferred solution for the proposed store. However, due to the presence of residual contamination within the soil and groundwater below the site, the Environment Agency (EA) issued preliminary consultee comments outlining that insufficient information had been provided to demonstrate that the VSC proposal does not represent a risk to controlled waters through the creation of preferential pathways to the bedrock aquifer.

Within this response the EA did note that they would lift the objection if either a piled foundation solution was adopted and /or if the source of contamination is removed or remediated to an acceptable standard.

On the basis that the scope of ground investigation works completed by Stantec were to solely aid in providing a preliminary assessment of potential environmental constraints at the site, further consultation was held with the EA to re-assure them that further groundwater testing and analysis, including the completion of a detailed groundwater risk assessment (DQRA) would be completed prior to development works commencing to confirm the suitability of foundation proposals.

Based on this the EA withdrew their objection subject to the inclusion of the above-mentioned planning condition, and following subsequent separate condition:

> **Condition 8 – Piling**
>
> **The development hereby approved shall not include the use of vibro-stone foundations unless it can be demonstrated to the satisfaction of the Local Planning Authority that their use will not cause or exacerbate the transmission of contamination into underlying strata and groundwater. Vibro-stone foundations or piling using penetrative methods shall not be used other than with the written consent of the Local Planning Authority.**

A further investigation to satisfy Condition 7 (1) was undertaken in 2025 (ref: 333701974-STN-XX-XX-RP-GE-1001).

Stantec understands that the proposed development is to comprise the construction of an Aldi store and associated car parking area, details of which are provided on Projekt Drawing 0541-PA-XX-00-DR-A-PM_40_40-79-0002 included in Appendix A.

1.3 Objectives

This report has been prepared to satisfy Condition 7 (2), which includes a Detailed Quantitative Risk Assessment (DQRA) (Appendix B) and preparation of a Remediation Strategy (including Options Appraisal if appropriate), as well as Condition 7 (3), which consists of preparation of a Verification Plan. A piling risk assessment is included as Appendix C to satisfy Condition 8.

The objective of this RSVP is to fulfil Stage 3: Remediation and Verification of the Environment Agency's (EA) Land Contamination Risk Management (LCRM), specifically the development of a remediation strategy to ensure that, on completion, the site can be shown to be suitable for its intended use, such that it will not pose an unacceptable contamination risk to the identified receptors.

This document ultimately seeks to agree the remediation concept for the proposed development with the relevant regulatory authorities and discharge of planning conditions. Significant departures and/or variations to this strategy will require approval from the regulators.

1.4 Scope

This RSVP has been undertaken in general accordance with EA guidance LCRM and the scope comprises:

- Provision of a summary of the conceptual site model (CSM).
- A review of the risk assessments and undertaking DQRA, where required.
- Provision of an outline of the remedial strategy.
- Provision of details of the remedial strategy implementation during the enablement and construction phases.
- Outlining monitoring (if required) and maintenance requirements.
- Provision of details for supervision, verification and reporting requirements.
- Summarising requirements for reuse of soils on site and material management.
- Provision a contingency plan for areas of unexpected contamination.

This report provides an overview of the site development proposals and discusses the remediation measures required to ensure the site is suitable for use with respect to the identified receptors. This document does not cover the geotechnical requirements for the proposed development.

1.5 Available information

The following notable documents have been used in the preparation of this report:

- 3E (Stantec), September 2021. Proposed Aldi Store, Wyndham Place, Egremont, Cumbria. Phase I Geo-environmental Assessment. Ref: P21-172/P1.
- Hydrock (Stantec), December 2023. Wyndham Place, Egremont: Ground Investigation Report. Ref: 28850-HYD-XX-XX-RP-GE-0001.
- Stantec), December 2025. Wyndham Place, Egremont: Ground Investigation Report. Ref: 333800252-STN-XX-XX-RP-GE-2001.
- Projekt, April 2021. Proposed Site Plan. Wyndham Place Egremont. Ref: 0541 - SK05.

It is assumed that the reader has full knowledge of the ground conditions as detailed in the above documents.

1.6 Limitations

The report has been prepared by Stantec on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, all of the potential environmental constraints or liabilities associated with the site may not have been revealed.

The report has been prepared for the exclusive benefit of the Client for the purpose of providing information on the remediation options for development of the site. The report contents should only be used in that context. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

Stantec has used reasonable skill, care and diligence in the design of the remediation of the site. The inherent variation in ground conditions allows only definition of the actual conditions at the locations and depths of exploratory locations at the time of the investigations. At intermediate locations, conditions can only be inferred.

Information provided by third parties has been used in good faith and is taken at face value. However, Stantec cannot guarantee the accuracy or completeness of any information provided by others.

The RSVP has been carried out in general accordance with EA guidance LCRM. Other relevant guidance that has been cross-referenced is indicated in the report text.

This report is subject to review and approval by the regulators.

2 Site description and Conceptual Site Model

2.1 Site location

The site is located approximately 500m north of Egremont town centre and immediately east of Egremont Bypass (A595). A roundabout is located directly to the northwest at the junction of East Road and Egremont Bypass. The approximate centre of the site is centred on National Grid Reference 301180E, 511080N. A Site Location Plan (333701974-STN-XX-XX-DR-GE-1001) is included in Appendix A.

2.2 Site description

The site is approximately 0.67 Hectares (Ha) in size, is roughly rectangular in shape and sloped shallowly to the south.

The site is currently occupied by open yard of a former petrol fuel station and garage, the buildings of which have since been demolished, formerly located in the northern portion of site.

The site is surrounded by heras fencing in the northern portion of site, around the former petrol station access. A retaining wall is present in the northwest portion, the eastern boundary is bound by timber post and rail fence, and southwest boundary is formed by mature trees and vegetation.

The adjacent land use is generally as follows:

- North: East Road, Wyndham Place with housing and open parcels of land beyond.
- Northwest: Egremont bypass with shops, car parking and residential properties beyond.
- East: Wyndham Place and residential properties.
- Southwest: Residential properties.

2.3 Former site use

The site has remained undeveloped from the earliest plans until the late 1960s when a garage building was constructed in the north of the site. This building was extended a number of times from the early 1990s, with a canopy for the fuel filling station added and construction of the car sales showroom and garage services to the south. In the 1960s, levels in the south of the site appear to have been cut to form a yard to the south of the garage.

Historical maps and environmental data search (reviewed as part of the Phase 1 desk study) indicated the former presence of a fuel filling station in the north of the site. A plan of the fuel filling station infrastructure plan is included in Appendix A (Stantec Drawing 333801974-STN-XX-XX-DR-GE-1003).

Following the demolition of the buildings on site to slab level in October 2025, a specialist contractor (APK) was instructed to undertake a tank cleaning operation, which comprised a visual inspection of each tank's interior following cleaning, and a gas free certification. All tanks were observed to be in generally good condition, and no flammable or hazardous gases were recorded following the cleaning operation. Records of these works are presented in Appendix D.

The tanks remain in the ground, empty, to be removed at a later date. Table 2.1 lists the details of each tank.

Table 2.1: Underground buried tank details

Tank Reference	Capacity (L)	Fuel Type	Comments
1	26,452	Petrol	No corrosion issues
2	13,230	Diesel	No corrosion issues
3	13,240	Petrol	No corrosion issues
4	13,230	Petrol	No corrosion issues
5	13,230	Diesel	No corrosion issues
6	8,891	Diesel	No corrosion issues
7	8,891	Diesel	No corrosion issues
8	17,460	Diesel	No corrosion issues. 2 x 8730 litre diesel - cut baffle

3 Ground model

The ground model for the assessment is discussed in Table 3.1, and includes discussion of visual and olfactory evidence of contamination across the three investigations.

Table 3.1: Ground Model

Strata	Comments and Description
Artificial Ground/Topsoil	
Hardstanding	• Light grey concrete, sometimes reinforced. Encountered in the footprint of the former buildings. • Black asphalt, found in the areas surrounding the buildings.
Made Ground	Encountered in all locations below the surface covering, where present, or from surface to depths of between 0.13m and 2.50m. In WS09 due to limited recovery, the depth of Made Ground could not be determined, but was between 2.50m and 4.00m bgl. Similarly in WS12 and WS13, limited recovery from 1.85m and 1.70m bgl respectively meant the base of the Made Ground could not be identified. The base of the Made Ground was not proven in WS10, WS204 and WS208. The Made Ground was generally recorded as: • upper layers: coarse grey sandy gravel of mixed lithology with brick, concrete and metal present. • with depth: brown silty, sandy and slightly sandy, slightly gravelly and gravelly clay with frequent brick, rootlets, sandstone and quartzite gravel.
Superficial Deposits	
Glaciofluvial Deposits/River Terrace Deposits	Recorded in all locations below the Made Ground. The base of the strata was not proven. The superficial deposits were generally described as: • multi-coloured coarse sandy gravel of mixed natural lithologies (sandstone, mudstone and granite) and occasional cobbles; • brown sometimes sandy gravelly clay with mixed natural lithologies (sandstone and mudstone); • dark grey silty gravelly clay with mixed natural lithologies and occasional cobbles; • orangish brown fine sand with sandstone and mudstone gravel.
Solid Geology	
Frizington Limestone Formation	Frizington Limestone deposits were not encountered in ground investigation works undertaken on the site to date.

Strata	Comments and Description
Fieldwork observations	
Fieldwork observations	Visual and olfactory evidence of petroleum hydrocarbon contamination in the Made Ground and Superficial Deposits was reported in WS06 from 0.30m to 0.55m bgl, WS09 from 4.00m to 4.30m bgl, WS10 from 0.40m to 0.70m bgl, WS12 from 0.80m to 1.40m bgl, WS17 between 4.10m and 4.70m bgl, BH203 from 4.50m to 5.50m bgl, WS202 between 0.34m and 1.10m bgl, WS205 between 2.00m and 2.50m bgl, WS206 between 2.25m and 3.70m bgl.
Groundwater	

Generally, groundwater was encountered during the site works in exploratory holes in the north of the site, at depths between 3.55m and 4.67m bgl. During the monitoring groundwater levels were recorded at between 1.05m and 5.80m bgl. In general, groundwater was encountered (predominantly) within the granular layers of the Superficial Deposits between 43.17m and 50.86m AOD.

Based on the contour map shown in Figure 3.1, groundwater flows to the southeast, towards the River Ehen 150m east of the site. The river levels sit at approximately 47m OD.

Limited non-aqueous phase liquid (NAPL) petroleum hydrocarbons have been noted within BH202 with a thickness of 1mm on both 13/11/2025 and 18/11/2025. This appears to be localised, as other visual or olfactory evidence of petroleum hydrocarbons within the groundwater was limited to mild hydrocarbon odours and sheens/residue.

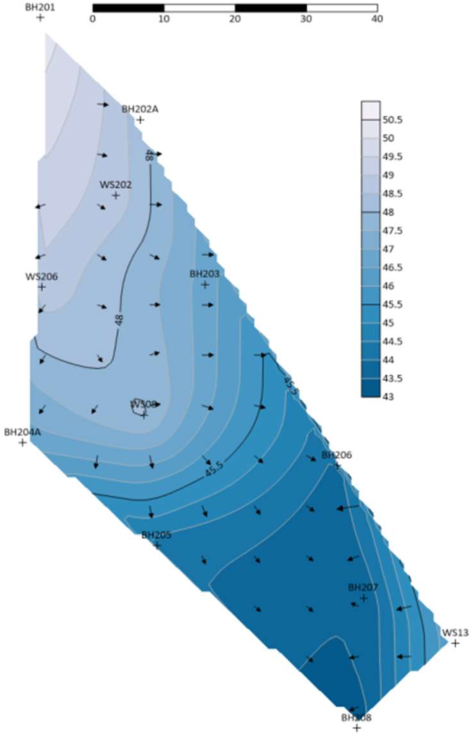

Figure 3.1: Groundwater levels and flow direction (17/11/25)

4 Risk assessment summary

4.1 Outcome of risk assessments

4.1.1 Human Health

With regards to soils, no contaminants of potential concern (CoPC) were identified above the generic assessment criteria (GAC), with the exception of asbestos, which was encountered within Made Ground at several locations in the northern portion of site, comprising loose chrysotile and amosite. Identified asbestos concentrations ranged from 0.001% to 0.134% in weight.

Asbestos therefore is considered to represent an unacceptable risk to end users, and mitigation is required. This will be in the form of a dedicated clean cover system within all areas of new proposed soft landscaping comprising a minimum 450mm clean 'suitable for use' imported soil overlying a geotextile marker layer at the base of the clean cover system. Over-excavation of service trenches and backfill with clean materials is also required to reduce the risk to future maintenance workers coming into contact with Made Ground soils which contain asbestos.

During construction, materials management and appropriate wetting down, RPE and PPE, will be required to ensure risks to workers remains low. Groundworkers should be asbestos awareness trained and be vigilant for visible pieces of possible asbestos containing material. Any suspected asbestos should be segregated and disposed of as hazardous waste.

4.1.2 Controlled Waters

Elevated concentrations of metals (copper, nickel, selenium and zinc) and sulphate were reported above the Water Quality Targets (WQTs) but were considered unlikely to pose a significant risk to Controlled Waters from an on-site source as there was no evidence of anthropogenic accumulations of these substances in the soils on the site. They were therefore considered to be naturally occurring, or representative of the wider groundwater environment.

The remaining CoPC (PAHs) required further assessment. These exceedances, found within boreholes in the north of the site, were considered likely to be associated with leaching from impacted soils in the vicinity of the petroleum infrastructure associated with the historical fuel filling station on site.

Given the proximity of the site to the nearest surface water receptor, the exceedances of PAHs and previously petroleum hydrocarbons, it was considered there may be a potential risk to Controlled Waters and further assessment was required to quantify the risk in the form of a DQRA, as well as a piling risk assessment.

The DQRA has been undertaken and is included in Appendix B and a piling risk assessment is presented in Appendix C.

Following the DQRA, travel times (both soil and groundwater) significantly exceed 1,000 years for all of the petroleum hydrocarbon fractions and PAHs modelled. It was considered that these petroleum hydrocarbon fractions or PAHs will not reach the surface water receptor and, therefore, do not pose a significant risk to Controlled Waters and no remediation is required.

Based on the PRA, following removal of tanks and associated infrastructure the use of the proposed vibro stone column (VSC) foundation solution poses a low risk to Controlled Waters beneath the site.

A suitable regime of groundwater sampling and surface water monitoring, sampling and testing should be carried out at regular intervals during and after the construction period (where development allows), to monitor whether contamination has been mobilised and allow for works to be modified if necessary.

4.1.3 Vapours

With no exceedances of the soil or groundwater GAC in relation to vapours, no further assessment or mitigation measures were required. However, as the area of the tank farm itself has not been able to be investigated, a watching brief during removal of petroleum infrastructure (tanks, lines, fill points etc) and sampling of soils at the base and walls of excavations should be undertaken to validate the removal of potentially impacted soils in that area.

4.1.4 Ground Gas

The site has been classified as CS2 based on observed maximum concentrations of Methane of 8.8% and Carbon Dioxide of 7.7%. A maximum flow rate of 0.3 l/s was observed during the original 2023 ground investigation monitoring period. Ground gas protective measures will be required for the proposed development commensurate with CS2.

The site is also located within an area of 10% to 30% radon potential, and basic radon protective measures will be required for the end-development.

4.1.5 Construction Materials

Barrier pipe is likely to be required, but confirmation should be sought from the water supply company at the earliest opportunity.

If pipework is to be laid in areas where elevated petroleum hydrocarbons and PAHs have been reported in soils, the manufacturer should be consulted with regard the suitability of the preferred pipework.

When the fuel infrastructure is removed, any impacted soil encountered during excavation works will be removed prior to any foundation or ground improvement works. A concrete plug across the zones of natural strata each column crosses may be prudent to restrict the potential migration of contaminants and ground gas through an otherwise highly permeable stone column.

4.2 Conceptual Site Model

The CSM following the risk assessments is presented in Table 4.1.

Table 4.1: Updated plausible contaminant linkages

Sources	Pathways	Receptors	Probability	Consequence	Risk Level	Comments
Potential for unidentified residual hydrocarbon contamination to be present within the immediate areas of the tanks and associated infrastructure of the former petrol filling station in the north of the site.	Ingestion, dermal contact, inhalation of soil-derived dust	Human Health – future site users	Unlikely	Medium	Low Risk	All soil testing reported no exceedances of the soil GAC, however, a watching brief during removal of petroleum infrastructure (tanks, lines, fill points etc) and sampling of soils at the base and walls of excavations should be undertaken to validate the removal of potentially impacted soils in that area.
	Direct Contact	Water pipes and plastic pipes for drains and sewers	Likely	Mild	Low Risk	Elevated petroleum hydrocarbons have been reported at the site. Mitigation required installation of Barrier Pipework (subject to approval from the water company) and consultation with the pipework manufacturer with regard the suitability of the pipework.
Elevated concentrations of PAHs within groundwater. Potential for unidentified residual hydrocarbon contamination to be present within the immediate areas of the tanks and associated infrastructure of the former petrol filling station in the north of the site.	Leaching through unsaturated zone	Controlled Waters – groundwater and nearby surface watercourses	Unlikely	Medium	Low Risk	Following DQRA, CoPC do not pose a significant risk to Controlled Waters and no remediation is required.
	Vertical migration caused by piling/ ground improvement	Controlled Waters – groundwater and nearby surface watercourses	Unlikely	Medium	Low Risk	Based on the piling risk assessment, following removal of tanks and associated infrastructure the use of the proposed VSCs pose a low risk to Controlled Waters beneath the site.
Potential for asbestos and ACM associated with other on-site activities and construction materials.	Inhalation of fibres.	Human Health – site end users and future intrusive maintenance workers.	Likely	Severe	High risk	Asbestos has been identified in the Made Ground. A clean cover system is recommended, along with over excavation of service trenches.
Ground gases	Vertical and lateral migration, ingress and accumulation of ground gases/vapours into buildings and service entries	Human Health – future site users	Low	Severe	Moderate Risk	The site can be classified as CS2, with gas protection measures required.
Vapours			Low	Medium	Low Risk	No vapour protection measures are required, however, a watching brief during removal of petroleum infrastructure (tanks, lines, fill points etc) and sampling of soils at the base and walls of excavations should be undertaken to validate the removal of potentially impacted soils in that area.

5 Outline Remediation Strategy

5.1 Introduction

The following section of this report is to outline the remediation strategy which will be applied in order to achieve a site which is suitable for the proposed development.

The objectives of the remediation works are to:

- Break the linkage between the contamination in soils and future site users (including users of neighbouring properties).
- Demonstrate that the remediation is a sustainable approach.
- Avoid unacceptable environmental impacts, health and safety issues and minimise long term liabilities associated with the remedial approach.
- Avoid the requirement for long term monitoring or maintenance.
- Complete the remediation within the programme timescale of the development.

The RSVP detailed in the following sections is based on Stage 3: Remediation and Verification of LCRM, specifically the development of a remediation strategy (Step 1).

The remediation strategy is generally structured as follows:

- Summarising the key remediation criteria, including the derivation of Remedial Target Values (RTVs) (where applicable).
- Summarising the remediation stages and their implementation.
- Summarising the regulatory controls that need to be in place.
- Detailing the monitoring requirements.
- Detailing how the remediation will be verified.
- Contingency planning and unexpected contamination.

5.2 Remediation requirements and mitigation measures

From the findings of the human health, Controlled Water and construction materials risk assessments, Stantec considers the following mitigation is required to ensure the site is suitable for use for the proposed end use. The mitigation measures include:

- Consultation with the pipework manufacturer with regard the suitability of the pipework.
- Removal, excavation and validation of USTs and associated infrastructure and lines present on the site under a watching brief.
- Removal of NAPL, where reasonably practicable.
- Over-excavation of service trenches and backfill with clean materials.
- Installation of Barrier Pipework (subject to approval from the water company).
- Installation of ground gas protection measures in accordance with CS2.
- The installation of a cover system in areas of soft landscaping, comprising topsoil / subsoil of at least 450mm.

5.3 Remediation criteria

Since the ground investigations and risk assessments presented within the Phase 2 reports concluded that the soils on site are chemically suitable for a commercial land use (with the exception of asbestos), it is considered unnecessary to develop soil re-use criteria for site won Made Ground. However, if unforeseen contamination is encountered then the protocol in Appendix F shall be followed. Remediation criteria are considered necessary to validate the soils surrounding the USTs and pipework, and to allow reuse of Made Ground so as not to pose a risk to Controlled Waters.

Remediation criteria are required to demonstrate and verify the performance of the remediation. In accordance with LCRM these can be both numerical (for example model-derived concentration values) and/or qualitative/descriptive (for example “the removal of all visually contaminated material”).

Materials re-used or imported to site shall comply with the following:

- Meet the site-specific remedial target values (RTVs) presented in Appendix F.
- No visual or olfactory contamination (oil staining, odours etc.).
- Limited deleterious material (organics, wood, metal etc.), in accordance with any geotechnical specification.
- No visible asbestos containing material (ACM).
- asbestos fibres content <0.1%.

The Contractor will need to have an experienced Geo-environmental Engineer or Consultant present during excavation, to inspect for suspect material and oversee effective segregation, stockpiling and verification of removal of soils. All soils that are potentially impacted with contamination shall be stored in a manner to protect the site surface and therefore end users such as placing on a low permeability membrane and preventing run off and leaching by covering the stockpile.

5.4 Remedial target values

Remediation target values for validation of tank removal, import of soils and re-use of soils are presented in Appendix F.

5.5 Implementation phases

It is envisaged that the remediation will be undertaken in the following phases as part of the wider project:

5.5.1 Enabling works

The following works are considered necessary during the enabling works phase and are discussed in more detail in Section 6.1:

- Consultation with the pipework manufacturer with regard the suitability of the pipework.
- Removal and validation of all historical tanks and associated infrastructure.
- Removal of NAPL, where reasonably practicable.

5.5.2 Construction phase

The following works are considered necessary during the construction phase and are discussed in more detail in Section 6.3:

- Over-excavation of service trenches and backfill with clean materials.
- Installation of Barrier Pipework (subject to approval from the water company).
- Installation of ground gas and radon protection measures.
- Installation of the clean cover system.

5.6 Other considerations

5.6.1 Management of asbestos containing materials

Asbestos fibres were identified during testing of samples of Made Ground soils. The potential exists for discovery of and exposure to ACM and asbestos fibres during any stage of works. Such discoveries will require agreed management and action protocols to be adopted where suspected ACM is identified to ensure proper management and control of impacted volumes.

The Principal Contractor shall have in place at the start of the contract, work procedures designed to ensure they are working in full compliance of all Health and Safety requirements (including, but not exclusively CAR 2012 and CAR soils) and that the control measures are sufficiently robust to prevent release of airborne asbestos fibres into the surrounding environment. Appropriate PPE, and if required RPE, shall be provided and utilised.

There is the potential for asbestos to be encountered during all phases of development and it is important that the control measures in place are sufficiently robust to prevent release of airborne asbestos fibres into the surrounding environment.

If asbestos is encountered the Contractor shall comply with all Health and Safety requirements (including, but not exclusively CAR 2012).

The Principal Contractor must manage the risks in accordance with their legal requirements and will need to prepare appropriate health and safety documentation and obtain appropriate approvals, licences, consents and permits prior to commencement.

Prior to commencing ground works, the Contractor shall ensure a detailed Method Statement and Risk Assessment, and any other necessary information, are written and submitted to Network Space for approval. It will be the responsibility of the Contractor to ensure that the methods adopted for the removal of the asbestos is of a standard acceptable to the Health & Safety Executive (HSE) and in accordance with relevant guidance and legislation.

6 Implementation

The anticipated stages of work required to implement the remediation strategy are detailed below. The Contractor will be required to prepare a Detailed Remediation Method Statement to address, in detail, the design and working methods by which the requirements of this strategy will be implemented. The details below are therefore interim and indicative only, and are subject to confirmation by the appointed Contractor. The stages of work have been split into an enabling works phase and construction phase to indicate at what stage in the wider site programme the stages in the remediation scope are expected to be implemented.

6.1 Enabling Works

The anticipated stages of the remediation during the enabling works phase are detailed in the following sections.

6.1.1 Consultation with pipework manufacturer

The Contractor will discuss the concentrations of petroleum hydrocarbons and PAHs with pipework manufacturers to inform pipework material selection. Outcomes of discussions should be documented and provided for inclusion in the verification report.

6.1.2 Removal of tanks and associated infrastructure

The identified underground tanks and associated infrastructure are summarised Table 2.1 and are shown on the drawings provided in Appendix A.

The remediation works will include the removal of all tanks and associated infrastructure (including but not limited to fuel lines, vent pipes and interceptor tanks). Any previously unrecorded tanks identified during the enablement works will also be removed.

The following works are recommended:

- Breaking out of hardstanding.
- Degassing and decontamination of all tanks (including interceptor tanks) to remove any residual product (already undertaken by APK) before subsequent decommissioning and removal.
- Removal of fuel lines and vent pipes are also shown in the area of the former forecourt and tank farm.
- Removal of contaminated soils in the vicinity of the tanks/pipework (as identified by the presence of visual/olfactory evidence of contamination) as required.

The delineation of the extent of the potentially contaminated soils has not been undertaken during the intrusive investigation works to date. The Contractor will be required to fully delineate the areas of impacted ground requiring remediation.

Due to the potential for unidentified free phase hydrocarbon contamination within the groundwater below areas of the site as a precautionary measure it is also recommended that a water control system (i.e. appropriate pumping equipment and dedicated tanker/s) be on standby prior to the start of the excavation works, should significant unidentified contamination be encountered.

Validation of the removal of the tanks/associated infrastructure is proposed via chemical analysis of samples recovered from the sides and base of small tank excavations (<100m^2). For large excavations in excess of 100m^2, a 10m validation grid (on the base) and 10m linear sampling (along the side walls) is proposed. Soil testing requirements are set out in Table 6.1.

Validation is to be undertaken by an experienced geo-environmental engineer (working on behalf of the Client) in accordance with the RTVs presented in Table F.1 (Appendix F).

The Contractor is to satisfy itself with regards to volumes of soil to be excavated, remediated or disposed of and replaced. Stantec accept no liability with regards to volume estimates calculated.

Table 6.1: Testing methodology and suites

Material	Frequency	Testing Suite (soil)
Validation samples following removal of tanks and associated infrastructure and contaminated soils (as identified by the presence of visual/olfactory evidence of contamination)	Each side and the base of excavation. If the excavation is greater than 100m², a 10m validation grid (on all sides and base) is required.	• PAHs (USEPA 16) • TPH CWG • BTEX & MTBE

6.1.3 Removal of NAPL

Limited NAPL have been noted within BH202 with a thickness of 1mm on both 13/11/2025 and 18/11/2025, which appears to be localised, as other visual or olfactory evidence of petroleum hydrocarbons within the groundwater was limited to mild hydrocarbon odours and sheens/residue.

As minimal amounts of NAPL have been recorded, and as excavation is more intrusive than in situ techniques, it is proposed to undertake downhole skimming in BH202 as no tank or petroleum infrastructure removal is proposed in that area.

If soils containing NAPL are excavated during the removal of the tanks and associated infrastructure, they are to be placed in a secure bunded area on an impermeable membrane, with the NAPL being allowed to drain to a sump for collection. The excavated soils (following draining of the free product) are then to tested to see if they are suitable for re-use or if they need to be disposed of off-site (see Section 6.2.2).

Any free phase hydrocarbons removed shall be disposed of in accordance with current legislation.

Watching brief

A full-time watching brief is required during removal of tanks and associated infrastructure to confirm the absence of further significant unidentified contamination, as well as to observe whether NAPL is present or not. This will be undertaken by the appointed Geo-environmental Engineer from Stantec.

The Contractor shall liaise with the appointed Geo-environmental Engineer with regards to the programme and timing of the works, to ensure attendance on site at appropriate times.

Appropriate samples will be taken by Stantec of materials removed during excavation works in these areas to determine the extent of potentially significantly impacted hydrocarbon impacted soils and perched water (if identified) and determine the requirement for possible remedial measures. The proposed sampling methodology is outlined in Table 6.1.

As part of these works it is also recommended that an allowance be included for the deployment of a water control system (i.e. pumping equipment and tanker) and where surface waters are impacted by free phase hydrocarbons they should be treated with absorbent materials or a surface skimmer pump for removal off-site within a dedicated tanker.

If during the groundworks and watching brief, should areas of suspected significant contamination, which differ from those encountered in the ground investigation works be encountered the appointed Geo-environmental Engineer will be informed to allow an assessment to be made (including laboratory testing where required) and appropriate remediation carried out as necessary.

6.2 Other considerations

6.2.1 Earthworks and reinstatement of excavations

The reinstatement of excavations as part of the earthworks is to be undertaken in accordance with an Earthworks Specification that details the methodology for placement of fill and should also detail associated geotechnical testing and verification requirements. Chemical testing of site won soils and comparison against the reuse criteria presented in Appendix F will be required prior to reuse of site won soils within earthworks.

6.2.2 Off-site disposal of unsuitable materials

The works should seek to reduce and control impacts upon the natural environment, therefore, the Contractor shall seek to reuse materials within the works, where appropriate.

However, where identified, any surplus (i.e., soils which cannot be reused on-site due to volumes), or unsuitable soils (i.e., soils which cannot be treated and/or reused in an appropriate location), or are geotechnically unsuitable for use in the earthworks, shall be disposed of off-site by the Contractor.

If a material does not comply with the relevant criteria for its intended use (e.g., reinstatement of excavations in line with reuse criteria, clean cover system, etc.), then, by definition, the material is not suitable for use.

Given that the soils with elevated petroleum hydrocarbons and PAHs are expected to form discrete layers/areas, efforts should be made to segregate this material during excavation works. This will allow for the material to be sampled and tested prior to re-use (where suitable) or to provide an indication of the waste classification prior to off-site disposal.

All waste materials generated during the works shall be dealt with in full compliance with the statutory Duty of Care as defined by the Environmental Protection Act (1990) and all subsequent amendments. The Contractor shall be the waste producer and is responsible for the production of all documentation required under relevant legislation, ensuring this is kept up to date and is available on-site for inspection.

Further details on the disposal of unsuitable materials, and a preliminary indication of the waste classification of the soils recorded on-site, is presented in Section 8.4.

6.2.3 Dewatering

It is considered unlikely that groundwater pumping will be required to facilitate the construction, however, if required then any groundwater pumped will likely need to be treated prior to discharge. Any short-term dewatering of strata using boreholes or wells to enable construction must now have an abstraction licence following changes to Environment Agency guidance in November 2024.

6.3 Construction phase

The anticipated stages of the remediation during the construction phase are detailed in the following sections.

6.3.1 Over-excavation of service trenches and backfill with clean materials

In areas where Made Ground is present and if excavation to install services is required; to protect future maintenance workers, service trenches are to be over excavated by the Contractor, 300mm either side and 300mm below the edge of the service being installed. The excavation is to be backfilled with soils which are proven as suitable for use by comparison to the reuse RTVs presented in Appendix F.

The excavated soils from over-excavation of services are to be disposed of off-site by the Ground Works Contractor in accordance with Section 8.4.

The Contractor is to validate the over-excavation of service trenches as per Section 7.3.

6.3.2 Installation of barrier pipe

All potable water supplies are to be installed with barrier pipe as an additional precaution to ensure that the service is protected from permeation by any remaining organic contaminants that may be above Threshold Values for standard water supply pipework.

This is to be verified by the Contractor by the provision of delivery tickets showing barrier pipe has been delivered to the site and by photographic evidence that the pipework has been installed across the site. The full construction phase verification requirements are detailed in Section 7.3.

Installation should comply with all relevant local Water company guidance.

6.3.3 Installation of ground gas protection measures

In accordance with BS 8485:2015+A1:2019, the site has been classified as CS2 and the proposed building type has been classified as Type C, i.e. commercial building with central building management control of any alterations to the building or its uses and central building management control of the maintenance of the building, including the gas protection measures. In accordance with section 7.2 of BS 8485 the required gas protection score is 2.5.

However, it is not appropriate to increase the site CS nor design the BS 8485 points system where stone columns are present as per CL:AIRE (2025) '*Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention*'. The gas protection system and sub-slab venting should be designed based on modelling gas generation, flow towards and accumulation in the stone columns, followed by gas generation up the columns. Gas screening values or hazardous gas flow rates are not appropriate in this instance, and models should be based on diffusive and/or advective flow.

6.3.4 Installation of radon protection measures

The site is within a 10-30% radon risk area. Basic radon protection measures should be installed in accordance with BRE BR211, 2023, and the detailed design of these protection measures should be subject to a specific radon protection design in accordance with BR211.

6.3.5 Installation of the cover system

A clean cover system is required for landscaped areas. The cover system should be designed and validated in accordance with NCLOG, 2024.

The general principles for the cover system design are:

- Building footprints as per the structural design (by others): the floor slab will break the linkage between the soils and potential receptors.
- Areas of hardstanding (roads, pavements, etc.) as per the design (by others): the hardstanding will break the linkage between the soils and potential receptors.
- Soft landscaped areas a minimum of 450 mm clean cover system to reach final ground level with clean soils complying with the import criteria presented in Appendix F.

Where hardstanding is present, this is considered to have suitably severed the pathway from underlying contamination to future users. The design thickness of the hardstanding (e.g., concrete or asphaltic material, and not loose gravel or shingle at surface) and the underlying subbase should be of the required thicknesses for the construction build ups.

A clean cover system shall be installed in all soft landscaping areas across areas of landscaping/public open space in accordance with NCLOG guidance.

The clean cover system is to comprise (from base up):

- A suitable basal geo-fabric separation layer; and
- A minimum 450 mm combined thickness of topsoil and subsoil (minimum 150mm topsoil).

The clean cover system installation should be undertaken in the following steps:

1. Check the elevation of the formation level to ensure that it is at the correct level and allows for the placement of the full required thickness of the clean cover system.
2. Install the basal geo-fabric separation layer.
3. Place the required thickness of topsoil and subsoil as detailed above (of which a minimum 150 mm is to be topsoil).

Chemical testing of the soils against the import criteria presented in Appendix F is to be undertaken to ensure that the clean cover is suitable for use. The soils should also comply with any additional criteria stipulated by the landscape architect. It is recommended that the Contractor also samples and analyses the materials prior to placement to avoid the requirement for abortive works and removal of such materials.

For areas of proposed trees, the depth of growing medium will be deeper and tree pits will need to be excavated as per the requirements of an arboriculturist and/or landscape architect.

The clean cover systems shall also consider their permeability and the consequential impact upon both the surface runoff. This principally relates to their composition (e.g., granular, cohesive or composite).

Soils used as part of the clean cover system should be free of asbestos and significant quantities of anthropogenic materials (e.g., brick, concrete, etc.) or other potentially hazardous foreign material which could cause injury. In addition, all materials must be free from aggressive / invasive weeds (especially Japanese Knotweed and Giant Hogweed) and bulk vegetative growth, in order to ensure negligible risk of subsequent weed problems.

Verification of the installed thicknesses and the chemical quality of the soils should be completed in landscaping and public open space. The full construction phase verification requirements are detailed in Section 7.3.

All soils moved and placed as part of the clean cover system need to be transported and stored with care to prevent cross contamination. This is to include, but not be limited to, the following:

- The stockpiling of soils on a geotextile separator layer.
- Using dedicated plant to move the cover system soils or washing plant thoroughly before use to move cover system soils.
- Minimising tracking over contaminated soils.
- Separating clean and dirty areas of the site.
- Placing the soils into the final position and not pushing soils across the surface.

Due to the lack of a clean growing medium on-site, it is anticipated that the topsoil and subsoil to be used within clean cover systems will require import. The clean cover soils are to comply with the import criteria presented in Appendix F. It is recommended that the topsoil is tested and demonstrated to meet the criteria prior to import.

If clean naturally occurring site-won soils are used within the cover system, they similarly need to comply with the criteria presented in Appendix F. For clarity, treated materials should not be used as part of clean cover systems.

7 Verification and reporting

7.1 Introduction

The remediation works presented in this document need verification such that the regulating bodies can be satisfied that the strategy has been fully complied with, and ultimately, such that any associated planning conditions relating to land quality can be discharged. The verification process is also required to provide a permanent record of the remedial works undertaken at the site. The sections below summarise the various activities requiring verification and also comment upon the verification reporting process.

The following remediation works require verification:

Enabling works:

- Removal of tanks and associated infrastructure.
- Removal of NAPL.
- Off-site disposal of unsuitable waste materials.

Construction phase:

- Over-excavation of service trenches and backfill with clean materials.
- Installation of barrier pipe.
- Installation of ground gas protection measures.
- Installation of radon protection measures.
- Installation of the cover system.

Verification visits shall be made by a suitably experienced and qualified independent Geo-environmental Engineer or Consultant who shall undertake the necessary works outlined below.

7.2 Enabling works verification

7.2.1 Consultation with pipework manufacturer

Outcomes of discussions should be documented and provided for inclusion in the verification report.

7.2.2 Removal of tanks and associated infrastructure

The Verification Report shall incorporate a summary of and commentary on:

- An outline of the remedial action taken to remove any impacted soils.
- Records of excavations, including:
    - » Ordnance Datum survey of extents and depth.
    - » Ordnance Datum survey of extents and depth of any residual features.
    - » Photographic record of the excavation.
    - » Records of inspection and final extents of validation.

- Records of laboratory analytical and in situ field test results, including:
    - Laboratory results and location plan for each analytical test;
    - Chain of Custody forms.
- Waste classification and management documentation, including:
    - Copies of all consignment notes, in particular those relating to the hazardous waste regulations.
    - Details of waste facilities where materials were disposed of.
- Stockpile plan of all stockpiles generated by the works and remaining on site.
- Final as-built survey of the as excavated voids.

Confirmation that site levels are as required by the structural design and Geotechnical Design Report.

7.2.3 Removal of NAPL

The verification report should include the following information as a minimum in relation to removal of NAPL:

- Site visit record of geo-environmental engineer undertaking the watching brief.
- Waste classification and management documentation, including:
    - Copies of all consignment notes, in particular those relating to the hazardous waste regulations.
    - Details of waste facilities where materials were disposed of.

7.2.4 Earthworks

Upon completion of the enabling works, the supporting evidence demonstrating that the remediation objectives and criteria have been met is to be compiled into an Enabling Works Verification Report that meets the reporting requirements set out in LCRM.

The verification report should be prepared using a multiple line of evidence approach to demonstrate the successful implementation, and should include the following information as a minimum:

- A general description of the remediation works completed.
- Records of relic underground structure encountered and removed, including location within the site and at the site boundary.
- Details of all excavated material classifications, including site location, excavation extents and volumes.
- The volumes of excavated materials sentenced for reuse (either with or without treatment).
- Details of all imported material classifications and volumes.
- Results of all chemical testing, including both excavated and imported materials.
- Details of the final placement of materials.
- Details of the materials sentenced for off-site disposal, including waste classification, volumes and final disposal location.
- Results of all WAC testing to support off-site disposal.
- All waste management documentation for the materials disposed of off-site.
- Records of stockpiled materials.

- Details of any discharge consents required as part of the works, including chemical testing and volumes discharged.
- Details of required permits and compliance with permit conditions.
- Details of any alterations and amendments made to the Remediation Strategy.
- Details of any contingencies undertaken during the works, notably any unexpected contamination or identification of additional sources (e.g., unexpected underground tanks).
- Details of correspondence with the regulatory authorities during the works.
- Details of correspondence with relevant stakeholders.
- Description of the final condition of the site at completion.
- As-built drawings showing surveyed levels of base of temporary excavations, temporary sides of excavations and positions of samples and tests carried out.
- As-built drawings showing surveyed formation levels and positions of any samples and tests carried out at formation level.

7.3 Construction phase verification

7.3.1 Service Trenches and Barrier Pipe

Upon completion of the works, the supporting evidence is to be compiled into a Construction Phase Verification Report that meets the reporting requirements set out in LCRM.

The verification report should be prepared using a multiple line of evidence approach to demonstrate the successful implementation, and should include the following information as a minimum:

- Photographic proof of over-excavation of service trenches.
- Provision of delivery tickets showing barrier pipework has been delivered to site.
- Photographic proof that barrier pipework (Protectaline or similar) has been installed where agreed with the water supply company and the pipework manufacturer.
- Materials management data (see Section 8).

Barrier pipe verification should be in accordance with prevailing local Water Company guidance.

7.3.2 Gas and radon protection measures

The implementation of the gas protective measures as outlined in Section 6.3.3 and 6.3.4 will be verified by either a suitably qualified third-party installer or an experienced verification consultant, followed by the production of a verification/validation report, to ensure that all works are completed in accordance with CIRIA C735:2014 ‘Good practice on the testing and verification of protection systems for buildings against hazardous ground gases’ and the verification plan.

7.3.3 Clean cover system

Cover system verification should be in accordance with NCLOG, 2024 and YALPAG, 2021 unless local regulatory guidance prevails.

The installation of the clean cover system should be verified by verification visits made by a suitably experienced and qualified independent Geo-environmental Engineer or Consultant who should undertake a visual inspection of the installation and take samples for laboratory testing. This should be carried out at a minimum rate of 1 verification trial pit for every 500 m^2 of landscaping/public open space to verify the presence of the basal geofabric and the thickness of clean cover (with photographs) and collect samples of both topsoil and subsoil for chemical analysis.

Verification trial pits will be excavated at random locations as designated by the nominated verifier. This will take the form of a photograph with scale marker and accompanying photographic board detailing the measured clean cover system thickness.

The topsoil and subsoil samples should be analysed for compliance with the import criteria presented Appendix F.

It is recommended that the Contractor also samples and analyses the materials prior to placement to avoid the requirement for abortive works and removal of such materials. The soils should also comply with any criteria stipulated by the landscape architect.

If the clean cover system is deemed to be insufficient, the Contractor will be informed. In instances where the soil thicknesses are measured to be inadequate, following the addition of further soil, the verification pits will be re-excavated to confirm that a sufficient thickness of soil is now present. Verification of the clean cover system will only be carried out on areas where the cover system has been completed to finished surface level across the footprint of the landscaping or area of public open space.

The cover system verification documentation should include:

- The source of imported materials (topsoil and subsoil).
- The presence of a suitable basal geofabric separation layer.
- The clean cover system thicknesses, including photographs of the verification pits with a scaled marker;
- The chemical test results for the samples of topsoil and subsoil*.
- Comparison of the topsoil and subsoil samples against the import criteria presented in Appendix F.

Soil samples may be taken from stockpiles prior to placement in the clean cover system (this will require confirmation during verification that the placed materials are visually/physically consistent with those tested) or the samples are to be taken in situ once the clean cover system has been placed.

8 Materials management

The materials management strategy currently comprises maximising on-site reuse of excavated materials and minimising off-site disposal and import as far as reasonably practicable.

The reuse and imported of site-won soils on-site, should be managed in accordance with a Materials Management Plan (MMP) that is prepared in accordance with 'The Definition of Waste: Development Industry Code of Practice', Version 2 (CL:AIRE, 2011) (the ‘DoWCoP’). The Materials Management Plan will need to be signed off and Declared with CL:AIRE by a Qualified Person prior to commencing the earthworks. It should be noted that Version 3 of the DoWCoP is undergoing preliminary consultation, and recommendations within this report with regard to waste and re-use of soils will require review when the DoWCoP Version 3 is adopted. It is unknown at this stage whether MMPs for which a declaration has been accepted under version 2 will be impacted by changes in version 3.

8.1 Reuse of site-won soils

Site won asphalt should not be reused due to potential presence of coal tar, see Section 8.4 for further detail on disposal of hazardous materials.

Based on the findings of the Phase 2 ground investigations and risk assessments it is concluded that site won soils can be re-used on site without further testing (unless unforeseen or unexpected contamination is encountered). The general reuse criteria for site-won Made Ground materials are presented in Appendix F.

The proposed criteria are all based on Generic Assessment Criteria (GAC) for a commercial land use scenario or site-specific RTVs for the protection of Controlled Waters. These criteria are to initially act as a trigger value to ensure further consideration (if exceeded) of where the site-won material proposed for reuse is to be placed as part of the materials management strategy. An exceedance does not necessarily mean that the site-won material cannot be reused on-site, however, this may need to be beneath cover, buildings or hardstanding for example. Therefore, further consideration is required.

Chemical testing should be undertaken on the materials using the following sampling frequency:

- 1 sample per 50 m^3 of soil with a minimum of 3 samples per stockpile for soil from known remediation treatment areas.
- 1 sample per 250m^3 of soil with a minimum of 3 samples per stockpile for site-won material from outside of the treatment areas.

8.2 Sourcing of imported materials

Due to the lack of a clean growing medium on-site, it is anticipated that the topsoil and subsoil used within the soft landscaping area clean cover systems will require import. The clean cover soils are to comply with the testing frequencies and criteria presented in Appendix F.

Every effort should be made to ensure soils to be imported are accompanied by proof of provenance to demonstrate that there is no potential for the soils to have been contaminated as a result of past land uses or in the process of their creation, if a manufactured material. This information should be obtained in advance of the import on to site.

Chemical testing should be undertaken on the materials at source and prior to despatch to the site with a minimum of 3 samples per source (topsoil and subsoil to be sampled separately) to reduce the likelihood of importing soils that are not chemically suitable.

The requirements set out in the DoWCoP for importing materials under the 'Direct Transfer' scenario are clear. For clarity, the DoWCoP requirements for direct transfer of materials from one development site to another are:

- **Material must be clean naturally occurring soils and mineral materials.**

  'Clean' is defined as devoid of anthropogenic contamination to a degree or level that is considered harmful to living organisms (i.e. harmful is not a site-specific definition).

  Naturally occurring materials are defined as:
    - » *Soil, both topsoil and subsoil;*
    - » *Parent material;*
    - » *Clays, silts, sands and gravels;*
    - » *Underlying geology; and*
    - » *Made Ground consisting of the above materials only.*

The following protocol applies to all imported soils.

- The soil is from an identified site, which is clean and has no history of potentially contaminative uses. This should be supported by appropriate reporting, such as a Phase 1 Desk Study.
- A map and site plan showing the location of the site and area that the soils are from (with an approximate grid reference). When checking the source site, accurate details of where on the site the soil was derived are required, not just where they were stockpiled or screened.

The imported soils are to comply with the criteria presented in Appendix F.

8.3 Stockpiling

Any materials that are proposed for reuse shall be stockpiled separately by material type. Similarly, any materials being imported to site, for example clean topsoil or construction aggregates, or material awaiting disposal off-site, shall be stockpiled separately. Stockpile management shall be undertaken in accordance with the following protocol:

- Separate stockpiles shall be created for each material type, whether site-won or imported materials, and shall be appropriately labelled / identified on-site.
- The Contractor shall identify all stockpiles with clear signage.
- Stockpiles shall not be cross-contaminated, double handling shall be avoided, and stockpiles shall remain quarantined until ready for use.
- Topsoil shall not be placed during or after heavy or prolonged periods of rainfall.
- For imported materials, copies of the carrier's Consignment Notes shall be retained on-site and made available for inspection and as part of verification reporting.
- A record of all imported materials shall be maintained by the Contractor recording details of material type, source of the imported material and Consignment Note reference numbers. In addition, the Contractor shall record the status of each stockpile, in terms of material type, source site, volume and intended use on-site.

- Stockpiles of significantly contaminated materials (either generated during remediation of previously identified impacts or due to encountering unexpected finds) are to be placed in lined above-ground treatment areas comprised of impermeable membranes to prevent leaching and run off of the potential contaminant(s).

8.4 Disposal of materials

The Waste Framework Directive (WFD) (2009/98/EC) defines waste as *'any substance which the holder discards or intends to discard'*. In a geo-environmental context, the waste is most often 'soil' and the two main scenarios are offsite disposal of the material as a waste and/or reuse of the material on-site. For cost and sustainability reasons, reuse is preferred to off-site disposal.

The site is brownfield and based on the site history and previously reported HazWasteOnline™ assessment, if suitable segregation of different types of waste is put in place, it is considered that:

- The natural unimpacted subsoils are likely to be classified as non-hazardous, however, some natural materials within the area of the former tanks could potentially be classified as Hazardous.
- The majority of the Made Ground soils are likely to be classified as hazardous waste due to the presence of asbestos.
- Due to the history of the site, bituminous bound pavement may contain coal tar residues and should be assumed to be classified as hazardous waste unless testing demonstrates otherwise.
- Any soils containing > 0.1% asbestos fibres or containing visible ACM would be considered as hazardous.

It should be noted that:

- The above preliminary assessment has been made on the basis of the soils tested as part of the ground investigations undertaken to date and is only intended to provide an indication of potential waste classification. Prior to disposal, the characteristics of the actual soils to be disposed of will need testing and classification in consultation with landfill sites and waste disposal Contractors. The receiving landfill will make the final decision on the classification and acceptability of the waste.
- Non-hazardous soils require pre-treatment (separation, sorting and screening) prior to disposal.
- The costs for disposal of non-hazardous and hazardous soils are significant compared to disposal of inert material. Waste segregation (and especially hazardous waste) should always be undertaken where practicable.

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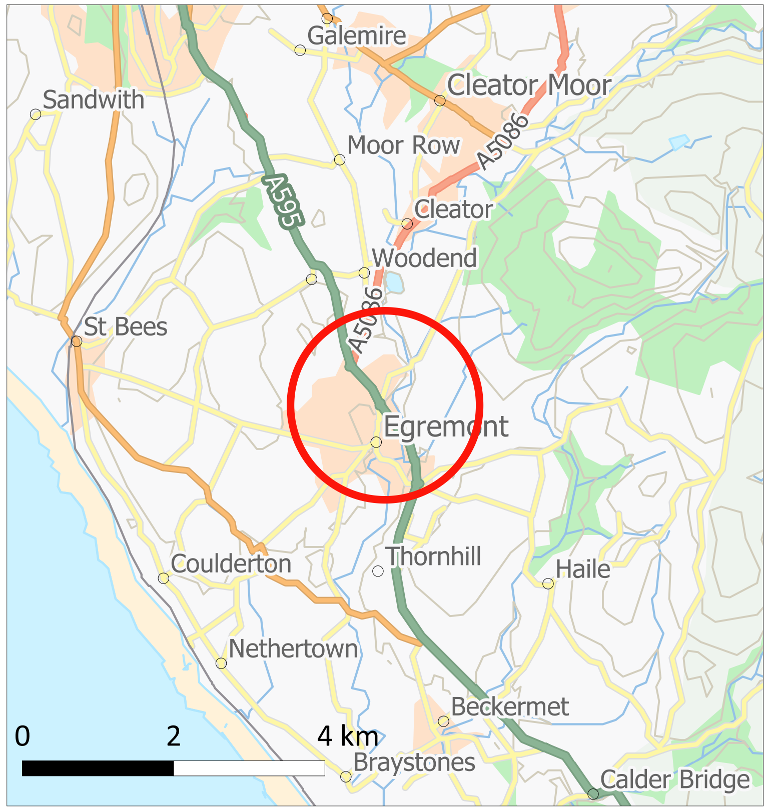
Appendices

Appendix A Drawings



KEY PLAN

🟥 Site Boundary

NOTES

1. Contains OS data © Crown copyright and database right (2025)

REVISIONS

REV.	DRAWN BY INITIALS	CHECKED BY INITIALS	DATE	REVISION NOTES/COMMENTS
P01	ZC	CLD	03/12/202	First issue

Hydrock now Stantec

TITLE
SITE LOCATION PLAN

HYDROCK PROJECT NO.
333701974

SCALE @ A3
1:1,500

CLIENT
Aldi Stores Limited

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS
S2

PROJECT
Aldi - Wyndham Terrace, Egremont

DRAWING NO.
333701974-STN-XX-XX-DR-GE-1001

REVISION
P01

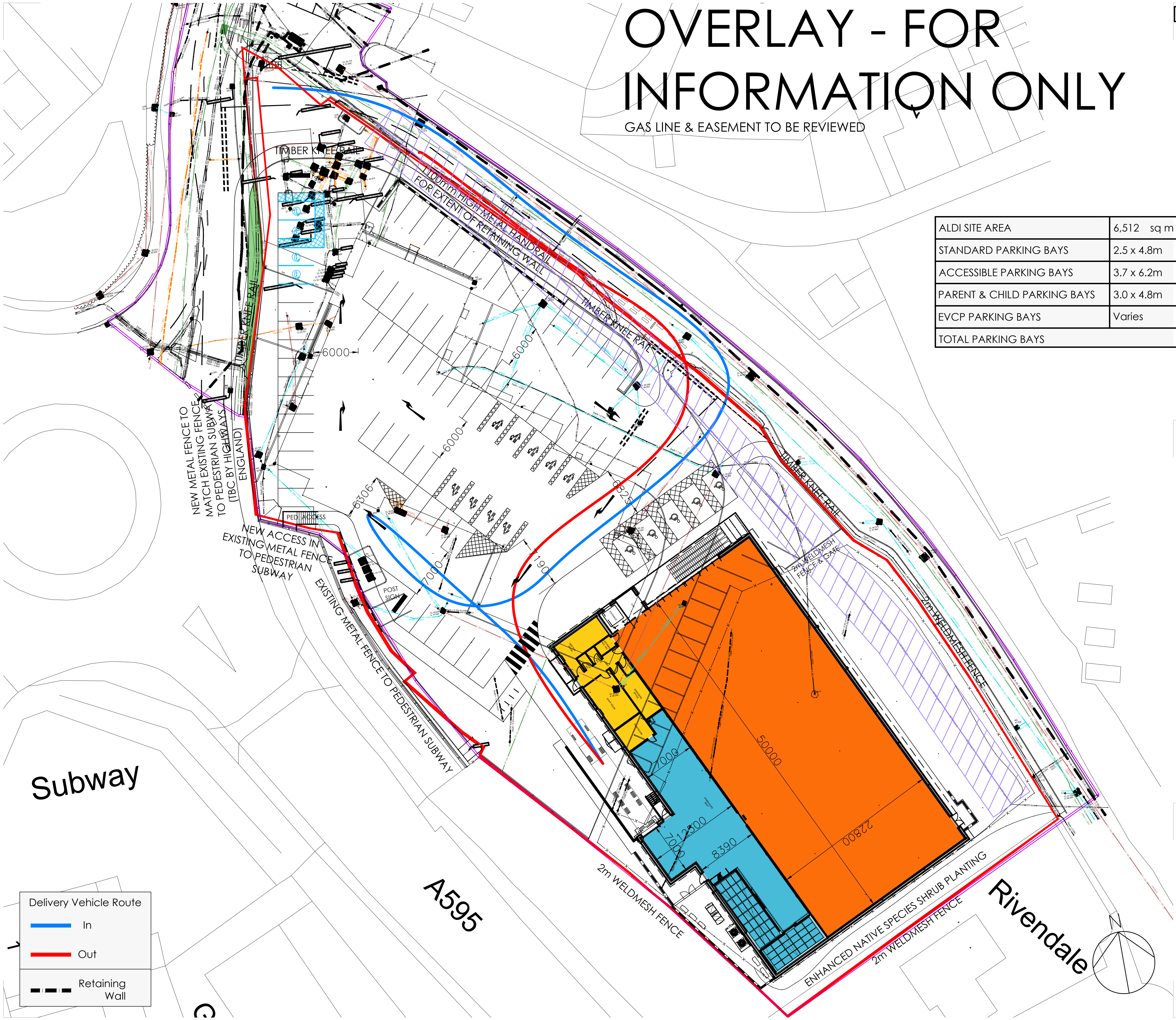
OVERLAY - FOR INFORMATION ONLY

GAS LINE & EASEMENT TO BE REVIEWED

REV	DATE	DESCRIPTION	DRW	CHK
P01	2021-11-19	First issue	AdeL	MJ
P02	2021-11-22	Pedestrian access added from subway	AdeL	
P03	2021-11-24	Pedestrian access path added	AdeL	
P04	2021-12-22	EVCP bays moved	LAV	MJ
P05	2022-03-09	Layout revised to avoid gas main and reduce retention	AdeL	MJ

ALDI SITE AREA	6,512 sq m	1.6 ac
STANDARD PARKING BAYS	2.5 x 4.8m	73
ACCESSIBLE PARKING BAYS	3.7 x 6.2m	5
PARENT & CHILD PARKING BAYS	3.0 x 4.8m	9
EVCP PARKING BAYS	Varies	4
TOTAL PARKING BAYS		86

ALDI BLADE ROOF STORE		
GROSS EXTERNAL FLOOR AREA	1679 sq m	18,072 sq ft
GROSS INTERNAL AREA	1606 sq m	17,286 sq ft
🟧 RETAIL AREA (Inc. Lobby)	1140 sq m	12,270 sq ft
🟨 WELFARE BLOCK (Inc. Plant Room)	115 sq m	1,237 sq ft
🟦 WAREHOUSE (Inc. Loading Bay & Freezers)	320 sq m	3,444 sq ft



Client
Aldi Stores Ltd.

Project Title
Aldi - Egremont

Project Address
Wyndham Place
Egremont

Drawing Title
Site Plan as Proposed

Job No.	Originator	Zone	Level	Type	Role
0541	PA	XX	00	DR	A

System Classification	Drawing No.	Suitability	Revision
PM_40_40-79-0002		S4	P05

Drawn	Checked	Date	Scale	Size
AdeL	MJ	2021-11-19	1:500	A3

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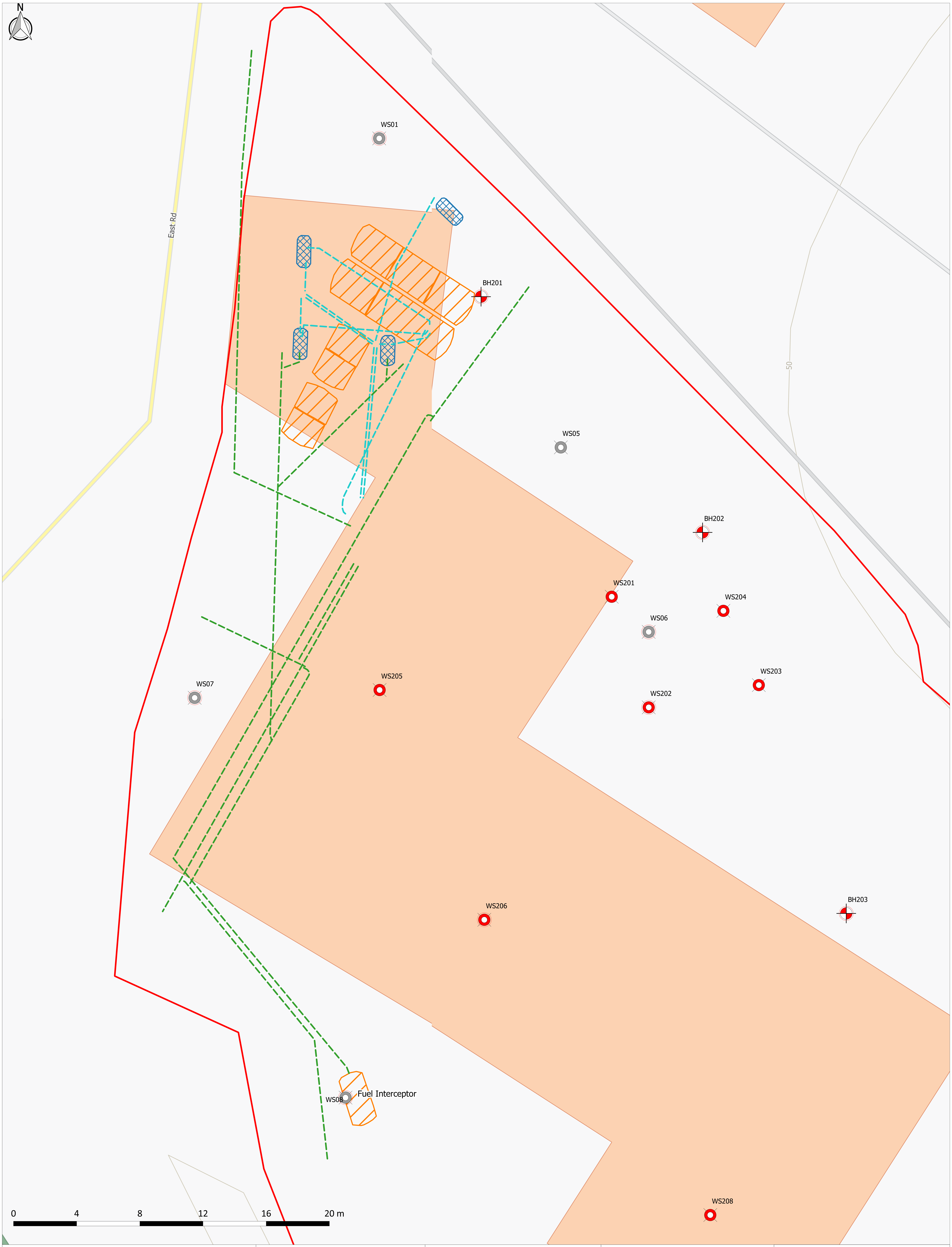


KEY PLAN

🟥 Site Boundary

Actual 2025 Exploratory Locations

- Window Sampling
- ✚ Cable Percussion
- ○ Installation

Historical 2023 Exploratory Locations

- Window Sampling
- ○ Installation

☒ Above Ground Pump Islands

— Assumed Drainage Channel

— Assumed Fuel Pipes

☐ Underground Tank Locations

NOTES

1. Contains OS data © Crown copyright and database right (2025)

REVISIONS

REV.	DRAWN BY INITIALS	CHECKED BY INITIALS	DATE	REVISION NOTES/COMMENTS
P01	ZC	CLD	11/12/202	First issue

Hydrock now Stantec

TITLE
APPROXIMATE TANK INFRASTRUCTURE PLAN

HYDROCK PROJECT NO.
333701974

SCALE @ A2
1:150

CLIENT
Aldi Stores Limited

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS
S2

PROJECT
Aldi - Wyndham Terrace, Egremont

DRAWING NO.
333701974-STN-XX-XX-DR-GE-1003

REVISION
P01

Appendix B Detailed Quantitative Risk Assessment

Project number	333701974	**Project name**	Wyndham Terrace, Egremont
Title	Controlled Waters Detailed Risk Assessment		
Doc ref	333701974-STN-XX-XX-RP-GE-2002		
Status	S2	**Issue number**	P01
Date	17 December 2025		
Prepared by		Zoe Cullerne BSc (Hons) MSc	
Checked and Approved by		Claire Daly BSc (Hons) FGS Geol EurGeol CSci ASoBRA	

1 Methodology

1.1 Guidance

The modelling for Controlled Waters that follows has been carried out in accordance with the following guidance documents:

- GOV.UK. March 2017. Collection: Groundwater protection. Groundwater protection guides covering: requirements, permissions, risk assessments and controls (previously covered in GP3).
- Environment Agency. 2006. Remedial Targets Methodology. Hydrogeological Risk Assessment for Land Contamination.

1.2 Model selection

The model chosen for this assessment is the Environment Agency's RTM Worksheet v3.2. This is a deterministic model that back-calculates acceptable contaminant concentrations at the source site based on defined acceptable environmental standards at a receptor.

1.3 Rationale

Ground investigation and generic quantitative risk assessment (GQRA) has shown there to be impacted groundwater beneath the site, considered likely to be associated with historical petrol filling station and associated infrastructure.

The detailed quantitative risk assessment (DQRA) generates soil and groundwater target concentrations (RTVs) for the contaminants of potential concern (CoPC) at the site that are protective of Controlled Waters. The basis for these concentrations are the relevant water quality targets (WQTs) presented in Section 1.5. Where site concentrations exceed the derived RTVs, there is considered to be a potential risk to Controlled Waters.

The RTM guidance suggests that when contaminants have a travel time of over 1,000 years, which can occur in low flowing groundwater systems and/or determinands with high partitioning coefficients, no action may need to be taken even if the RTV is exceeded. Whilst the travel time to the receptor is not explicitly provided in the RTM spreadsheets, the retarded contaminant velocity is included within the

Level 3 Soil RTM worksheets. Using this retarded contaminant velocity and the distance to the compliance point for each CoPC, the total travel time can be calculated, if required.

1.4 Compliance point

Current Environment Agency guidance on groundwater (see Section 1.1) states that the compliance point should be set at a distance of:

- 50 m hydraulically downgradient of the source area:
    - ‘for all hazardous substances in all aquifers’ (that is, those already in the groundwater or inputs from soils which cannot be prevented); and
    - ’for non-hazardous pollutants in groundwater with a strategic resource potential’ or
- 250 m hydraulically downgradient of the source area boundary:
    - ‘for non-hazardous pollutants in groundwater without a strategic resource potential’.

Substances have been determined as either hazardous substances or non-hazardous pollutants by the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) most recently in 2025. The list of substances is available by following this link: https://wfduk.org/sites/default/files/Media/JAGDAG/2025%2007%2015%20Confirmed%20hazardous%20substances%20list.pdf.

The following compliance point has been selected:

- 50m hydraulically downgradient of the site boundary due to the CoPC being polycyclic aromatic hydrocarbons (PAHs) (classified as hazardous) and petroleum hydrocarbons (petroleum oil is classified as hazardous).

1.5 Selection of water quality targets

Future groundwater abstraction from beneath the site or the surrounding area is considered possible due to the residential and rural use of the surrounding area. The relevant surface water receptor is considered to be the River Ehen, therefore, as in the GQRA in the previous reports, the groundwater data were compared against WQT derived for the protection of human health (based on Drinking Water Standards [DWS]) and for protection of aquatic ecosystems (Environmental Quality Standards [EQS]).

There are no published EQS for petroleum hydrocarbons represented as fractions based on equivalent carbon number. A common approach is to assess against the World Health Organisation (WHO) guide values for petroleum hydrocarbon fractions in drinking water (WHO, 2008), however, this is not considered relevant for EQS. Therefore, an initial target concentration of 10 µg/l at the receptor was used as part of the GQRA in the Stantec 2025 GIR and is continued to be used as the (receptor) target concentration in the DQRA presented in this document. The choice of this value is supported by the limited ecotoxicological evaluations submitted for diesel to the European Chemical Agency REACH database.

1.6 Limitations and uncertainty

The modelling is subject to the following limitations and uncertainties:

- Attenuation may occur in the unsaturated zone, but this is not included in the model, which may yield overly conservative predictions for soil sources.
- The model assumes instantaneous dilution of leaching contaminants in the groundwater body.

- Biodegradation is assumed to be occurring within the aquifer, although site-specific biodegradation rates have not been determined. Therefore, contaminant half-lives used in the model are based on values given in reliable literature sources and professional judgement.
- The model assesses the risks from dissolved contaminants only – there is no assessment within the model of potential risks from the non-aqueous phase liquid (NAPL). Limited non-aqueous phase liquid (NAPL) petroleum hydrocarbons have been noted within BH202. This appears to be localised, as other visual or olfactory evidence of petroleum hydrocarbons within the groundwater was limited to mild hydrocarbon odours and sheens/residue.

2 Modelling assumptions and parameterisation

2.1 Source area and plume characterisation

Elevated petroleum hydrocarbons have been reported within the Made Ground and natural soils, generally across the northeast and centre, within the vicinity of or downgradient of the historical fuel filing station.

Two rounds of groundwater sampling using low-flow techniques were undertaken over the period 10/11/2025 to 18/11/2025 to support this DQRA. The sampling method for the 2023 sampling is unknown.

Laboratory certificates are presented in the ground investigation reports:

- Hydrock (Stantec), December 2023. Wyndham Place, Egremont: Ground Investigation Report. Ref: 28850-HYD-XX-XX-RP-GE-0001.
- Stantec, December 2025. Wyndham Place, Egremont: Ground Investigation Report. Ref: 333800252-STN-XX-XX-RP-GE-2001.

Three rounds of groundwater sampling have now been completed across the site to date, comprising:

- Round 1: 4 December 2023.
- Round 2: 10 November 2025.
- Round 3: 18 November 2025.

The tabular presentation of these data comparing the three individual rounds of analytical data against the WQTs is provided in the Stantec 2025 ground investigation report (GIR) (333800252-STN-XX-XX-RP-GE-2001).

Groundwater impacts are considered to be one localised ‘plume’ rather than multiple plumes.

2.2 Contaminants of potential concern

CoPC were screened against generic WQTs as part of the GQRA in the above reports. Although several CoPC have exceeded their WQT, not all CoPC are considered to pose a significant risk to Controlled Waters.

This DQRA is focused on assessing the main risk drivers with regards to Controlled Waters. The CoPC that have not been taken forward for DQRA (namely metals and inorganics), along with their justification for removal from the process, are summarised in the Stantec 2025 GIR (333800252-STN-XX-XX-RP-GE-2001).

Relevant guidance by CL:AIRE (2017) recommends that, where justifiable, the risks to groundwater from petroleum hydrocarbon fractions should be assessed using specific indicator compounds rather than the fraction as a whole. For this approach to be justified, the individual compound should comprise a large percentage of the petroleum hydrocarbon fraction. Given the majority of petroleum hydrocarbon fractions were reported below the limit of detection, it is unclear whether indicator compounds represent significant portion of the relevant fractions.

Therefore, the individual petroleum hydrocarbon fractions and indicator compounds will all be taken forward and assessed as part of the DQRA.

The CoPC that are judged as the main risk drivers requiring DQRA are summarised in Table 2.1.

Table 2.1: CoPC considered main risk drivers for RTM modelling - water

CoPC	Target Concentration at Receptor (µg/l)	Groundwater Concentration at Source (µg/l)	WQT Source	Relative mobility in groundwater (CL:AIRE, 2017)
Aliphatic >EC$_{12}$-EC$_{16}$	10	51	See Section 1.5	Very low
Aliphatic >EC$_{16}$-EC$_{35}$	10	140		-
Anthracene	0.10	0.14		Low
Benzo(a)pyrene	0.00017	0.41		Very low
Benzo(b)fluoranthene	0.017	0.52		Very low
Benzo(ghi)perylene	0.0082	0.31		Very low
Benzo(k)fluoranthene	0.017	0.21		Very low
Fluoranthene	0.0063	0.76		-

In addition to the above, DQRA has been undertaken to develop soil RTVs for use in the validation of the tank removal works for the CoPC presented in Table 2.2. Only petroleum hydrocarbon fractions which have a relative mobility in groundwater of medium or higher have been taken forward with the exception of >EC$_5$-EC$_7$ and >EC$_7$-EC$_8$ aromatic fractions, where BTEX are assessed as indicator compounds. Similarly, naphthalene has been adopted as the most mobile PAH.

Table 2.2: CoPC considered main risk drivers for RTM modelling - soil

CoPC	Target Concentration at Receptor (µg/l)	Groundwater Concentration at Source (µg/l)	WQT Source	Relative mobility in groundwater (CL:AIRE, 2017)
Aliphatic >EC$_5$-EC$_6$	10	2.8	See Section 1.5	High
Aliphatic >EC$_6$-EC$_8$	10	<1		Moderate
Aromatic >EC$_8$-EC$_{10}$	10	<1		High
Aromatic >EC$_{10}$-EC$_{12}$	10	<10		Moderate
Aromatic >EC$_{12}$-EC$_{16}$	10	<10		Moderate
Naphthalene	2	<0.1		Moderate
Benzene	10	<1		High
Toluene	74	<1		High
Ethylbenzene	20	<1		High
m,p-xylene	30	<1		High
o-xylene	30	<1		High

2.3 Saturated zone

Hydraulic gradient

The groundwater flow direction is considered to be towards the southeast (i.e., towards the River Ehen). Gradients have been calculated based on data from BH201 in the north and BH208 in the south, both installed across the Made Ground and Superficial Deposits, which are approximately 113m apart. The calculated hydraulic gradients on each groundwater gauging round are summarised in Table 2.3.

Table 2.3: Summary of hydraulic gradient

Monitoring Date>>	10/11/2025	17/11/2025
Gradient	0.0637	0.0644

An average hydraulic gradient based on the two monitoring visits of 0.064 is used as part of the DQRA presented within this report.

Fractional organic carbon and moisture content

A total of 7 soil samples from the unimpacted Superficial Deposits (i.e., without visual and olfactory evidence of contamination) have been analysed for fractional organic carbon (FOC) content. The results are summarised in Table 2.4. All Made Ground and impacted results have been discounted as they are not considered representative of the aquifer, but it is noted are of similar values to the unimpacted Superficial Deposits.

Table 2.4: Fractional organic content

Location	Depth (m bgl)	Strata	Visual or Olfactory Evidence	Zone	FOC
WS202	0.70	Made Ground	Yes	Unsaturated	0.035
WS206	2.50		Yes	Unsaturated	0.027
WS10	0.60		Yes	Unsaturated	0.007
WS12	1.00		Yes	Unsaturated	0.017
WS201	0.30		No	Unsaturated	0.022
WS204	0.50		No	Unsaturated	0.0086
WS205	0.50		No	Unsaturated	0.0085
WS202	1.30		No	Unsaturated	0.015
WS203	1.20		No	Unsaturated	0.015
WS206	0.50		No	Unsaturated	0.012
WS203	0.50		No	Unsaturated	0.0039
WS208	1.30		No	Unsaturated	0.024
WS01	1.00		No	Unsaturated	0.028
WS05	0.30		No	Unsaturated	0.005
WS06	0.30		No	Unsaturated	0.056
WS09	1.70		No	Unsaturated	0.070
WS12	1.65		No	Unsaturated	0.022
WS12	3.30		No	Unsaturated	0.015
WS13	1.00		No	Unsaturated	0.036
WS13	2.20		No	Unsaturated	0.019

Location	Depth (m bgl)	Strata	Visual or Olfactory Evidence	Zone	FOC
WS205	2.00	Superficial Deposits	Yes	Unsaturated	0.0054
WS205	3.50		No	Unsaturated	0.029
WS05	1.45		No	Unsaturated	0.009
WS07	0.90		No	Unsaturated	0.004
WS204	1.10		No	Unsaturated	0.0073
BH203	5.00		Yes	Saturated	0.031
WS09	4.20		Yes	Saturated	0.035
BH205	7.00		No	Saturated	0.001
BH207	6.00		No	Saturated	0.0066
BH208	7.00		No	Saturated	0.001

Within the Superficial Deposits, the FOC content ranges from 0.004 to 0.029 within the unsaturated zone (i.e., the soil zone), and 0.001 to 0.0066 within the saturated zone (i.e., the aquifer), with averages of 0.049 and 0.0029, respectively, which have been used as part of the DQRA.

In addition, moisture content is also summarised in Table 2.5, where relevant, which is a key parameter for calculating porosity. All Made Ground results have been discounted as they are not considered representative of the aquifer.

Table 2.5: Moisture content

Location	Depth (m bgl)	Strata	Zone	Moisture Content (%)
WS09	1.90	Made Ground	Unsaturated	17
WS12	2.25		Unsaturated	22
WS203	1.00		Unsaturated	23.8
WS05	1.70	Superficial Deposits	Unsaturated	28
WS205	4.00		Unsaturated	8.0
WS201	3.50		Unsaturated	9.5
WS203	3.00		Unsaturated	29.8
BH205	6.50		Saturated	5.3
BH207	6.00		Saturated	6.0
BH208	6.00		Saturated	8.0
WS202	3.80		Saturated	9.3

The moisture content ranges from 8.0% to 29.8% within the unsaturated zone (i.e., the soil zone), and 5.3% to 9.3% within the saturated zone (i.e., the aquifer), with averages of 18.83% and 7.15%, respectively, which have been used as part of the DQRA.

Summary of physical parameters

The physical input parameters, including literature values, where relevant, are summarised in Table 2.6.

Table 2.6: Summary of physical input parameters

Parameter	Value	Units	Justification
Water filled porosity of soil zone materials	0.145	-	Calculated using RTM porosity calculator using site-specific moisture content data (see Table 2.5) and default density data within the calculator.
Air filled porosity of soil zone materials	0.125	-	
Bulk density of soil zone materials	2.03	g/cm³	Mid-point for Glacial Till from McGown (1975).
Bulk density of aquifer zone materials			
Infiltration rate	0.00029	m/d	10% of average annual rainfall (2015-2024) at Newton Rigg from Met Office (1074 mm/yr), converted to m/d. Considered suitable for a site to be covered by mixture of granular surfacing and hardstanding.
Saturated aquifer thickness	5.78	m	Average thickness of saturated aquifer (assumed to be Superficial Deposits) from ground investigation data. (Maximum measured depth of Superficial Deposits: 9.50m – average depth to groundwater: 3.72m)
Width of source	10	m	A conservative value of 10m x 10m has been assumed to represent the zone of hydrocarbon impacted soils around each tank.
Length of source	10	m	
Groundwater plume width at source	15	m	The groundwater plume is estimated based on the area of the tank farm beneath the fuel filling station in the north of the site.
Groundwater plume length at source	20	m	
Groundwater plume thickness at source	5.20	m	90% of saturated aquifer thickness.
Hydraulic gradient of water table	0.064	-	Mean hydraulic gradient for aquifer (see Table 2.3).
Hydraulic conductivity of aquifer	0.00012	m/d	Geomean of hydraulic conductivity values for Till from Domenico and Schwartz (1990).
FOC in soil zone materials	0.049	-	Mean of unsaturated/saturated Superficial Deposit samples (see Table 2.4). Samples free of visual/olfactory evidence of contamination.
FOC in aquifer	0.0029	-	
Effective porosity of aquifer	0.39	-	Average of gravel, sand, silt and clay from Domenico and Schwartz (1990).
Path distance (i.e., compliance point)	50	m	Default for hazardous chemicals.
Time since pollutant entered groundwater	1×10^{100}	Years	Very large time chosen to achieve a steady-state solution.

2.4 Summary of contaminant parameters

The contaminant-specific input parameters are summarised in Table 2.7.

Table 2.7: Contaminant-specific input parameters

CoPC	K_{OC} (cm³/g)	Henry's Law Constant	Contaminant half-life (d)
Aliphatic >EC_5-EC_6	794 (1)	33 (1)	730 (4)
Aliphatic >EC_6-EC_8	3981 (1)	50 (1)	730 (4)
Aliphatic >EC_{12}-EC_{16}	5010000 (1)	520 (1)	5000 (4)
Aliphatic >EC_{16}-EC_{21}	631000000 (1)	4900 (1)	5000 (4)

CoPC	K_{OC} (cm^3/g)	Henry's Law Constant	Contaminant half-life (d)
Aliphatic >EC_{21}-E_{35}	631000000 (1)	4900 (1)	5000 (4)
Aromatic >EC_8-EC_{10}	1585 (1)	0.48 (1)	125 (9)
Aromatic >EC_{10}-EC_{12}	2512 (1)	0.14 (1)	130 (5)
Aromatic >EC_{12}-EC_{16}	5012 (1)	0.053 (1)	115 (6)
Anthracene	5620 (2)	0.000181 (2)	510 (7)
Benzo(a)pyrene	129000 (3)	0.0000186 (3)	587 (9)
Benzo(b)fluoranthene	105000 (3)	0.0000206 (3)	969 (9)
Benzo(ghi)perylene	148000 (3)	0.0000174 (3)	1240 (9)
Benzo(k)fluoranthene	417000 (3)	0.0000303 (3)	3050 (9)
Fluoranthene	18197 (3)	0.0003783 (3)	580 (8)
Naphthalene	647.7 (3)	0.0182 (3)	130 (5)
Benzene	67.60 (3)	0.23 (3)	200 (10)
Toluene	204 (3)	0.279 (3)	9999 (11)
Ethylbenzene	477 (3)	0.357 (3)	125 (10)
m-xylene	489.78 (3)	0.309 (3)	9999 (11)
o-xylene	426.58 (3)	0.233 (3)	125 (10)
p-xylene	446.68 (3)	0.283 (3)	9999 (11)

Notes:

1. TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3.
2. LQM/CIEH 2nd Edition
3. EA Science report 7, 2008
4. Professional judgement taking ‘Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand’ (Ministry for the Environment, 2011) and also the relative ease of degradation of the various types of petroleum hydrocarbons using corresponding aromatic fractions as a general guide (i.e., also using notes [4] to [7] from Howard et al [1991]).
5. Midpoint naphthalene (Howard et al, 1991).
7. Midpoint of range for fluorene, anthracene, phenanthrene (Howard et al, 1991).
8. Midpoint fluoranthene (Howard et al, 1991).
9. Midpoint for benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene (Howard et al, 1991).
10. EA2002 average aerobic conditions (benzene, toluene and xylene).
11. Maximum, none assumed.
Although corresponding indicator compounds are not being assessed, information on their potential degradation rates from Howard et al (1991) are still considered relevant for the petroleum hydrocarbon fractions listed above (since information on these is not widely available elsewhere).

3 Risk assessment results

3.1 Modelled target concentrations

The full RTM worksheets for each of the CoPC are presented in Annex A (Groundwater DQRA) and the results are summarised in Table 3.1.

Table 3.1: Summary of modelling results

CoPC	Target Concentration at Receptor (µg/l)	50m Compliance Point			
		Level 3 Soil RTV (mg/kg)	Travel Time (soil) (years)	Level 3 Groundwater RTV (µg/l)	Travel Time (years) (groundwater)
Aliphatic >EC_{12}-EC_{16}	10	224,012.19	7,931,349	No impact	526,081,977
Aliphatic >EC_{16}-EC_{21}	10	28,210,498.16	998,925,330	No impact	66,258,158,354
Aliphatic >EC_{21}-EC_{35}	10	28,210,498.16	998,925,330	No impact	66,258,158,354

CoPC	**Target Concentration at Receptor (µg/l)**	**50m Compliance Point**			
		Level 3 Soil RTV (mg/kg)	**Travel Time (soil) (years)**	**Level 3 Groundwater RTV (µg/l)**	**Travel Time (years) (groundwater)**
Anthracene	0.10	5,063,009.70	9,007	No impact	597,442
Benzo(a)pyrene	0.00017	43,541.60	204,045	No impact	13,534,224
Benzo(b)fluoranthene	0.017	37,241.49	165,874	No impact	1,1002,333
Benzo(ghi)perylene	0.0082	4,060.14	234,401	No impact	15,547,695
Benzo(k)fluoranthene	0.017	182.86	660,250	No impact	43,794,038
Fluoranthene	0.0063	258,172.77	28,912	No impact	1,917,732

Travel times (both soil and groundwater) significantly exceed 1,000 years for all of the petroleum hydrocarbon fractions and PAHs modelled. It is considered that these petroleum hydrocarbon fractions or PAHs will not reach the surface water receptor and, therefore, do not pose a significant risk to Controlled Waters and no remediation is required.

RTVs for use in validating soils during the removal of the fuel tanks and infrastructure are presented in Table 3.2, and the full RTM worksheets for each of the CoPC are presented in Annex B (Soil RTV derivation).

Table 3.2: Summary of soil RTVs

CoPC	**Target Concentration at Receptor (µg/l)**	**50m Compliance Point**	
		Level 3 Soil RTV (mg/kg)	**Travel Time (soil) (years)**
Aliphatic >EC$_{5}$-EC$_{6}$	10	1.98E+06	1,361.84
Aliphatic >EC$_{6}$-EC$_{8}$	10	9.55E+06	6,407.13
Aromatic >EC$_{8}$-EC$_{10}$	10	1.38E+18	2,614.06
Aromatic >EC$_{10}$-EC$_{12}$	10	8.99E+17	4,081.58
Aromatic >EC$_{12}$-EC$_{16}$	10	3.07E+19	8,039.29
Naphthalene	2.4	5.55E+16	1,127.07
Benzene	10	4.18E+12	211.89
Toluene	74	1.47E+00	428.14
Ethylbenzene	20	7.81E+17	812.51
m,p-xylene	30	1.30E+00	812.01
o-xylene	30	1.12E+18	780.19

3.2 Comparison against site conditions

The modelled RTVs have been compared to the on-site soil concentrations recorded during the ground investigations as shown in Table 3.3 to highlight areas where additional remediation may be required.

Table 3.3: Comparison of derived soil target against on site concentrations

CoPC	Level 3 Soil RTV (mg/kg)	Maximum Soil Concentration at Source (mg/kg)	Number of Exceedances
Aliphatic $>EC_5-EC_6$	1.98E+06	0.02	0
Aliphatic $>EC_6-EC_8$	9.55E+06	0.64	0
Aromatic $>EC_8-EC_{10}$	1.38E+18	0.05	0
Aromatic $>EC_{10}-EC_{12}$	8.99E+17	34	0
Aromatic $>EC_{12}-EC_{16}$	3.07E+19	1100	0
Naphthalene	5.55E+16	3.80	0
Benzene	4.18E+12	0.01	0
Toluene	1.47E+00	0.01	0
Ethylbenzene	7.81E+17	0.01	0
m,p-xylene	1.30E+00	0.01	0
o-xylene	1.12E+18	0.01	0

The assessment in Table 3.3 records no exceedances of the soil modelled RTVs, indicating no additional areas require remediation.

4 Sensitivity analysis

Several of the parameters used within the model are not site specific and based on published literature or assumptions based on other site data. Consequently, a sensitivity analysis has been undertaken to understand which parameters are most sensitive within the model. Where a range of values exists, either for the site-specific data or in published literature (see Table 2.7), this range has been used. The results of the sensitivity analysis for anthracene are summarised in Table 4.1.

The sensitivity analysis indicates that the model is not sensitive to porosity, bulk density or aquifer FOC and has a low sensitivity to the source dimensions used. The most sensitive parameters are infiltration, saturated aquifer thickness and path distance.

Following the sensitivity analysis the model is considered to be appropriate for the following reasons:

- Infiltration rates have been calculated based on actual Met Office data for the nearest station to the site. Significantly increasing the values would likely significantly decrease the modelled RTVs.
- The saturated aquifer thickness is based on site-specific data of the groundwater and ground conditions encountered. Significantly increasing the values would likely significantly increase the modelled RTVs.
- A compliance point has been selected as the 50m default compliance point recommended by the Environment Agency for release of hazardous substances into groundwater. The nearest Controlled Water receptor is the River Ehen. Reducing the compliance point would increase the RTVs.

Table 4.1: Soil RTM sensitivity analysis for Anthracene

Parameter	Original Value	Sensitivity Analysis		Soil RTV (Minimum) (mg/kg)	Soil RTV (Maximum) (mg/kg)
		Minimum Value	Maximum Value		
Infiltration	1.22E-04	9.18E-05	1.53E-04	1.10E+14	1.96E+10
Saturated Aquifer thickness	5.78	2.89	8.67	4.38E+07	1.08E+15
Path distance	50	40	60	1.47E+10	2.13E+13

Sensitivity analysis was not undertaken for groundwater level 3 RTVs due to the results being ‘no impact’ rather than a number, therefore, changes cannot be quantified.

Annex A – RTM Worksheets – Groundwater DQRA

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

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		**Aliphatic C12-16**	
Target concentration	C_T	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	5.20E+02	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	5.01E+06	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.45E+05**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**2.46E+03**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C12-16**		from Level 1
Target concentration	**C_T**	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**1.04E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		2.54E+03	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Environment Agency

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aliphatic C12-16		from Level 1
Target Concentration	C_T	0.01	mg/l	from Level 1
Dilution Factor	DF	1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*None assumed*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sanc*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.45E+04	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	5.62E-04	m/d
Retardation factor	Rf	7.56E+04	fraction
Decay rate used	λ	1.83E-09	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	7.44E-09	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	3.94E-04	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**2.54E+03**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**2.63E+01**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		6.45E+06	**mg/kg**	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point		**50**	**m**	
Ratio of Compliance Point to Source Concentration	**C_{ED}/C_0**	**3.94E-04**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+06	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.45E+04	l/kg

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

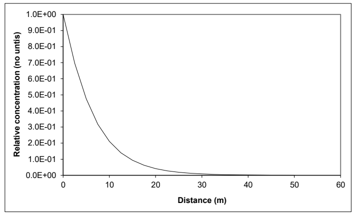
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	6.97E-01	0.00E+00
5.0	4.76E-01	0.00E+00
7.5	3.18E-01	0.00E+00
10.0	2.11E-01	0.00E+00
12.5	1.40E-01	0.00E+00
15.0	9.33E-02	0.00E+00
17.5	6.23E-02	0.00E+00
20.0	4.17E-02	0.00E+00
22.5	2.80E-02	0.00E+00
25.0	1.89E-02	0.00E+00
27.5	1.27E-02	0.00E+00
30.0	8.61E-03	0.00E+00
32.5	5.83E-03	0.00E+00
35.0	3.96E-03	0.00E+00
37.5	2.69E-03	0.00E+00
40.0	1.83E-03	0.00E+00
42.5	1.24E-03	0.00E+00
45.0	8.47E-04	0.00E+00
47.5	5.78E-04	0.00E+00
50.0	3.94E-04	0.00E+00

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		**Aliphatic C12-16**		from Level 1
Target Concentration	C_T	**1.00E-02**	mg/l	from Level 1

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

Ogata Banks **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*None assumed*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.45E+04	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	7.56E+04	fraction
Decay rate used	λ	1.83E-09	d^{-1}
Rate of contaminant flow due to retardation	u	2.60E-10	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target		No impact	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+06	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.45E+04	l/kg

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

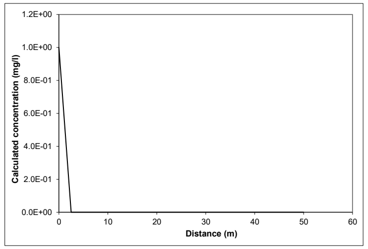
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.0E+00**
2.5	**0.00E+00**
5.0	**0.00E+00**
7.5	**0.00E+00**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

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		**Aliphatic C16-21**	
Target concentration	C_T	**0.01**	mg/l

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	4.90E+03	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	6.31E+08	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**3.09E+07**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**3.09E+05**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C16-21**		from Level 1	
Target concentration	C_T	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**1.04E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		3.20E+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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aliphatic C16-21		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	**DF**	**1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*None assumed*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.83E+06	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	5.62E-04	m/d
Retardation factor	Rf	9.52E+06	fraction
Decay rate used	λ	1.46E-11	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	5.90E-11	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	3.94E-04	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**2.54E+03**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**2.63E+01**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		8.12E+08	**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_{ED}/C_0	**3.94E-04**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.83E+06	l/kg

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

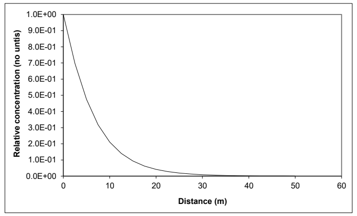
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	6.97E-01	0.00E+00
5.0	4.76E-01	0.00E+00
7.5	3.18E-01	0.00E+00
10.0	2.11E-01	0.00E+00
12.5	1.40E-01	0.00E+00
15.0	9.33E-02	0.00E+00
17.5	6.23E-02	0.00E+00
20.0	4.17E-02	0.00E+00
22.5	2.80E-02	0.00E+00
25.0	1.89E-02	0.00E+00
27.5	1.27E-02	0.00E+00
30.0	8.61E-03	0.00E+00
32.5	5.83E-03	0.00E+00
35.0	3.96E-03	0.00E+00
37.5	2.69E-03	0.00E+00
40.0	1.83E-03	0.00E+00
42.5	1.24E-03	0.00E+00
45.0	8.47E-04	0.00E+00
47.5	5.78E-04	0.00E+00
50.0	3.94E-04	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

Input Parameters (using pull down menu)	Variable	Value	Unit	Source
Contaminant		Aliphatic C16-21		from Level 1
Target Concentration	C_T	1.00E-02	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

	Variable	Value	Unit	Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*None assumed*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.83E+06	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

Calculated Parameters	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	9.52E+06	fraction
Decay rate used	λ	1.46E-11	d^{-1}
Rate of contaminant flow due to retardation	u	2.07E-12	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target		No impact	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.83E+06	l/kg

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

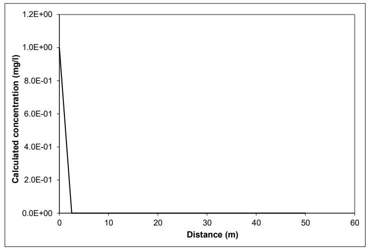
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

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

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	1.0E+00
2.5	0.00E+00
5.0	0.00E+00
7.5	0.00E+00
10.0	0.00E+00
12.5	0.00E+00
15.0	0.00E+00
17.5	0.00E+00
20.0	0.00E+00
22.5	0.00E+00
25.0	0.00E+00
27.5	0.00E+00
30.0	0.00E+00
32.5	0.00E+00
35.0	0.00E+00
37.5	0.00E+00
40.0	0.00E+00
42.5	0.00E+00
45.0	0.00E+00
47.5	0.00E+00
50.0	0.00E+00

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Remedial Targets Worksheet , Release 3.2

Environment Agency

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		**Aliphatic C21-35**	
Target concentration	C_T	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	4.90E+03	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	6.31E+08	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**3.09E+07**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**3.09E+05**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C21-35**		from Level 1
Target concentration	**C_T**	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**1.04E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		3.20E+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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aliphatic C21-35		from Level 1
Target Concentration	C_T	0.01	mg/l	from Level 1
Dilution Factor	DF	1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*None assumed*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.83E+06	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	5.62E-04	m/d
Retardation factor	Rf	9.52E+06	fraction
Decay rate used	λ	1.46E-11	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	5.90E-11	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	3.94E-04	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**2.54E+03**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**2.63E+01**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		8.12E+08	**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_{ED}/C_0**	**3.94E-04**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.83E+06	l/kg

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

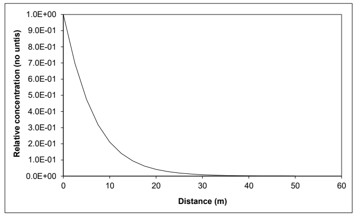
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	6.97E-01	0.00E+00
5.0	4.76E-01	0.00E+00
7.5	3.18E-01	0.00E+00
10.0	2.11E-01	0.00E+00
12.5	1.40E-01	0.00E+00
15.0	9.33E-02	0.00E+00
17.5	6.23E-02	0.00E+00
20.0	4.17E-02	0.00E+00
22.5	2.80E-02	0.00E+00
25.0	1.89E-02	0.00E+00
27.5	1.27E-02	0.00E+00
30.0	8.61E-03	0.00E+00
32.5	5.83E-03	0.00E+00
35.0	3.96E-03	0.00E+00
37.5	2.69E-03	0.00E+00
40.0	1.83E-03	0.00E+00
42.5	1.24E-03	0.00E+00
45.0	8.47E-04	0.00E+00
47.5	5.78E-04	0.00E+00
50.0	3.94E-04	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Environment Agency

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Aliphatic C21-35**		from Level 1
Target Concentration	C_T	**1.00E-02**	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+03	days	*None assumed*
Calculated decay rate	λ	1.39E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.83E+06	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	9.52E+06	fraction
Decay rate used	λ	1.46E-11	d^{-1}
Rate of contaminant flow due to retardation	u	2.07E-12	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target		No impact	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	6.31E+08	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.83E+06	l/kg

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

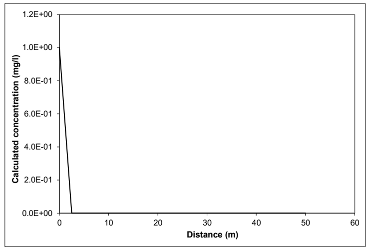
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.0E+00**
2.5	**0.00E+00**
5.0	**0.00E+00**
7.5	**0.00E+00**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

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		Anthracene		
Target concentration	C_T	**0.0001**	mg/l	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	1.81E-04	dimensionless	*LQM/CIEH 2nd Ed. - Kaw*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd	[redacted]	l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	5.62E+03	l/kg	*LQM/CIEH 2nd Ed.*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$	[redacted]	l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$	[redacted]	l/kg	-
pH value	pH	[redacted]	pH units	*Only polar*
Acid dissociation constant	pKa	[redacted]		-
Fraction of organic carbon (in soil)	foc	[redacted]	fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.76E+02**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**2.76E-02**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.0001	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Environment Agency

Level 2 - Soil

Contaminant		Anthracene		from Level 1	
Target concentration	C_T	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**1.04E-04**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		2.86E-02	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Environment Agency

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Anthracene**		from Level 1
Target Concentration	C_T	**0.0001**	mg/l	from Level 1
Dilution Factor	**DF**	**1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.10E+02	days	*Howard et al*
Calculated decay rate	λ	1.36E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.63E+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	5.62E-04	m/d
Retardation factor	Rf	8.59E+01	fraction
Decay rate used	λ	1.58E-05	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	6.55E-06	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	4.29E-14	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**2.33E+13**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**2.42E+09**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		6.66E+11	**mg/kg**	For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water partitioning equation.
Distance to compliance point		**50**	**m**	
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**4.29E-14**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	5.62E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.63E+01	l/kg

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

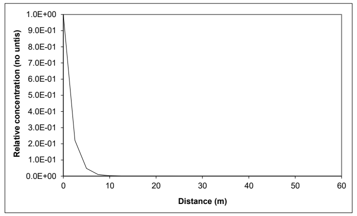
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	**1.0E+00**	**0.00E+00**
2.5	**2.21E-01**	**0.00E+00**
5.0	**4.80E-02**	**0.00E+00**
7.5	**1.02E-02**	**0.00E+00**
10.0	**2.15E-03**	**0.00E+00**
12.5	**4.53E-04**	**0.00E+00**
15.0	**9.57E-05**	**0.00E+00**
17.5	**2.03E-05**	**0.00E+00**
20.0	**4.32E-06**	**0.00E+00**
22.5	**9.21E-07**	**0.00E+00**
25.0	**1.97E-07**	**0.00E+00**
27.5	**4.22E-08**	**0.00E+00**
30.0	**9.06E-09**	**0.00E+00**
32.5	**1.95E-09**	**0.00E+00**
35.0	**4.20E-10**	**0.00E+00**
37.5	**9.05E-11**	**0.00E+00**
40.0	**1.95E-11**	**0.00E+00**
42.5	**4.22E-12**	**0.00E+00**
45.0	**9.14E-13**	**0.00E+00**
47.5	**1.98E-13**	**0.00E+00**
50.0	**4.29E-14**	**0.00E+00**

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Anthracene**		from Level 1
Target Concentration	C_T	**1.00E-04**	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	5.10E+02	days	*Howard et al*
Calculated decay rate	λ	1.36E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.63E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	5.62E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.63E+01	l/kg

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

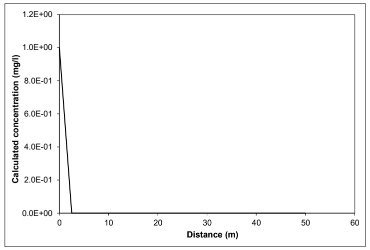
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

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

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.0E+00**
2.5	**0.00E+00**
5.0	**0.00E+00**
7.5	**0.00E+00**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

Calculated Parameters

	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	8.59E+01	fraction
Decay rate used	λ	1.58E-05	d^{-1}
Rate of contaminant flow due to retardation	u	2.29E-07	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	**C_{ED}/C_0**	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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		**Benzo(a)pyrene**	
Target concentration	C_T	**0.00000017**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	1.86E-05	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	1.29E+05	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**6.31E+03**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**1.07E-03**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.00000017	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Environment Agency

Level 2 - Soil

Contaminant		**Benzo(a)pyrene**		from Level 1
Target concentration	C_T	**0.00000017**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**1.76E-07**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		1.11E-03	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

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	C_T	0.00000017	mg/l	from Level 1
Dilution Factor	DF	1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.87E+02	days	*Howard et al*
Calculated decay rate	λ	1.18E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	3.74E+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		
Groundwater flow velocity	v	5.62E-04	m/d
Retardation factor	Rf	1.95E+03	fraction
Decay rate used	λ	6.07E-07	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	2.89E-07	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	4.43E-13	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**2.26E+12**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**3.98E+05**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		2.51E+09	**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_{ED}/C_0**	**4.43E-13**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.29E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.74E+02	l/kg

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

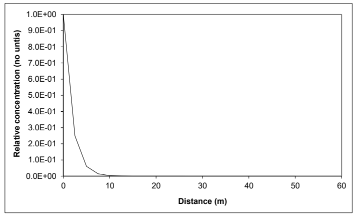
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed: Aldi - Wyndham Terrace, Egremont
Completed by: Zoe Cullerne
Date: #######
Version: 1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Relative concentration (No units)**	**Concentration mg/l**
0	**1.0E+00**	**0.00E+00**
2.5	**2.49E-01**	**0.00E+00**
5.0	**6.06E-02**	**0.00E+00**
7.5	**1.44E-02**	**0.00E+00**
10.0	**3.42E-03**	**0.00E+00**
12.5	**8.11E-04**	**0.00E+00**
15.0	**1.93E-04**	**0.00E+00**
17.5	**4.59E-05**	**0.00E+00**
20.0	**1.10E-05**	**0.00E+00**
22.5	**2.63E-06**	**0.00E+00**
25.0	**6.32E-07**	**0.00E+00**
27.5	**1.52E-07**	**0.00E+00**
30.0	**3.67E-08**	**0.00E+00**
32.5	**8.88E-09**	**0.00E+00**
35.0	**2.15E-09**	**0.00E+00**
37.5	**5.21E-10**	**0.00E+00**
40.0	**1.26E-10**	**0.00E+00**
42.5	**3.07E-11**	**0.00E+00**
45.0	**7.47E-12**	**0.00E+00**
47.5	**1.82E-12**	**0.00E+00**
50.0	**4.43E-13**	**0.00E+00**

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Benzo(a)pyrene**		from Level 1
Target Concentration	C_T	**1.70E-07**	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	5.87E+02	days	*Howard et al*
Calculated decay rate	λ	1.18E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.74E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	1.95E+03	fraction
Decay rate used	λ	6.07E-07	d^{-1}
Rate of contaminant flow due to retardation	u	1.01E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.29E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.74E+02	l/kg

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

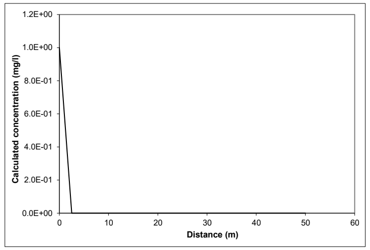
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.0E+00**
2.5	**0.00E+00**
5.0	**0.00E+00**
7.5	**0.00E+00**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

Remedial Targets Worksheet , Release 3.2

Environment Agency

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		**Benzo(b)fluoranthene**		
Target concentration	C_T	**0.000017**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	2.06E-05	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	1.05E+05	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**5.13E+03**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**8.72E-02**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.000017	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Benzo(b)fluoranthene**		from Level 1
Target concentration	C_T	**0.000017**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**1.76E-05**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		9.04E-02	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Environment Agency

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Benzo(b)fluoranthene		from Level 1
Target Concentration	C_T	0.000017	mg/l	from Level 1
Dilution Factor	DF	1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	9.69E+02	days	*Howard et al*
Calculated decay rate	λ	7.15E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sanc*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	3.04E+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		
Groundwater flow velocity	v	5.62E-04	m/d
Retardation factor	Rf	1.58E+03	fraction
Decay rate used	λ	4.52E-07	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	3.56E-07	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	5.23E-10	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.91E+09**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**3.37E+04**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.73E+08	**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_{ED}/C_0	**5.23E-10**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.05E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.04E+02	l/kg

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

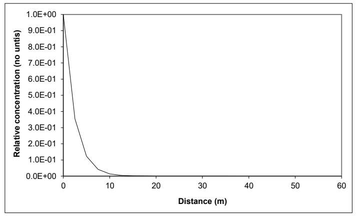
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	3.55E-01	0.00E+00
5.0	1.23E-01	0.00E+00
7.5	4.17E-02	0.00E+00
10.0	1.41E-02	0.00E+00
12.5	4.76E-03	0.00E+00
15.0	1.61E-03	0.00E+00
17.5	5.47E-04	0.00E+00
20.0	1.86E-04	0.00E+00
22.5	6.35E-05	0.00E+00
25.0	2.17E-05	0.00E+00
27.5	7.46E-06	0.00E+00
30.0	2.56E-06	0.00E+00
32.5	8.82E-07	0.00E+00
35.0	3.04E-07	0.00E+00
37.5	1.05E-07	0.00E+00
40.0	3.63E-08	0.00E+00
42.5	1.26E-08	0.00E+00
45.0	4.35E-09	0.00E+00
47.5	1.51E-09	0.00E+00
50.0	5.23E-10	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Benzo(b)fluoranthene		from Level 1
Target Concentration	C_T	**1.70E-05**	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	9.69E+02	days	*Howard et al*
Calculated decay rate	λ	7.15E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	3.04E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	1.58E+03	fraction
Decay rate used	λ	4.52E-07	d^{-1}
Rate of contaminant flow due to retardation	u	1.25E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.05E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	3.04E+02	l/kg

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

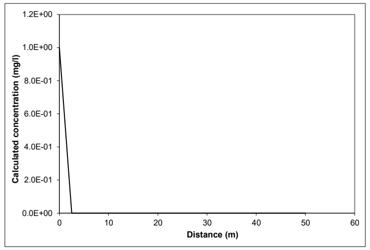
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	1.0E+00
2.5	0.00E+00
5.0	0.00E+00
7.5	0.00E+00
10.0	0.00E+00
12.5	0.00E+00
15.0	0.00E+00
17.5	0.00E+00
20.0	0.00E+00
22.5	0.00E+00
25.0	0.00E+00
27.5	0.00E+00
30.0	0.00E+00
32.5	0.00E+00
35.0	0.00E+00
37.5	0.00E+00
40.0	0.00E+00
42.5	0.00E+00
45.0	0.00E+00
47.5	0.00E+00
50.0	0.00E+00

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		**Benzo(ghi)perylene**	
Target concentration	C_T	**0.0000082**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	1.74E-05	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	1.48E+05	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**7.25E+03**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**5.95E-02**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.0000082	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Benzo(ghi)perylene**		from Level 1
Target concentration	**C_T**	**0.0000082**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**8.50E-06**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		6.16E-02	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Benzo(ghi)perylene**		from Level 1
Target Concentration	**C_T**	**0.0000082**	mg/l	from Level 1
Dilution Factor	**DF**	**1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.24E+03	days	*Literature*
Calculated decay rate	λ	5.59E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	4.29E+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		
Groundwater flow velocity	v	5.62E-04	m/d
Retardation factor	Rf	2.24E+03	fraction
Decay rate used	λ	2.50E-07	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	2.52E-07	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	9.24E-09	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.08E+08**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**9.20E+02**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		6.67E+06	**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_{ED}/C_0**	**9.24E-09**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.48E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	4.29E+02	l/kg

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

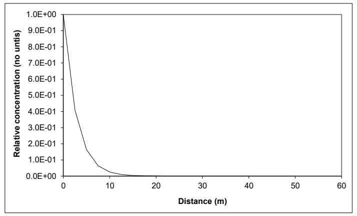
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	4.09E-01	0.00E+00
5.0	1.64E-01	0.00E+00
7.5	6.42E-02	0.00E+00
10.0	2.50E-02	0.00E+00
12.5	9.75E-03	0.00E+00
15.0	3.81E-03	0.00E+00
17.5	1.49E-03	0.00E+00
20.0	5.87E-04	0.00E+00
22.5	2.31E-04	0.00E+00
25.0	9.14E-05	0.00E+00
27.5	3.62E-05	0.00E+00
30.0	1.44E-05	0.00E+00
32.5	5.70E-06	0.00E+00
35.0	2.27E-06	0.00E+00
37.5	9.05E-07	0.00E+00
40.0	3.61E-07	0.00E+00
42.5	1.44E-07	0.00E+00
45.0	5.76E-08	0.00E+00
47.5	2.31E-08	0.00E+00
50.0	9.24E-09	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Benzo(ghi)perylene**		from Level 1
Target Concentration	C_T	**8.20E-06**	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

	Variable	Value	Unit	**Source of parameter value**
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	1.24E+03	days	*Literature*
Calculated decay rate	λ	5.59E-04	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	4.29E+02	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable	Value	Unit
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	2.24E+03	fraction
Decay rate used	λ	2.50E-07	d^{-1}
Rate of contaminant flow due to retardation	u	8.81E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target		**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.48E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	4.29E+02	l/kg

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

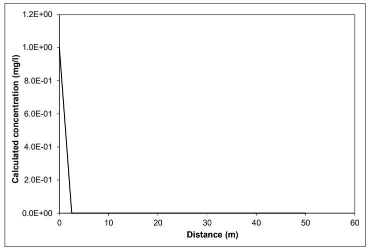
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.0E+00**
2.5	**0.00E+00**
5.0	**0.00E+00**
7.5	**0.00E+00**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

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		**Benzo(k)fluoranthene**		
Target concentration	C_T	**0.000017**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	3.03E-05	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	4.17E+05	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.04E+04**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**3.47E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.000017	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Environment Agency

Level 2 - Soil

Contaminant		**Benzo(k)fluoranthene**		from Level 1
Target concentration	C_T	**0.000017**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**1.76E-05**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		3.60E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Benzo(k)fluoranthene		from Level 1
Target Concentration	C_T	0.000017	mg/l	from Level 1
Dilution Factor	DF	1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	3.05E+03	days	*Howard et al*
Calculated decay rate	λ	2.28E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	[redacted]	m	
Distance (depth) to compliance point perpendicular to flow direction	y	[redacted]	m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.21E+03	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	5.62E-04	m/d
Retardation factor	Rf	6.30E+03	fraction
Decay rate used	λ	3.61E-08	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	8.93E-08	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	2.17E-05	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**4.61E+04**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**8.13E-01**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.66E+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_{ED}/C_0**	**2.17E-05**	**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	[redacted]	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	4.17E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$	[redacted]	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	1.21E+03	l/kg

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

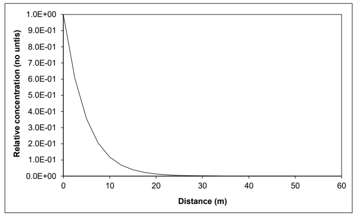
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	6.03E-01	0.00E+00
5.0	3.56E-01	0.00E+00
7.5	2.06E-01	0.00E+00
10.0	1.18E-01	0.00E+00
12.5	6.79E-02	0.00E+00
15.0	3.91E-02	0.00E+00
17.5	2.26E-02	0.00E+00
20.0	1.31E-02	0.00E+00
22.5	7.60E-03	0.00E+00
25.0	4.43E-03	0.00E+00
27.5	2.58E-03	0.00E+00
30.0	1.51E-03	0.00E+00
32.5	8.85E-04	0.00E+00
35.0	5.19E-04	0.00E+00
37.5	3.05E-04	0.00E+00
40.0	1.79E-04	0.00E+00
42.5	1.06E-04	0.00E+00
45.0	6.23E-05	0.00E+00
47.5	3.67E-05	0.00E+00
50.0	2.17E-05	0.00E+00

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Benzo(k)fluoranthene**		from Level 1
Target Concentration	C_T	**1.70E-05**	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	3.05E+03	days	*Howard et al*
Calculated decay rate	λ	2.28E-04	days^{-1}	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.21E+03	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	6.30E+03	fraction
Decay rate used	λ	3.61E-08	d^{-1}
Rate of contaminant flow due to retardation	u	3.13E-09	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**breakthrough at compliance point**	

Remedial Targets

Remedial Target	**No impact**	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks			
Distance to compliance point	**50**	**m**	
Concentration of contaminant at compliance point C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after	**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	4.17E+05	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.21E+03	l/kg

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

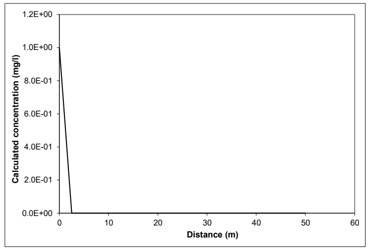
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.0E+00**
2.5	**0.00E+00**
5.0	**0.00E+00**
7.5	**0.00E+00**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

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		**Fluoranthene**	
Target concentration	C_T	**0.0000063**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	3.78E-04	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	1.82E+04	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**8.92E+02**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**5.62E-03**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.0000063	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Fluoranthene**		from Level 1
Target concentration	**C_T**	**0.0000063**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	1.22E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.04E+00**		
Level 2 Remedial Target		**6.53E-06**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		5.82E-03	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		**Fluoranthene**		from Level 1
Target Concentration	C_T	**0.0000063**	mg/l	from Level 1
Dilution Factor	**DF**	**1.04E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.80E+02	days	*Howard et al*
Calculated decay rate	λ	1.20E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	1.83E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	5.28E+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	5.62E-04	m/d
Retardation factor	Rf	2.76E+02	fraction
Decay rate used	λ	4.34E-06	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	1.83E+00	fraction
Rate of contaminant flow due to retardation	u	2.04E-06	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	3.65E-13	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**2.74E+12**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**1.79E+07**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.60E+10	**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_{ED}/C_0**	**3.65E-13**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.82E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	5.28E+01	l/kg

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

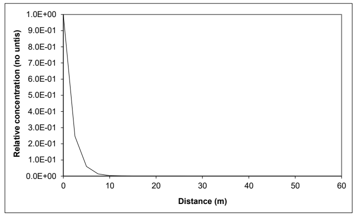
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Relative concentration (No units)**	**Concentration mg/l**
0	**1.0E+00**	**0.00E+00**
2.5	**2.47E-01**	**0.00E+00**
5.0	**5.94E-02**	**0.00E+00**
7.5	**1.40E-02**	**0.00E+00**
10.0	**3.29E-03**	**0.00E+00**
12.5	**7.73E-04**	**0.00E+00**
15.0	**1.82E-04**	**0.00E+00**
17.5	**4.29E-05**	**0.00E+00**
20.0	**1.02E-05**	**0.00E+00**
22.5	**2.41E-06**	**0.00E+00**
25.0	**5.74E-07**	**0.00E+00**
27.5	**1.37E-07**	**0.00E+00**
30.0	**3.27E-08**	**0.00E+00**
32.5	**7.84E-09**	**0.00E+00**
35.0	**1.88E-09**	**0.00E+00**
37.5	**4.51E-10**	**0.00E+00**
40.0	**1.08E-10**	**0.00E+00**
42.5	**2.61E-11**	**0.00E+00**
45.0	**6.28E-12**	**0.00E+00**
47.5	**1.51E-12**	**0.00E+00**
50.0	**3.65E-13**	**0.00E+00**

R&D Publication 20 Remedial Targets Worksheet, Release 3.2

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		**Fluoranthene**		from Level 1
Target Concentration	C_T	**6.30E-06**	mg/l	from Level 1

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

Ogata Banks — **Equations in HRA publication**

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

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

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

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.00E+00	mg/l	*Holding Value - Not used to determined RTV*
Half life for degradation of contaminant in water	$t_{1/2}$	5.80E+02	days	*Howard et al*
Calculated decay rate	λ	1.20E-03	days^{-1}	
Width of plume in aquifer at source (perpendicular to flow)	Sz	1.00E+01	m	*Site specific*
Plume thickness at source	Sy	0.00E+00	m	*Saturated Thickness*
Saturated aquifer thickness	da	5.78E+00	m	*Observed based on maximum thicness re*
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand and gravel*
Hydraulic gradient	i	6.40E-02	fraction	*Midrange of observed values*
Hydraulic conductivity of aquifer	K	1.20E-04	m/d	*Observed from site specific slug tests.*
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	5.28E+01	l/kg	*see options*
Longitudinal dispersivity	ax	5.00E+00	m	*see options*
Transverse dispersivity	az	5.00E-01	m	*see options*
Vertical dispersivity	ay	5.00E-02	m	*see options*

Calculated Parameters

	Variable		
Groundwater flow velocity	v	1.97E-05	m/d
Retardation factor	Rf	2.76E+02	fraction
Decay rate used	λ	4.34E-06	d^{-1}
Rate of contaminant flow due to retardation	u	7.14E-08	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	0.00E+00	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	breakthrough at compliance point	

Remedial Targets

Remedial Target		No impact	**mg/l**	For comparison with measured groundwater concentration.
Ogata Banks				
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point	C_{ED}/C_0	**0.00E+00**	**mg/l**	Ogata Banks
after		**1.0E+100**	**days**	

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

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

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.82E+04	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	5.28E+01	l/kg

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

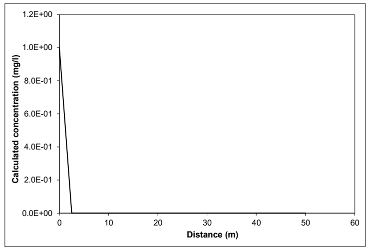
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	m
Longitudinal dispersivity	**ax**	1.00E-04	#######	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	

Note values of dispersivity must be > 0

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

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



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

Note

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

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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Concentration**
	mg/l
0	**1.0E+00**
2.5	**0.00E+00**
5.0	**0.00E+00**
7.5	**0.00E+00**
10.0	**0.00E+00**
12.5	**0.00E+00**
15.0	**0.00E+00**
17.5	**0.00E+00**
20.0	**0.00E+00**
22.5	**0.00E+00**
25.0	**0.00E+00**
27.5	**0.00E+00**
30.0	**0.00E+00**
32.5	**0.00E+00**
35.0	**0.00E+00**
37.5	**0.00E+00**
40.0	**0.00E+00**
42.5	**0.00E+00**
45.0	**0.00E+00**
47.5	**0.00E+00**
50.0	**0.00E+00**

Annex B – RTM Worksheets – Soil RTV Derivation

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

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		**Aliphatic C5-6**	
Target concentration	C_T	**0.01**	mg/l

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	3.30E+01	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	7.94E+02	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**3.89E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**4.10E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C5-6**		from Level 1
Target concentration	C_T	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**1.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		4.16E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aliphatic C5-6		from Level 1
Target Concentration	C_T	0.01	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	7.30E+02	days	*Table E1a of Appendix 4E, pg.2 of the New Ze*
Calculated decay rate	λ	9.50E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	2.30E+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		
Groundwater flow velocity	v	1.31E-03	m/d
Retardation factor	Rf	1.30E+01	fraction
Decay rate used	λ	7.31E-05	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	1.01E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	2.11E-07	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**4.74E+06**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**4.82E+04**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.98E+06	**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_{ED}/C_0	**2.11E-07**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	7.94E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	2.30E+00	l/kg

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

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

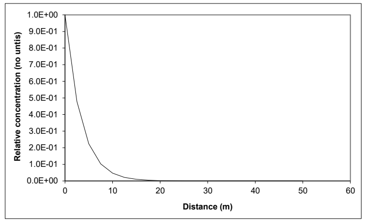
		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	2.98E-02	m

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 desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than an alternative solution should be used

Environment Agency



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

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	4.79E-01	0.00E+00
5.0	2.24E-01	0.00E+00
7.5	1.03E-01	0.00E+00
10.0	4.68E-02	0.00E+00
12.5	2.13E-02	0.00E+00
15.0	9.74E-03	0.00E+00
17.5	4.46E-03	0.00E+00
20.0	2.05E-03	0.00E+00
22.5	9.45E-04	0.00E+00
25.0	4.36E-04	0.00E+00
27.5	2.02E-04	0.00E+00
30.0	9.37E-05	0.00E+00
32.5	4.36E-05	0.00E+00
35.0	2.03E-05	0.00E+00
37.5	9.45E-06	0.00E+00
40.0	4.41E-06	0.00E+00
42.5	2.06E-06	0.00E+00
45.0	9.62E-07	0.00E+00
47.5	4.50E-07	0.00E+00
50.0	2.11E-07	0.00E+00

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		**Aliphatic C6-8**	
Target concentration	C_T	**0.01**	mg/l

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.

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	5.00E+01	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	3.98E+03	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**1.95E+02**	**l/kg**	*Calculated value*

Level 1 Remedial Target

Level 1 Remedial Target	**1.98E+00**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aliphatic C6-8**		from Level 1
Target concentration	C_T	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**1.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		2.01E+00	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aliphatic C6-8		from Level 1
Target Concentration	C_T	0.01	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	7.30E+02	days	*Table E1a of Appendix 4E, pg.2 of the New Ze*
Calculated decay rate	λ	9.50E-04	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.15E+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	1.31E-03	m/d
Retardation factor	Rf	6.11E+01	fraction
Decay rate used	λ	1.55E-05	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	2.14E-05	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	2.11E-07	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**4.74E+06**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**4.82E+04**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		9.55E+06	**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_{ED}/C_0	**2.11E-07**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	3.98E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.15E+01	l/kg

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

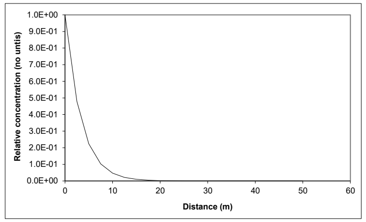
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed: Aldi - Wyndham Terrace, Egremont
Completed by: Zoe Cullerne
Date: #######
Version: 1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	4.79E-01	0.00E+00
5.0	2.24E-01	0.00E+00
7.5	1.03E-01	0.00E+00
10.0	4.68E-02	0.00E+00
12.5	2.13E-02	0.00E+00
15.0	9.74E-03	0.00E+00
17.5	4.46E-03	0.00E+00
20.0	2.05E-03	0.00E+00
22.5	9.45E-04	0.00E+00
25.0	4.36E-04	0.00E+00
27.5	2.02E-04	0.00E+00
30.0	9.37E-05	0.00E+00
32.5	4.36E-05	0.00E+00
35.0	2.03E-05	0.00E+00
37.5	9.45E-06	0.00E+00
40.0	4.41E-06	0.00E+00
42.5	2.06E-06	0.00E+00
45.0	9.62E-07	0.00E+00
47.5	4.50E-07	0.00E+00
50.0	2.11E-07	0.00E+00

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		**Aromatic C8-10**		
Target concentration	C_T	**0.01**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_w	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θ_a	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	4.80E-01	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	1.59E+03	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**7.77E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**7.78E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aromatic C8-10**		from Level 1
Target concentration	**C_T**	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**1.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		7.90E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aromatic C8-10		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	**DF**	**1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.25E+02	days	*Xylene used to represent this range (EA2002*
Calculated decay rate	λ	5.55E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	4.60E+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		
Groundwater flow velocity	v	1.31E-03	m/d
Retardation factor	Rf	2.49E+01	fraction
Decay rate used	λ	2.22E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	5.24E-05	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	5.72E-19	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.75E+18**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**1.78E+16**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.38E+18	**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_{ED}/C_0	**5.72E-19**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	1.59E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	4.60E+00	l/kg

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

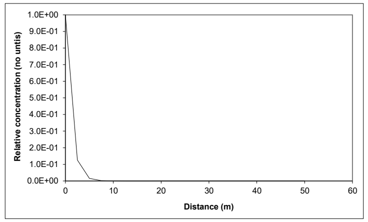
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	1.26E-01	0.00E+00
5.0	1.56E-02	0.00E+00
7.5	1.89E-03	0.00E+00
10.0	2.27E-04	0.00E+00
12.5	2.73E-05	0.00E+00
15.0	3.30E-06	0.00E+00
17.5	3.99E-07	0.00E+00
20.0	4.84E-08	0.00E+00
22.5	5.89E-09	0.00E+00
25.0	7.19E-10	0.00E+00
27.5	8.79E-11	0.00E+00
30.0	1.08E-11	0.00E+00
32.5	1.32E-12	0.00E+00
35.0	1.62E-13	0.00E+00
37.5	2.00E-14	0.00E+00
40.0	2.46E-15	0.00E+00
42.5	3.03E-16	0.00E+00
45.0	3.74E-17	0.00E+00
47.5	4.62E-18	0.00E+00
50.0	5.72E-19	0.00E+00

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

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		**Aromatic C10-12**	
Target concentration	C_T	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	1.40E-01	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	2.51E+03	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**1.23E+02**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**1.23E+00**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aromatic C10-12**		from Level 1
Target concentration	**C_T**	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**1.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		1.25E+00	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aromatic C10-12		from Level 1
Target Concentration	C_T	**0.01**	mg/l	from Level 1
Dilution Factor	**DF**	**1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.30E+02	days	*Midpoint Nahthalene Howard et al*
Calculated decay rate	λ	5.33E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	7.28E+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		
Groundwater flow velocity	v	1.31E-03	m/d
Retardation factor	Rf	3.89E+01	fraction
Decay rate used	λ	1.37E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	3.36E-05	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	1.39E-18	fraction
Attenuation factor (C_0/C_{ED})	**AF**	**7.19E+17**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target Ogata Banks		**7.30E+15** **or** **8.99E+17**	**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 partitioning equation.
Distance to compliance point		**50**	**m**	
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	**1.39E-18**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	2.51E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	7.28E+00	l/kg

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

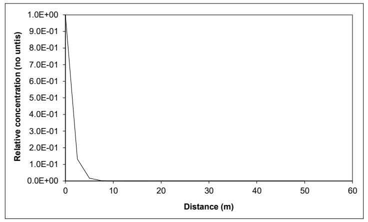
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	1.32E-01	0.00E+00
5.0	1.71E-02	0.00E+00
7.5	2.16E-03	0.00E+00
10.0	2.71E-04	0.00E+00
12.5	3.42E-05	0.00E+00
15.0	4.31E-06	0.00E+00
17.5	5.45E-07	0.00E+00
20.0	6.91E-08	0.00E+00
22.5	8.79E-09	0.00E+00
25.0	1.12E-09	0.00E+00
27.5	1.43E-10	0.00E+00
30.0	1.84E-11	0.00E+00
32.5	2.35E-12	0.00E+00
35.0	3.02E-13	0.00E+00
37.5	3.89E-14	0.00E+00
40.0	5.01E-15	0.00E+00
42.5	6.46E-16	0.00E+00
45.0	8.33E-17	0.00E+00
47.5	1.08E-17	0.00E+00
50.0	1.39E-18	0.00E+00

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		**Aromatic C12-16**		
Target concentration	C_T	**0.01**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	5.30E-02	dimensionless	*TPH: Total Petroleum Hydrocarbon Criteria Working*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd	[redacted]	l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	5.01E+03	l/kg	*TPH: Total Petroleum Hydrocarbon Criteria Working Group Series, Volume 3*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$	[redacted]	l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	-
pH value	pH		pH units	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.46E+02**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**2.46E+00**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Aromatic C12-16**		from Level 1
Target concentration	**C_T**	**0.01**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**1.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		2.49E+00	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Environment Agency

Input Parameters	Variable	Value	Unit	Source
Contaminant		Aromatic C12-16		from Level 1
Target Concentration	C_T	0.01	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.15E+02	days	*Midpoint of range for acenapthylene,acenapth*
Calculated decay rate	λ	6.03E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
Distance (lateral) to compliance point perpendicular to flow direction	z	[redacted]	m	
Distance (depth) to compliance point perpendicular to flow direction	y	[redacted]	m	
Time since pollutant entered groundwater	t	1.00E+99	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.45E+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	1.31E-03	m/d
Retardation factor	Rf	7.67E+01	fraction
Decay rate used	λ	7.86E-05	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	1.70E-05	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	8.13E-20	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.23E+19**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**1.25E+17**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		3.07E+19	**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_{ED}/C_0	**8.13E-20**	**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	[redacted]	l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	2.90E-03	fraction
Organic carbon partition coefficient	Koc	5.01E+03	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$	[redacted]	l/kg
Sorption coefficient for ionised species	$K_{oc.i}$	[redacted]	l/kg
pH value	pH	[redacted]	
Acid dissociation constant	pKa	[redacted]	
Fraction of organic carbon in aquifer	foc	[redacted]	fraction
Soil water partition coefficient	Kd	1.45E+01	l/kg

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

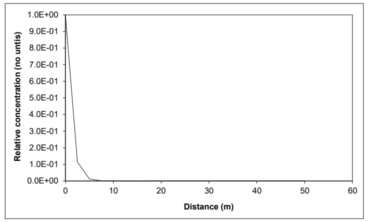
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	1.15E-01	0.00E+00
5.0	1.28E-02	0.00E+00
7.5	1.41E-03	0.00E+00
10.0	1.54E-04	0.00E+00
12.5	1.68E-05	0.00E+00
15.0	1.84E-06	0.00E+00
17.5	2.02E-07	0.00E+00
20.0	2.22E-08	0.00E+00
22.5	2.45E-09	0.00E+00
25.0	2.71E-10	0.00E+00
27.5	3.01E-11	0.00E+00
30.0	3.34E-12	0.00E+00
32.5	3.72E-13	0.00E+00
35.0	4.14E-14	0.00E+00
37.5	4.62E-15	0.00E+00
40.0	5.17E-16	0.00E+00
42.5	5.78E-17	0.00E+00
45.0	6.47E-18	0.00E+00
47.5	7.25E-19	0.00E+00
50.0	8.13E-20	0.00E+00

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		**Benzene**	
Target concentration	C_T	**0.01**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	2.30E-01	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	6.76E+01	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**3.31E+00**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**3.40E-02**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.01	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Benzene**		from Level 1	This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).
Target concentration	C_T	**0.01**	**mg/l**	from Level 1	

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

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**1.02E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		3.45E-02	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Benzene		from Level 1
Target Concentration	C_T	0.01	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	2.00E+02	days	*EA2002*
Calculated decay rate	λ	3.47E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.96E-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	1.31E-03	m/d
Retardation factor	Rf	2.02E+00	fraction
Decay rate used	λ	1.72E-03	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	6.46E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	8.26E-15	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.21E+14**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**1.23E+12**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		4.18E+12	**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_{ED}/C_0**	**8.26E-15**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	6.76E+01	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.96E-01	l/kg

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

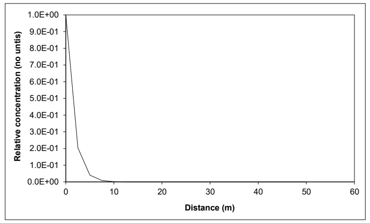
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	2.04E-01	0.00E+00
5.0	4.07E-02	0.00E+00
7.5	7.95E-03	0.00E+00
10.0	1.54E-03	0.00E+00
12.5	3.00E-04	0.00E+00
15.0	5.84E-05	0.00E+00
17.5	1.14E-05	0.00E+00
20.0	2.23E-06	0.00E+00
22.5	4.39E-07	0.00E+00
25.0	8.64E-08	0.00E+00
27.5	1.70E-08	0.00E+00
30.0	3.37E-09	0.00E+00
32.5	6.68E-10	0.00E+00
35.0	1.32E-10	0.00E+00
37.5	2.63E-11	0.00E+00
40.0	5.23E-12	0.00E+00
42.5	1.04E-12	0.00E+00
45.0	2.07E-13	0.00E+00
47.5	4.14E-14	0.00E+00
50.0	8.26E-15	0.00E+00

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

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		**Ethylbenzene**		
Target concentration	C_T	**0.02**	**mg/l**	
Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_w	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	3.57E-01	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	4.47E+02	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.19E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**4.40E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.02	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Ethylbenzene**		from Level 1
Target concentration	**C_T**	**0.02**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**2.03E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		4.47E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Environment Agency

Input Parameters	Variable	Value	Unit	Source
Contaminant		Ethylbenzene		from Level 1
Target Concentration	C_T	0.02	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.25E+02	days	*EA2002*
Calculated decay rate	λ	5.55E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.30E+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		
Groundwater flow velocity	v	1.31E-03	m/d
Retardation factor	Rf	7.75E+00	fraction
Decay rate used	λ	7.16E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	1.69E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	5.72E-19	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.75E+18**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**3.55E+16**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		7.81E+17	**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_{ED}/C_0	**5.72E-19**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	4.47E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.30E+00	l/kg

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

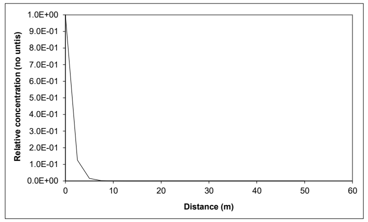
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	1.26E-01	0.00E+00
5.0	1.56E-02	0.00E+00
7.5	1.89E-03	0.00E+00
10.0	2.27E-04	0.00E+00
12.5	2.73E-05	0.00E+00
15.0	3.30E-06	0.00E+00
17.5	3.99E-07	0.00E+00
20.0	4.84E-08	0.00E+00
22.5	5.89E-09	0.00E+00
25.0	7.19E-10	0.00E+00
27.5	8.79E-11	0.00E+00
30.0	1.08E-11	0.00E+00
32.5	1.32E-12	0.00E+00
35.0	1.62E-13	0.00E+00
37.5	2.00E-14	0.00E+00
40.0	2.46E-15	0.00E+00
42.5	3.03E-16	0.00E+00
45.0	3.74E-17	0.00E+00
47.5	4.62E-18	0.00E+00
50.0	5.72E-19	0.00E+00

Remedial Targets Worksheet , Release 3.2

Level 1 - Soil

Environment Agency

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		**m-Xylene**	
Target concentration	C_T	**0.03**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	3.09E-01	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	4.90E+02	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.40E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**7.23E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.03	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Environment Agency

Contaminant		**m-Xylene**		from Level 1
Target concentration	C_T	**0.03**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**3.05E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		7.34E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		m-Xylene		from Level 1
Target Concentration	C_T	**0.03**	mg/l	from Level 1
Dilution Factor	**DF**	**1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days	*Maximum (ie none assumed)*
Calculated decay rate	λ	7.00E-101	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.42E+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		
Groundwater flow velocity	v	1.31E-03	m/d
Retardation factor	Rf	8.39E+00	fraction
Decay rate used	λ	8.34E-102	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	1.56E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	5.15E-01	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.94E+00**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**5.91E-02**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.42E+00	**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_{ED}/C_0**	**5.15E-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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	4.90E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.42E+00	l/kg

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

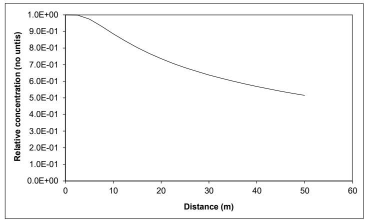
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	9.98E-01	0.00E+00
5.0	9.75E-01	0.00E+00
7.5	9.32E-01	0.00E+00
10.0	8.86E-01	0.00E+00
12.5	8.43E-01	0.00E+00
15.0	8.03E-01	0.00E+00
17.5	7.68E-01	0.00E+00
20.0	7.36E-01	0.00E+00
22.5	7.08E-01	0.00E+00
25.0	6.83E-01	0.00E+00
27.5	6.59E-01	0.00E+00
30.0	6.38E-01	0.00E+00
32.5	6.19E-01	0.00E+00
35.0	6.01E-01	0.00E+00
37.5	5.84E-01	0.00E+00
40.0	5.69E-01	0.00E+00
42.5	5.54E-01	0.00E+00
45.0	5.40E-01	0.00E+00
47.5	5.28E-01	0.00E+00
50.0	5.15E-01	0.00E+00

Remedial Targets Worksheet , Release 3.2

Environment Agency

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		**Naphthalene**		
Target concentration	C_T	**0.0024**	mg/l	

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	1.82E-02	dimensionless	*EA Science report 7, 2008*
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd	[redacted]	l/kg	-
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	6.46E+02	l/kg	*EA Science report 7, 2008*
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$	[redacted]	l/kg	-
Sorption coefficient for ionised species	$K_{oc,i}$	[redacted]	l/kg	-
pH value	pH	[redacted]	pH units	*Only polar*
Acid dissociation constant	pKa	[redacted]		-
Fraction of organic carbon (in soil)	foc	[redacted]	fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**3.16E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**7.61E-02**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.0024	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

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

Contaminant		**Naphthalene**		from Level 1
Target concentration	**C_T**	**0.0024**	**mg/l**	from Level 1

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

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**2.44E-03**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		7.73E-02	**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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Environment Agency

Input Parameters	Variable	Value	Unit	Source
Contaminant		Naphthalene		from Level 1
Target Concentration	C_T	0.0024	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.30E+02	days	*Howard et al*
Calculated decay rate	λ	5.33E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.87E+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		
Groundwater flow velocity	v	1.31E-03	m/d
Retardation factor	Rf	1.07E+01	fraction
Decay rate used	λ	4.96E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	1.22E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	1.39E-18	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**7.19E+17**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**1.75E+15**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		5.55E+16	**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_{ED}/C_0	**1.39E-18**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	6.46E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.87E+00	l/kg

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

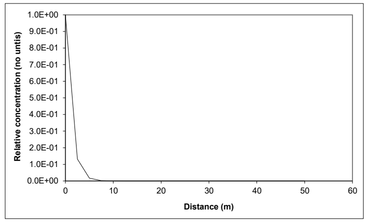
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	1.32E-01	0.00E+00
5.0	1.71E-02	0.00E+00
7.5	2.16E-03	0.00E+00
10.0	2.71E-04	0.00E+00
12.5	3.42E-05	0.00E+00
15.0	4.31E-06	0.00E+00
17.5	5.45E-07	0.00E+00
20.0	6.91E-08	0.00E+00
22.5	8.79E-09	0.00E+00
25.0	1.12E-09	0.00E+00
27.5	1.43E-10	0.00E+00
30.0	1.84E-11	0.00E+00
32.5	2.35E-12	0.00E+00
35.0	3.02E-13	0.00E+00
37.5	3.89E-14	0.00E+00
40.0	5.01E-15	0.00E+00
42.5	6.46E-16	0.00E+00
45.0	8.33E-17	0.00E+00
47.5	1.08E-17	0.00E+00
50.0	1.39E-18	0.00E+00

Remedial Targets Worksheet , Release 3.2

Environment Agency

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		**o-Xylene**	
Target concentration	C_T	**0.03**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	2.33E-01	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	4.27E+02	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.09E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**6.30E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.03	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Environment Agency

Level 2 - Soil

Contaminant		**o-Xylene**		from Level 1
Target concentration	C_T	**0.03**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**3.05E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		6.39E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		o-Xylene		from Level 1
Target Concentration	C_T	0.03	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	1.25E+02	days	*Maximum (ie none assumed)*
Calculated decay rate	λ	5.55E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.24E+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	1.31E-03	m/d
Retardation factor	Rf	7.44E+00	fraction
Decay rate used	λ	7.45E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	1.76E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	5.72E-19	fraction
Attenuation factor (C_0/C_{ED})	**AF**	**1.75E+18**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

		Value	Unit	
Level 3 Remedial Target		**5.33E+16**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.12E+18	**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_{ED}/C_0	**5.72E-19**	**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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	4.27E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.24E+00	l/kg

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

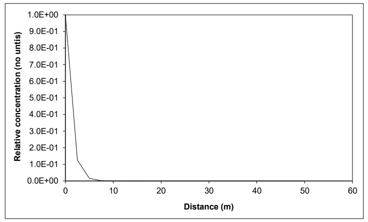
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed: Aldi - Wyndham Terrace, Egremont
Completed by: Zoe Cullerne
Date: #######
Version: 1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	**Relative concentration (No units)**	**Concentration mg/l**
0	**1.0E+00**	**0.00E+00**
2.5	**1.26E-01**	**0.00E+00**
5.0	**1.56E-02**	**0.00E+00**
7.5	**1.89E-03**	**0.00E+00**
10.0	**2.27E-04**	**0.00E+00**
12.5	**2.73E-05**	**0.00E+00**
15.0	**3.30E-06**	**0.00E+00**
17.5	**3.99E-07**	**0.00E+00**
20.0	**4.84E-08**	**0.00E+00**
22.5	**5.89E-09**	**0.00E+00**
25.0	**7.19E-10**	**0.00E+00**
27.5	**8.79E-11**	**0.00E+00**
30.0	**1.08E-11**	**0.00E+00**
32.5	**1.32E-12**	**0.00E+00**
35.0	**1.62E-13**	**0.00E+00**
37.5	**2.00E-14**	**0.00E+00**
40.0	**2.46E-15**	**0.00E+00**
42.5	**3.03E-16**	**0.00E+00**
45.0	**3.74E-17**	**0.00E+00**
47.5	**4.62E-18**	**0.00E+00**
50.0	**5.72E-19**	**0.00E+00**

Remedial Targets Worksheet , Release 3.2

Environment Agency

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		**p-Xylene**	
Target concentration	C_T	**0.03**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	2.83E-01	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	4.47E+02	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**2.19E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**6.59E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.03	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**p-Xylene**		from Level 1
Target concentration	**C_T**	**0.03**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**3.05E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		6.69E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		p-Xylene		from Level 1
Target Concentration	C_T	**0.03**	mg/l	from Level 1
Dilution Factor	**DF**	**1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		**Soil concentration as mg/kg**		
Enter soil concentration		**0**	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days	*Maximum (ie none assumed)*
Calculated decay rate	λ	7.00E-101	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	1.30E+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		
Groundwater flow velocity	v	1.31E-03	m/d
Retardation factor	Rf	7.74E+00	fraction
Decay rate used	λ	9.04E-102	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	1.69E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	5.15E-01	fraction
Attenuation factor (C_0/C_{ED})	**AF**	**1.94E+00**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**5.91E-02**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.30E+00	**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_{ED}/C_0	**5.15E-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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	4.47E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.30E+00	l/kg

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

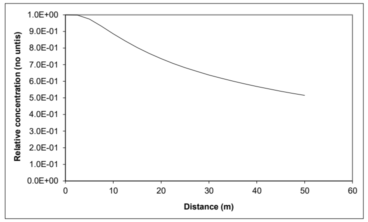
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	9.98E-01	0.00E+00
5.0	9.75E-01	0.00E+00
7.5	9.32E-01	0.00E+00
10.0	8.86E-01	0.00E+00
12.5	8.43E-01	0.00E+00
15.0	8.03E-01	0.00E+00
17.5	7.68E-01	0.00E+00
20.0	7.36E-01	0.00E+00
22.5	7.08E-01	0.00E+00
25.0	6.83E-01	0.00E+00
27.5	6.59E-01	0.00E+00
30.0	6.38E-01	0.00E+00
32.5	6.19E-01	0.00E+00
35.0	6.01E-01	0.00E+00
37.5	5.84E-01	0.00E+00
40.0	5.69E-01	0.00E+00
42.5	5.54E-01	0.00E+00
45.0	5.40E-01	0.00E+00
47.5	5.28E-01	0.00E+00
50.0	5.15E-01	0.00E+00

Remedial Targets Worksheet , Release 3.2

Environment Agency

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		**Toluene**	
Target concentration	C_T	**0.074**	**mg/l**

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	1.45E-01	fraction	Based on RTM calculations from site data
Air filled soil porosity	θa	1.25E-01	fraction	Based on RTM calculation from site data
Bulk density of soil zone material	ρ	2.03E+00	g/cm^3	Midpoint for Glacial Till
Henry's Law constant	H	2.79E-01	dimensionless	*EA Science report 7, 2008*
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 soil)	foc	4.90E-02	fraction	MG with no visual/olfactory evidence of hydrocarbons
Organic carbon partition coefficient	Koc	2.04E+02	l/kg	*EA Science report 7, 2008*
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	*Only polar*
Acid dissociation constant	pKa			-
Fraction of organic carbon (in soil)	foc		fraction	*MG with no visual/olfactory evidence of hydrocarbons*
Soil water partition coefficient used in Level Assessment	**Kd**	**1.00E+01**	**l/kg**	*Calculated 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.

Level 1 Remedial Target

Level 1 Remedial Target	**7.47E-01**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.074	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 2 - Soil

Contaminant		**Toluene**		from Level 1
Target concentration	C_T	**0.074**	**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 contamiantion' (Environment Agency 2006)

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**	
Standard entry					
Infiltration	Inf	2.90E-04	m/d	**30% average annual rainfall Bingley**	
Area of contaminant source	A	0.00E+00	m^2		Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	1.00E+01	m	**Site specific**	
Saturated aquifer thickness	da	5.78E+00	m	**d on maximum thicness recorded during Hydrock 20**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.20E-04	m/d	**Observed from site specific slug tests.**	
Hydraulic gradient of water table	i	6.40E-02	fraction	**Midrange of observed values**	
Width of contaminant source perpendicular to groundwater flow	w	1.00E+01	m	**Site specific**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**No background concentrations assumed**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m	Only if selected	
Calculated mixing zone thickness	Mz	5.78E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**1.02E+00**		
Level 2 Remedial Target		**7.51E-02**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentra**
		or		
		7.58E-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:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	16-Dec-25
Version:	1

Remedial Targets Worksheet , Release 3.2

Level 3 - Soil

See Note

Input Parameters	Variable	Value	Unit	Source
Contaminant		Toluene		from Level 1
Target Concentration	C_T	0.074	mg/l	from Level 1
Dilution Factor	DF	1.02E+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**

	Variable	Value	Unit	Source of parameter value
Enter source concentration	**Soil concentration as mg/kg**			
Enter soil concentration		0	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	9.90E+99	days	*Maximum (ie none assumed)*
Calculated decay rate	λ	7.00E-101	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	1.00E+01	m	from Level 2
Plume thickness in aquifer at source	Sy	5.78E+00	m	from Level 2
Bulk density of aquifer materials	ρ	2.03E+00	g/cm^3	*Midpoint for Glacial Till*
Effective porosity of aquifer	n	3.90E-01	fraction	*Domenico and Schwartz average of clay,sand*
Hydraulic gradient	i	4.25E+00	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.20E-04	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Default compliance point*
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	5.92E-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	1.31E-03	m/d
Retardation factor	Rf	4.08E+00	fraction
Decay rate used	λ	1.72E-101	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	4.25E+00	fraction
Rate of contaminant flow due to retardation	u	3.20E-04	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	5.15E-01	fraction
Attenuation factor (C_O/C_{ED})	**AF**	**1.94E+00**	**fraction**
Calculated soil leachate concentration	Co	0.00E+00	mg/l

Remedial Targets

Level 3 Remedial Target		**1.46E-01**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks		**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
		1.47E+00	**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_{ED}/C_0	**5.15E-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	2.90E-03	fraction
Organic carbon partition coefficient	Koc	2.04E+02	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc.n}$		l/kg
Sorption coefficient for ionised species	$K_{oc.i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	5.92E-01	l/kg

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

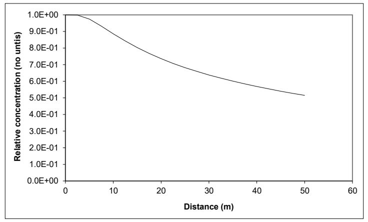
Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	1.00E-04	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	1.00E-04	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	1.00E-04	5.00E-02	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 desribed 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 concentation at a given position compared to the source concentration. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

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

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

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

Site being assessed:	Aldi - Wyndham Terrace, Egremont
Completed by:	Zoe Cullerne
Date:	#######
Version:	1

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	0.00E+00
2.5	9.98E-01	0.00E+00
5.0	9.75E-01	0.00E+00
7.5	9.32E-01	0.00E+00
10.0	8.86E-01	0.00E+00
12.5	8.43E-01	0.00E+00
15.0	8.03E-01	0.00E+00
17.5	7.68E-01	0.00E+00
20.0	7.36E-01	0.00E+00
22.5	7.08E-01	0.00E+00
25.0	6.83E-01	0.00E+00
27.5	6.59E-01	0.00E+00
30.0	6.38E-01	0.00E+00
32.5	6.19E-01	0.00E+00
35.0	6.01E-01	0.00E+00
37.5	5.84E-01	0.00E+00
40.0	5.69E-01	0.00E+00
42.5	5.54E-01	0.00E+00
45.0	5.40E-01	0.00E+00
47.5	5.28E-01	0.00E+00
50.0	5.15E-01	0.00E+00

Appendix C Piling Risk Assessment

Project number	333701974	**Project name**	Wyndham Terrace, Egremont
Title	Piling Risk Assessment		
Doc ref	333701974-STN-XX-XX-RP-GE-5001		
Status	S2	**Issue number**	P02
Date	27 January 2026		
Prepared by		Iain Reid BSc (hons) MSc	
Checked and Approved by		Claire Daly BSc (Hons) FGS Geol EurGeol CSci ASoBRA	

1 Introduction

1.1 Background

This document has been written to support discharge of Planning Condition 8 of Planning Consent 4/24/2044/0F1 at a former petrol station located off Wyndham Terrace, Egremont, CA22 2DY (the site), which states:

> **Condition 8 – Piling**
>
> **The development hereby approved shall not include the use of vibro-stone foundations unless it can be demonstrated to the satisfaction of the Local Planning Authority that their use will not cause or exacerbate the transmission of contamination into underlying strata and groundwater. Vibro-stone foundations or piling using penetrative methods shall not be used other than with the written consent of the Local Planning Authority.**

1.2 Objectives

The objective of this document is to provide a Piling Method Statement and Foundation Works Risk Assessment to support discharge of Planning Condition 8 (detailed in Section 1.1).

The Piling / Deep Foundations Method Statement will include an assessment on the impacts on vibration, land stability, groundwater levels, underground pipes and other infrastructure, along with measures proposed to mitigate adverse effects.

Stantec will also undertake a Foundation Works Risk Assessment in accordance with Environment Agency Guidance to identify what additional risks to the environment piling may introduce and, if necessary, recommend measures that will mitigate any significant adverse environmental impacts.

The Foundation Works Risk Assessment will be undertaken using the risk assessment flowchart from CL:AIRE document reference 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention', 2025 and will assess the site conditions against the seven pollution scenarios suggested CL:AIRE in terms of their potential source-pathway-receptor (SPR) linkages on the site.

1.3 Available information

The following documents, reports etc have been provided to Stantec by the Client for use in the preparation of this report or obtained from the proposed development publicly available planning application:

- 3E (Stantec), September 2021. Proposed Aldi Store, Wyndham Place, Egremont, Cumbria. Phase I Geo-environmental Assessment. Ref: P21-172/P1.
- Hydrock (Stantec), December 2023. Wyndham Place, Egremont: Ground Investigation Report. Ref: 28850-HYD-XX-XX-RP-GE-0001.
- Stantec, December 2025. Wyndham Place, Egremont: Ground Investigation Report. Ref: 333800252-STN-XX-XX-RP-GE-2001.
- Projekt, April 2021. Proposed Site Plan. Wyndham Place Egremont. Ref: 0541 - SK05.

1.4 Limitations

The report has been prepared by Hydrock on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, all potential environmental constraints or liabilities associated with the site may not have been revealed.

The report has been prepared for the exclusive benefit of Stoford Properties Ltd and those parties designated by them for the purpose of providing information on the potential environmental risks associated with installing deep foundations at the site during the development. The report contents should only be used in that context. Furthermore, new information, changed practices or new legislation may necessitate revised interpretation of the report after the date of its submission.

Hydrock has used reasonable skill, care and diligence in producing this foundation works risk assessment. The inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths of trial pits and boreholes at the time of the investigation. At intermediate locations, conditions can only be inferred.

Information provided by third parties has been used in good faith and is taken at face value. However, Hydrock cannot guarantee the accuracy or completeness of any information provided by others.

The work has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in the Land Contamination Risk Management (LCRM) guidance (Environment Agency 2023), BS 5930:2015+A1:2020, BS 10175: 2011+A2:2017 and NC/99/73.

2 Summary of Previous Reports

2.1.1 Phase 1 Geo-environmental Assessment

The Phase 1 desk study report identified the site was underdeveloped up until the 1960's, when a vehicle garage was developed, undergoing numerous extensions in the 1990's, with a yard in the southern half of site. The surrounding land historically supported a flax mill, gasometer, coal depots, railway lines and a brewery. Iron ore pits were indicated to the west and south of site.

The British Geological Survey (BGS) records indicated the site is underlain by Glaciofluvial deposits in the northern half and River Terrace Deposits in the south half of site, both underlain by Frizington Limestone Formation. All underlying geological strata are classified as Secondary A aquifers. The report highlighted the potential for deep Made Ground on site, based on available historical logs. The River Ehen is present 75m east of site, with the site not being at risk of flooding.

No landfill or waste transfer sites are within 250m of site. No license groundwater abstractions are present within 500m of site. The site located in an intermediate probability radon area (10% to 30%), with basic radon measures are considered necessary for new buildings on the site.

2.1.2 Phase 2 Ground Investigation Report (Ref: 28850-HYD-XX-XX-RP-GE-0001)

A preliminary ground investigation was undertaken to assess:

- Potential risks from ground or groundwater contamination, and identifying potential geo-environmental mitigation measures, where necessary.
- Risks posed by hazardous ground gases.
- Off-site disposal characterisation of materials on site.
- Geotechnical advice and recommendations.

The ground investigation comprised windowless sample boreholes with follow-on gas and groundwater monitoring, continuous penetration tests (CPTs), geotechnical and chemical testing.

Made Ground underlying hardstanding of the former fuel filling station and garage comprised beige sandy gravel of limestone with occasional cobbles to depths of 0.30m and 1.30m below ground level (bgl), with Made Ground comprising sandy gravel of concrete and mudstone to 0.60m bgl. Made Ground beneath sporadic hardstanding and sub-base materials generally comprised reworked gravelly clays and gravelly sands with gravels of mixed lithologies. Localised pockets of ashy sand with coal and clinker were present in the central and southern portions of site, where made ground was noted to be greatest in thickness. A former roadway was encountered from 0.30 to 0.40m bgl in the central northwest portion of site. Made Ground was recorded to depths of between 0.30m and >3.55m, with standard penetration tests (SPTs) ranging from 7 to 16.

Glaciofluvial Deposits in the northern and northwestern areas of site comprised medium dense gravelly sands and silty sandy gravels of mudstone, sandstone and limestone and were recorded from 0.30m and 1.70m to depths in excess of 2.50m and 5.00m, with SPT's ranging from 4 to 50, averaging 30 from 3m bgl. CPTs targeting the proposed building footprint refused at depths between 4.50m and 11.90m bgl, believed to be associated with dense Superficial Deposits or from cobbles and boulders. Groundwater strikes were recorded from 4.20m to 4.50m bgl in the central portion of site. Subsequent groundwater monitoring identified standing water between 1.05m to 4.13m bgl. Cohesive Superficial Deposits were assessed as having low volume change potential. Particle Size Distribution (PSD) tests identified 14%-16% of fines, 17%-31% of sand and 53%-69% of gravels. Made Ground was classified with a Design Sulphate Class DS-2 with ACEC site classification AC-2. Superficial Deposits were classified as DS-1 and AC-1.

Samples collected from Made Ground across site were compared against chemical screening criteria for a commercial end-use. No samples tested (15 in total) reported contaminants of potential concern (CoPC) above their respective screening criteria. Two samples in the northeast portion of site were found to contain loose asbestos fibres. One groundwater sample from the northwest portion of site was compared to screening criteria based on UK Drinking Water Standards (DWS) and Environmental Quality Standards (EQS). Slightly elevated levels of petroleum hydrocarbons (aliphatic $>EC_{12}$-EC_{35}) were recorded above their respective screening criteria, with all other CoPC below their laboratory detection limit. Effects of attenuation and dispersion were deemed to likely reduce concentrations to negligible levels before reaching a sensitive receptor.

Concentrations of methane and carbon dioxide were recorded to exceed the 5% and 1% Characteristic Situation (CS) 1 threshold, and CS2 gas protective measures were recommended for the proposed development. Gas membranes were recommended to be resistant to volatile organic compounds (VOCs). Waste acceptance criteria (WAC) analysis of soil samples collected from site indicated Made Ground and natural soils likely to be classified as hazardous waste, due to elevated total petroleum hydrocarbon (TPH) concentrations, as well as visible hydrocarbons recorded in this site. Remaining Made Ground was considered likely to be classified as non-hazardous, and non-impacted natural deposits as inert waste.

Due to the general thickness of Made Ground, conventional strip and pad foundations were not considered suitable. It was considered ground improvement techniques such as vibro-stone columns (VSCs) or controlled modulus columns (CMCs) may improve ground conditions to facilitate use of shallow foundation solutions. Should ground improvement techniques not be viable, a piled foundation solution was deemed necessary. A California bearing ratio (CBR) value of 2% with inclusion of 400mm of sub-base was recommended within external hardstanding areas.

The following further works were recommended as part of this assessment:

- Risks to controlled waters.
- Buried structures and voids.
- Ground conditions beneath existing buildings following demolition.
- Decommissioning and remedial works of the known underground storage tanks, infrastructure and impacted soils.
- Consultation with a specialist contractor regarding feasibility of ground improvement and/or piled foundation solutions.
- UKWIR assessment on suitable potable water supply pipe materials.
- Assessment of tree influence on foundation design.

2.1.3 Phase 2 Ground Investigation Report (Ref: 333701974-STN-XX-XX-RP-GE-1001)

Stantec undertook a supplementary ground investigation to resolve uncertainties identified in the previous reports, including the refinement of the conceptual site model (CSM), assess potential risk posed by ground or groundwater contamination, geo-environmental mitigation requirements, assess risks from hazardous ground gases and provide geotechnical recommendations.

The scope of this investigation comprised windowless sample boreholes and cable percussion boreholes, with groundwater monitoring follow-on, with additional chemical and geotechnical analysis.

Ground conditions encountered in the supplementary investigation generally matched those found within the initial investigation. Made Ground was proven between 0.20m to 6.00m in thickness, observed to generally be thicker in the southern portion of site.

Superficial Deposits comprising Glacifluvial Deposits and River Terrace Deposits were encountered beneath the Made Ground, however, were not fully penetrated in any exploratory location. Groundwater was encountered between 2.60m to 4.67m bgl within the Superficial Deposits. Subsequent monitoring found groundwater between 1.64m to 5.80m bgl, indicated to flow in a generally southeast direction.

Weak hydrocarbon odours and sheens were observed in Made Ground and Superficial Deposit soils sporadically, as well as within monitored groundwater in two locations along the northeast portion of site.

Asbestos was encountered within an additional five borehole locations, situated to the east of historical garage buildings in the northern portion of site. Asbestos was encountered as loose fibres of chrysotile and amosite, at concentrations ranging from <0.001% to 0.134%. No other CoPC were identified in excess of their respective screening criteria for human health within a commercial end use. A clean cover system within soft landscaping comprising a minimum of 450mm of clean soil over a geotextile membrane was recommended, along with over-excavation of service trenches to mitigate risks from asbestos fibres within soils. Validation testing of the soil surrounding the historical underground tanks was recommended following removal, to assess the potential impact of residual hydrocarbons within soils underlying site.

Groundwater chemical testing revealed some polycyclic aromatic hydrocarbon (PAH) concentrations in exceedance of their respective EQS/DWS and were considered likely to be associated with leaching from impacted soils in the vicinity of historical petroleum infrastructure. Due to site's proximity to the River Ehen, it was considered there may be a potential risk to controlled waters, which is further assessed within the Stantec detailed quantitative risk assessment (DQRA) included as an appendix to the remediation strategy and verification plan (RSVP).

Made Ground soils were assumed to be classified as hazardous waste without additional asbestos testing and site zoning. Natural soils were considered likely to be suitable for disposal within an inert landfill.

2.1.4 Remediation

The site is classified as Brownfield, due to its historical commercial use as a petrol station and vehicle garage.

2.2 Ground Model

2.2.1 Ground Conditions

Ground conditions encountered during the investigations.

Surface coverings

- Light grey concrete, sometimes reinforced. Encountered in the footprint of the former buildings.
- Black asphalt, found in the areas surrounding the buildings.

Made Ground

Encountered in all locations below the surface covering, where present, or from surface to depths of between 0.13m and 2.50m. In WS09 due to limited recovery, the depth of Made Ground could not be determined, but was between 2.50m and 4.00m bgl. Similarly in WS12 and WS13, limited recovery from 1.85m and 1.70m bgl respectively meant the base of the Made Ground could not be identified. The base of the Made Ground was not proven in WS10, WS204 and WS208.

The Made Ground was generally recorded as:

- upper layers: coarse grey sandy gravel of mixed lithology with brick, concrete and metal present.
- with depth: brown silty, sandy and slightly sandy, slightly gravelly and gravelly clay with frequent brick, rootlets, sandstone and quartzite gravel. Black staining, hydrocarbon odours and oily sheens were recorded.

Superficial Deposits

Glaciofluvial Deposits/River Terrace Deposits: Recorded in all locations below the Made Ground. The base of the strata was not proven (>9.50m below ground level (bgl)).

The superficial deposits were generally described as:

- multi-coloured coarse sandy gravel of mixed natural lithologies (sandstone, mudstone and granite) and occasional cobbles;
- brown sometimes sandy gravelly clay with mixed natural lithologies (sandstone and mudstone);
- dark grey silty gravelly clay with mixed natural lithologies and occasional cobbles;
- orangish brown fine sand with sandstone and mudstone gravel.

Bedrock

Frizington Limestone Formation: Not encountered during the investigations.

2.2.2 Groundwater Conditions

Generally, groundwater was encountered during the site works in exploratory holes in the north of the site, at depths between 3.55m and 4.67m bgl. During the monitoring groundwater levels were recorded at between 1.05m and 5.80m bgl. In general, groundwater was encountered (predominantly) within the granular layers of the Superficial Deposits between 43.17m and 50.86m AOD.

Groundwater flows to the southeast, towards the River Ehen 150m east of the site. The river levels sit at approximately 47m OD.

Limited non-aqueous phase liquid (NAPL) petroleum hydrocarbons have been noted within BH202 with a thickness of 1mm on both 13/11/2025 and 18/11/2025. This appears to be localised, as other visual or olfactory evidence of petroleum hydrocarbons within the groundwater was limited to mild hydrocarbon odours and sheens/residue.

2.2.3 Evidence of Contamination

Visual and olfactory evidence of petroleum hydrocarbon contamination in the Made Ground and Superficial Deposits was reported in WS06 from 0.30m to 0.55m bgl, WS09 from 4.00m to 4.30m bgl, WS10 from 0.40m to 0.70m bgl, WS12 from 0.80m to 1.40m bgl, WS17 between 4.10m and 4.70m bgl, BH203 from 4.50m to 5.50m bgl, WS202 between 0.34m and 1.10m bgl, WS205 between 2.00m and 2.50m bgl, WS206 between 2.25m and 3.70m bgl.

3 Risk Assessment Summary

The risk assessment review and CSM is presented in the RSVP.

4 Summary of Geotechnical and Environmental Considerations for Vibro-Stone Columns

4.1 Introduction

The proposed development comprises the erection of a 3-storey Aldi supermarket, with associated car parking, storage areas and loading bay.

Ground conditions comprise Made Ground beneath existing hardstanding with buried infrastructure in the western and northern portions of site. This is underlain by Superficial Deposits comprising interbedded gravelly sandy and sandy gravelly clays.

In general, groundwater was encountered (predominantly) within the granular layers of the Superficial Deposits between 43.17m and 50.86m AOD and flows to the southeast, towards the River Ehen 150m east of the site.

Ground investigation has extended to depths of 9.50m bgl. Vibro-stone columns would be installed no deeper than 6m bgl and would be designed by a specialist contractor.

4.2 Foundation Works Risk Assessment

The use of deep foundations has the potential to form preferential pathways for contamination migration. However, an unacceptable risk of pollution can only occur if there is a source of contamination and a receptor that could be harmed by exposure to those contaminants.

The Contaminated Land Applications in Real Environments (CL:AIRE) '*Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention*' dated 2025 report identifies seven potential source-pathway-receptor (SPR) contaminant linkages to consider in relation to piling and/or ground improvement works. These scenarios are:

1. Creation of preferential pathways, through a low permeability layer (an aquitard), to allow potential contamination of an underlying aquifer.
2. The driving of solid contaminants down into an aquifer during pile driving.
3. Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout.
4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration).
5. Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas, mine gas or contaminant vapours (e.g. VOCs) to the surface.
6. Causing off site migration of ground gas or increased vertical emissions as a result of vibration or other effects from the pile installation process.
7. Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface.

In Section 4.3, each of the proposed foundation solutions are initially screened against the seven preferential pathways to identify if there is a plausible environmental risk. Where a plausible risk is identified, further risk assessment is then undertaken for the proposed foundation solution and preferential pathways that are potentially affected.

4.3 Plausible Environmental Risks

Table 4.1 screens the VSC ground improvement solution against the seven preferential pathways with plausible environmental risks identified or discounted accordingly.

The following assessment is based on the available information from the available ground investigations (see RSVP text for full details).

Table 4.1: Summary of plausible environmental risks from deep foundations

Preferential Pathway Scenario	Proposed Foundation Solution	Plausible Risk	Comments
Scenario 1 Creation of preferential pathways, through a low permeability layer (an aquitard), to allow potential contamination of an underlying aquifer.	VSC	Yes	There is the potential to form a preferential pathway between the Made Ground and the underlying Glaciofluvial Deposits, although there does appear to be some hydraulic continuity between the strata. The permeability of the VSCs is likely to be high, and allow for migration of contaminants to underlying strata.
Scenario 2 The driving of solid contaminants down into an aquifer during pile driving.	VSC	No	VSCs involves horizontal displacement and densification of soil which the column is constructed. In normal circumstances this will not lead to soil being dragged downwards. The SPR linkage is therefore incomplete and this Scenario is not considered further.
Scenario 3 Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout.	VSC	No	VSCs will not lead to the leaching of concrete, cement paste or grout into fast flowing groundwater. The SPR linkage is therefore incomplete and this Scenario is not considered further. Note: vibro-replacement concrete columns are at risk of this.
Scenario 4 Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration).	VSC	No	Certain types of stone, particularly limestone and those derived from calcareous rock, may susceptible to attack under certain conditions. Selection of a durable and chemical resistant stone is an appropriate measure. The SPR linkage is therefore incomplete and this Scenario is not considered further. All below ground concrete to be designed in accordance with the requirements of BRE SD1.
Scenario 5 Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface.	VSC	Yes	The high permeability of VSCs make them a preferential migration route for ground gas. Gas protective measures may need specific design changes or enhancement to account for the stone columns.
Scenario 6 Causing off site migration of ground gas or increased vertical emissions as a result of vibration	VSC	No	VSCs are designed to densify the ground and therefore reduce the volume of space for gas. Gas is far more likely to migrate up the stone column rather than any distance horizontally.

Preferential Pathway Scenario	Proposed Foundation Solution	Plausible Risk	Comments
or other effects from the pile installation process.			
Scenario 7 Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface.	VSC	No	There are no arisings brought to the surface using this technique hence direct contact is not considered to be a viable pathway. The SPR linkage is therefore incomplete and this Scenario is not considered further.

4.4 Risk Assessment of Potential Environmental Adverse Impacts

4.4.1 Scenario 1 of preferential pathways, through a low permeability layer (an aquitard), to allow potential contamination of an underlying aquifer

The shallow groundwater body is likely to be perched and there appears to be some hydraulic continuity between the Made Ground and Superficial Deposits (Secondary A aquifer). The deeper Frizington Limestone Formation is also classified as a Secondary A, however, the depth and extent of this strata in relation to site is currently unknown. Both strata are likely to comprise permeable layers that can support local water supplies and may form the source of base flow to rivers.

Evidence of hydrocarbon contamination was identified during the two phases of intrusive ground investigation, associated with historical petrol station and garage fuel infrastructure. The first ground investigation identified hydrocarbon contamination within both Made Ground and natural strata which, where tested, was identified at concentrations slightly exceeding their Controlled Waters screening criteria. These concentrations were deemed low enough that natural attenuation through the groundwater would reduce chemical concentrations to which they would not be at risk to sensitive receptors following DQRA.

It is understood APK have undertaken a tank cleaning operation within the fuel infrastructure underlying site in October 2025. A gas free certification was then undertaken following the cleaning operation which confirmed the absence of flammable gases or vapours, indicating the tanks were safe undertaking works in confined spaces and hot works. The risk from contaminants originating directly from the fuel infrastructure is deemed to be negligible with respect to migration to Controlled Waters or to future site users via inhalation of harmful gases. It is understood buried fuel infrastructure will also be removed as part of the site redevelopment.

Given the fuel infrastructure is still within the ground and the site’s commercial history, the full extent of contamination within the underlying made ground or natural strata may not be fully understood. Additionally, both the Made Ground and Glaciofluvial Deposits comprised interbedded low permeability clays between granular strata, which may be preventing migration of contamination into the underlying water-bearing aquifer.

When the fuel infrastructure is removed, any impacted soil encountered during excavation works will be removed prior to any foundation or ground improvement works. Additionally, a concrete plug across the zones of natural strata each column crosses may be prudent to restrict the potential migration of contaminants through an otherwise highly permeable stone column.

4.4.2 Scenario 5 of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface

VSCs are highly permeable, making them a preferential migration route for ground gas. Slightly elevated methane and carbon dioxide concentrations have been identified in the southwest portion of site during the first ground investigation. These concentrations indicate the site is classified as Characteristic Situation (CS) 2, and the proposed development requires basic gas protective measures. Likewise, the site lies within an area of 10% to 30% radon potential, indicating radon protective measures will also be required for the proposed build.

Gas flow was recorded at a maximum flow rate of 0.3 l/s. While not particularly fast flowing, gas migration may be promoted via the preferential pathway created by the VSCs high permeability. With this in mind, gas protective measures may require specific adjustments or enhancements to account for the preferential pathway of ground gas migrating to the proposed development.

It is not appropriate to increase the site CS nor design the BS 8485 points system where stone columns are present. The gas protection system and sub-slab venting should be designed based on modelling gas generation, flow towards and accumulation in the stone columns, followed by gas generation up the columns. Gas screening values or hazardous gas flow rates are not appropriate in this instance, and models should be based on diffusive and/or advective flow.

Where columns are located below foundations and are covered by concrete foundations, it is likely the columns will not increase gas risk. Where columns are present below floor slabs connected to the sub-base, may increase gas risk if columns are present at sufficient number. If an active gas extraction system is installed in the gas source, the provision of stone columns may allow ingress of air into the ground, with deleterious effects. Active sub slab pressurisation systems can also force air into the ground via the columns, and effects should be considered as this can increase the risk of spontaneous combustion.

4.4.3 Summary

Based on the discussions in the sections above, following removal of tanks and associated infrastructure the use of the proposed VSCs pose a low risk to Controlled Waters beneath the site.

A suitable regime of groundwater sampling and surface water monitoring, sampling and testing should be carried out at regular intervals during and after the construction period (where development allows), to monitor whether contamination has been mobilised and allow for works to be modified if necessary.

4.4.4 VSC QA/QC Control Measures

Outside of normal QA/QC control measures imposed in ground improvement measures, additional groundwater monitoring prior to, during and after VSC installation would be recommended to confirm the presence of contaminants within the underlying groundwater. Should contaminants of concern be observed within the underlying groundwater, advise from a specialist environmental consultant should be sought.

Gas monitoring and headspace testing proposed development should also be undertaken within the vicinity of installed VSCs to assess the potential risk from migrating ground gases to the proposed build. Should hazardous levels of ground gases be detected, advise should be sought from a ground gas specialist to advise on potential mitigation measures.

As mentioned above, concrete may be introduced to the VSCs to act as a relatively impermeable barrier to migrating contaminants in groundwater and upward migrating hazardous gases. Should this be considered further, advise from a specialist ground improvement contractor should be sought to confirm its potential feasibility, and contractors on site should monitor for concrete/grout bleeding into underlying groundwater.

Due to the potential for soil contaminants to be present within Made Ground and natural strata on site, risk to groundworkers is considered low to moderate. All construction workers should use appropriate PPE in the form of gloves, overalls and protective eyewear. Groundworkers should maintain good hand washing regime and adopt designated eating, drinking and smoking areas.

Should evidence of soil contamination be encountered during the proposed development, advise from the specialist environmental consultant should be sought. Site soils will be exposed for a limited duration during construction operations and standard site security measures such as fencing around the works will prevent access by members of the public to any exposed soils. Measures will be taken to prevent dust generation from stockpiles and excavations, and damping down may be necessary during periods of dry windy weather.

5 Vibro-Stone Column Method Statement

5.1 Introduction

The potential environmental impacts of VSCs on vibration, land stability, groundwater levels, underground pipes and other infrastructure is summarised below.

5.2 Vibration

Significant vibration is not likely to be generated by installing VSCs, however, use of vibration monitoring on the surrounding site boundaries and in the vicinity of existing buried services, should they be proposed to remain in situ for the proposed development, may be used to monitor vibration levels and ensure they are kept below threshold values.

5.3 Land Stability

The use of ground improvement rigs on the Made Ground and Superficial Deposits is likely to lead to excessive settlement beneath the rigs and/or stability issues due to the rigs weight and their expected poor bearing capacity and high compressibility.

To mitigate this risk, the design and construction of a working platform for piling rigs should be undertaken in accordance with BRE 470 '*Working platform for tracked plant - good practice guide to the design, installation, maintenance and repair of ground-supported working platforms*', or a working platform design by a specialist supplier.

5.4 Groundwater Levels

The VSC works are not proposed to alter the groundwater levels beneath the site as part of the construction works.

5.5 Underground Infrastructure

Prior to installing the VSCs, service plans should be consulted and underground services located and marked out. This will include using the current utility records and any information obtained from existing Ground Penetrating Radar (GPR) surveys. Vacuum excavated trenches and hand dug pits will also be used to locate underground services and prevent damage to them during the piling works.

It may also be necessary to re-route underground services if they clash with the locations of proposed piles.

5.6 Overhead Infrastructure

There are no overhead services on site.

6 References

BRE 470. 2004. ‘Working platforms for tracked plant: good practise guide to the design, installation, maintenance and repair of ground-supported working platforms’. BRE, Garston, Watford.

BRITISH STANDARDS INSTITUTION 2009. ‘Code of Practise for noise and vibration control on construction and open sites’. BS 5228-1:2009+A1:2014. BSI, London.

BRITISH STANDARDS INSTITUTION. 2020. Code of practice for ground investigations. BS 5930:2015+A1:2020. BSI, London.

FEDERATION OF PILING SPECIALISTS. 2014. ‘CFA Piling: Preventing ground and rig instability through over-flighting’. FPS.

HIRD. C.C., EMMETT K.B. & DAVIES G. 2006. ‘Piling in layered ground: risks to groundwater and archaeology’. Science Report SC020074/SR. Environment Agency.

CL:AIRE 2025 ‘Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention’.

Appendix D Tank Cleaning Records

J.W Hinchliffe (Tanks) Ltd
Weaver Street, Kirkstall Road
Leeds
LS4 2AU

Customer	WYNDHAM PLACE - FORMER PETROL STATION
Contact	Adam Kirkbride
Address	Wyndham Place Egremont CA22 2DY
Billing address	APK Demolition & Remediation Ltd Milburn House, Oxford Street Workington CA14 2AL

Resource	John Hinchliffe
Assisted by	Alex Leadbeater, Harry McGurk
Job type	Commercial Tank Clean
Reference	62609
Order number	APK839/180925
Date	14/10/2025 08:00
Distance travelled	0 mi

Notes Attend site, drain back suction lines and disconnect pumps, Clean x9 USTs to gas free standards and issue certs to allow main contractor to remove safely tanks.

Customer notes

Murphy

Trevor

001. Pre Start Checks

	Answer	Notes
Have you signed in at site and attended induction if required?	Yes	
Have you located the fire muster point?	Yes	

How many engineers are on site?	Three
1. RAMS confirmation signature	John Hinchliffe
2. RAMS confirmation signature	Harry mcgurk
3. RAMS confirmation signature	Alex Leadbeater
Are there any additional hazards not covered by your RAMS e.g. additional works not included?	No
Will any ladders be used in this job?	Yes
Has the ladder been inspected for damage and is it suitable for the task?	Yes
Have suitable arrangements been made to safely tie off or foot any ladders being used?	Yes

Please take photo of work area upon arrival	
Do you need a confined space permit?	Yes

1.2 Confined Space Permit

	Answer	Notes
Are all personnel involved trained in their respective roles for CS?	Yes	
Is there a suitable rescue plan in place?	Yes	
Please insert a photo of the gas monitor results for pre-entry?		
Is the required rescue equipment in place, suitable and in good condition?	Yes	
Support team in place, trained and aware of procedures for rescue?	Yes	

Entry point to confined space suitable and barriered if potential for fall from height?	Yes
Any required lock off carried out?	Yes
Suitable and if required ATEX lighting in place?	Yes
Breathing apparatus in place, checked and in good order?	Yes
Person/s entering the space trained for confined space entry?	Yes
Supervisor issuing the permit.	Harry mcgurk
Time of entry:	09:31
Entrant 1	John Hinchliffe
Is there a 2nd entrant	No
Entrant 2	Alex Leadbeater
Periodic gas reading 1	O2 = 20.8% , CO = 0%, H2S = 0%, LEL = 0%
Periodic gas reading 2	O2 = 20.8% , CO = 0%, H2S = 0%, LEL = 0%
Periodic gas reading 3	O2 = 20.8% , CO = 0%, H2S = 0%, LEL = 0%
Periodic gas reading 4	O2 = 20.8% , CO = 0%, H2S = 0%, LEL = 0%

Supervisor cancellation.	Harry mcgurk
Time of exit:	11:44
Entrant 1	John Hinchliffe
Is there a 2nd entrant	No

5. Cleaning Certificate - Tank Cleaning V2

	Answer	Notes
Has the job been completed as per the quotation?	Yes	
Do you need to issue a tank cleaning report?	Yes	
Is a gas free certificate required?	Yes	
Is a duty of care note required?	No	
Are there any advisory notes for the client?	No	
Does a Haz waste note require issuing?	Yes	

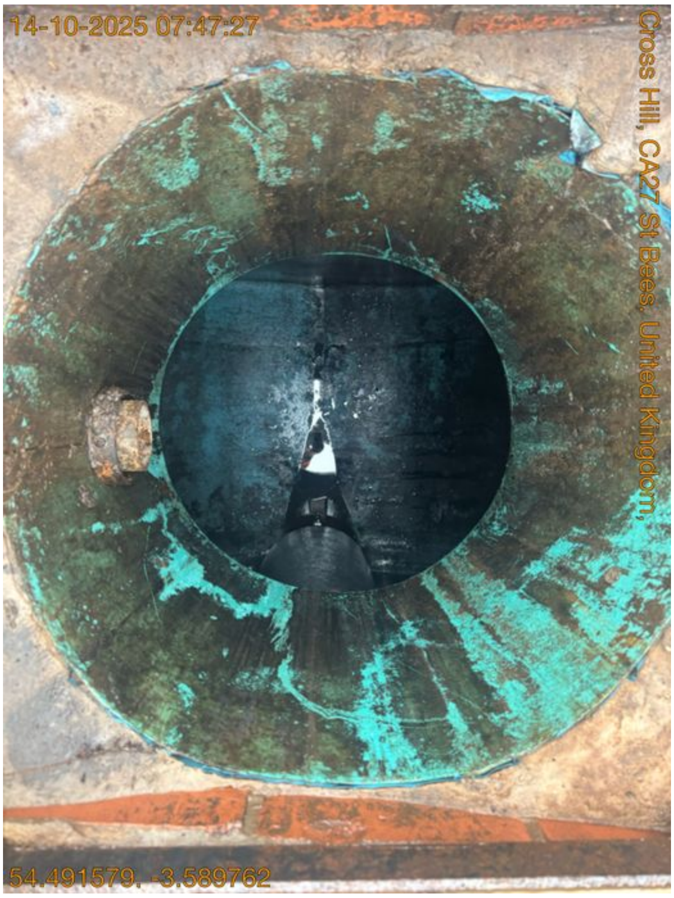
Add a photo of completed work area.

62609_1

62609_2


14-10-2025 07:47:22
Cross Hill, CA27 St Bees, United Kingdom,
54.491579, -3.589762

62609_3


14-10-2025 07:47:27
Cross Hill, CA27 St Bees, United Kingdom,
54.491579, -3.589762

Gas Free Certificate

JWH Tanks

Weaver Street
Leeds
LS4 2AU

Tel: 0113 2635163
Fax: 0113 2635164
Email: info@jwhtanks.co.uk
Web: www.jwhtanks.co.uk

Date of Issue: 14/10/2025
Time of Issue: 12:03
Customer Name: Wyndham Place - Former Petrol Station
Location: Wyndham Place, Egremont CA22 2DY
Job Ref: 62609

Declaration:

At the date and time shown, JWH Tanks Ltd, completed an atmospheric monitoring test of the installation named, with a calibrated LEL (Lower Explosive Limit) gas monitor. The Installation(s) mentioned were found to be free from the flammable gas or vapour and (subject to the conditions and advisory notes below) are deemed safe for the use of hot works.

Conditions:

The area observed should remain isolated for the duration of the works. Should the conditions observed during the examination be changed, this certificate will be cancelled. The certificate only relates to the area inside the installation, the entire area must be cleared of combustible material prior to any hot works.

Advisory Notes:

Works using hot cutting equipment and/or involving entering a confined space should only be undertaken by trained and competent personnel under a permit to work system. Reference should be made to The Confined Spaces Regulations 1997 and Management of Health and Safety Regulations 1999 along with relevant HSE guidance notes.

Petrol Tanks – Valid for 24 hours from the time stated above

Number of tanks cleaned or cold cut?	Capacities of tanks?	Identities of tanks? (if present)
3	2 x 13200 litre and 1 x 26400 litre	Tanks 1, 2 & 4

Diesel / Kerosene / Oil Tanks – Valid for 7 days from the time stated above

Number of tanks cleaned or cold cut?	Capacities of tanks?	Identities of tanks? (if present)
6	4 x 8800 litre and 2 x 13200 litre	Tanks 2,5,6,7,& 8 (split compartment)

Client Signature:	**Client Name:** Trevor

Engineer Name & Signature: John Hinchliffe

JWH Tanks
Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Tank Cleaning Report Certificate

Job Ref: 62609
Date: 14/10/2025

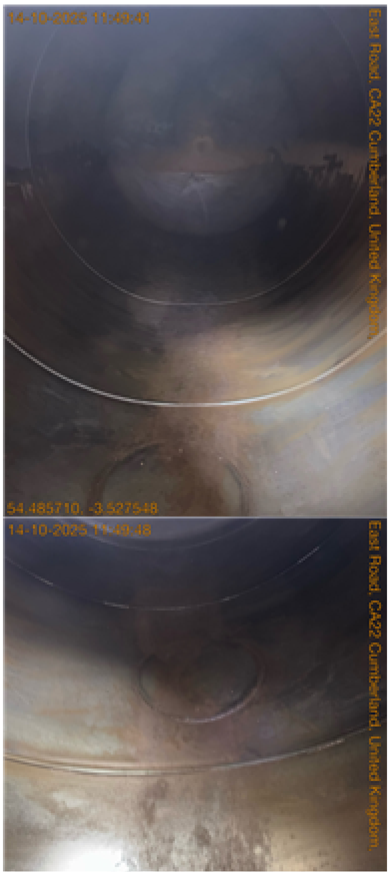
Section 1 – Tank Details

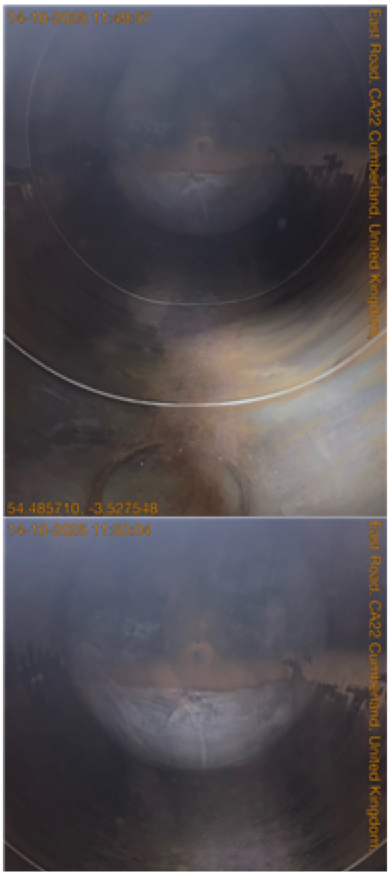
Tank Identification? Tank 1 - 26,452 litre petrol

Site Location? Wyndham Place - Former

Has the Tank been cleaned to the correct standard? Yes

Please provide pictures of internals





Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? No

Are there any other issues to raise in regard to the tank internals? *Leave blank if Not Applicable.*

Is there another tank to report on? No

DISCLAIMER: Please note, this tank cleaning report must only be used for hot works if in conjunction with a valid gas free certificate.

JWH Tanks
Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Tank Cleaning Report Certificate

Job Ref: 62562

Date: 15/10/2025

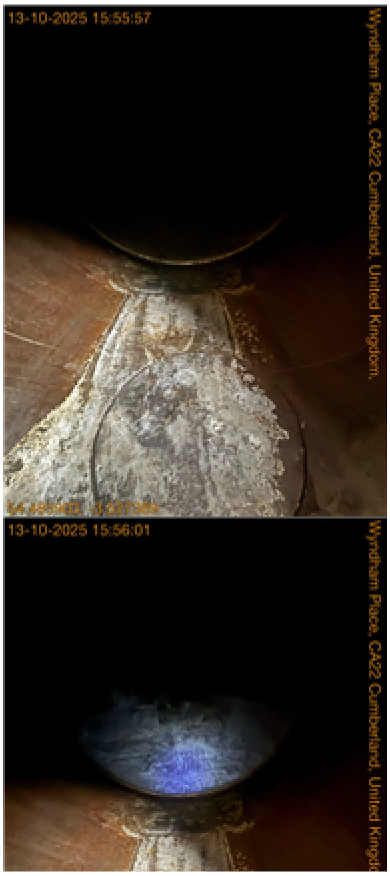
Section 1 – Tank Details

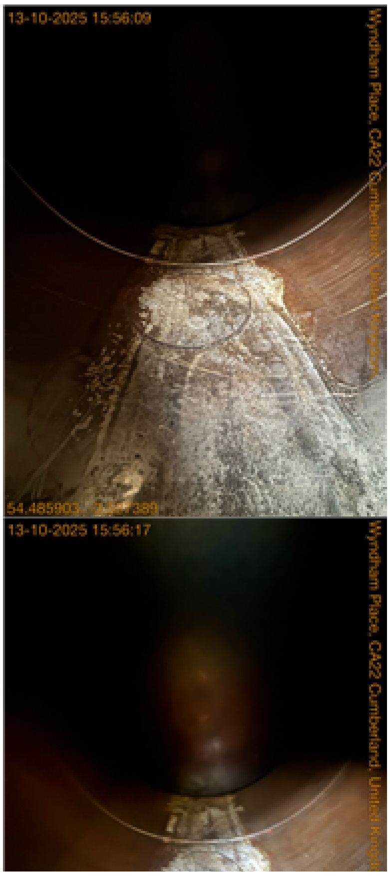
Tank Identification? Tank 2 - 13230 litre diesel

Site Location? East end garage, Egremont

Has the Tank been cleaned to the correct standard? Yes

Please provide pictures of internals





Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? No

Are there any other issues to raise in regard to the tank internals? *Leave blank if Not Applicable.*

No

Is there another tank to report on? Yes

DISCLAIMER: Please note, this is a Tank Cleaning Report Certificate, not a Gas Free Certificate

JWH Tanks

Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Job Ref:	62609
Date:	14/10/2025

Tank cleaning certificate for Wyndham Place - Former Petrol Station

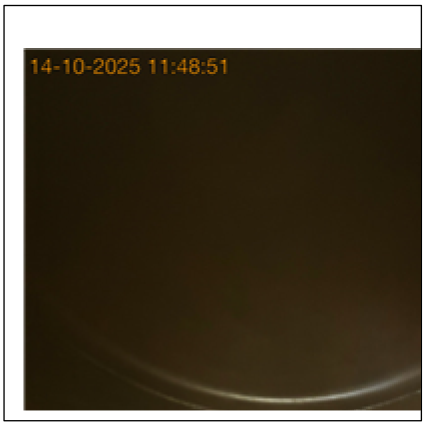
Section 1 – Tank Details

Tank Identification? Tank 3 - 13240 litre petrol

Has the Tank been cleaned to the correct standard? Yes

Tank / lid photographs:

14-10-2025 11:48:46



14-10-2025 11:48:51

14-10-2025 11:48:55

14-10-2025 11:48:58

14-10-2025 11:49:03

Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? No

Are there any other issues to raise regarding the fuel infrastructure?

Is there another tank to report on? Yes

Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Job Ref:	62609
Date:	14/10/2025

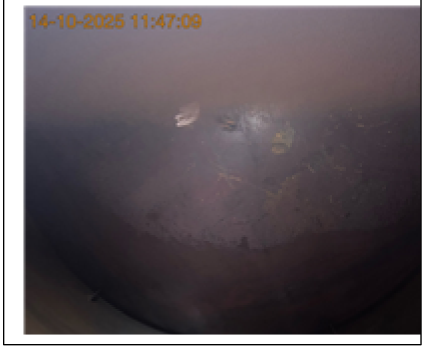
Tank cleaning certificate for Wyndham Place - Former Petrol Station

Section 1 – Tank Details

Tank Identification? Tank 4 - 13230 litre petrol

Has the Tank been cleaned to the correct standard? Yes

Tank / lid photographs:



Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? No

Are there any other issues to raise in regard to the fuel infrastructure?

\

Is there another tank to report on? Yes

Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Job Ref:	62562
Date:	13/10/2025

Tank cleaning certificate for Wyndham Place - Former Petrol Station

Section 1 – Tank Details

Tank Identification? Tank 5 - 13230 litre diesel

Has the Tank been cleaned to the correct standard? Yes

Tank / lid photographs:


13-10-2025 15:57:48


13-10-2025 13:46:30


13-10-2025 13:46:34


13-10-2025 13:46:39


13-10-2025 13:47:07

Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? Yes

Are there any other issues to raise regarding the fuel infrastructure?

No

Is there another tank to report on? Yes

Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Job Ref:	62562
Date:	13/10/2025

Tank cleaning certificate for Wyndham Place - Former Petrol Station

Section 1 – Tank Details

Tank Identification? Tank 6 - 8819 litre diesel

Has the Tank been cleaned to the correct standard? Yes

Tank / lid photographs:


13-10-2025 13:46:24


13-10-2025 13:46:30


13-10-2025 13:46:34


13-10-2025 13:46:39


13-10-2025 13:47:07

Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? Yes

Are there any other issues to raise regarding the fuel infrastructure?

No

Is there another tank to report on? Yes

Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Job Ref:	62562
Date:	13/10/2025

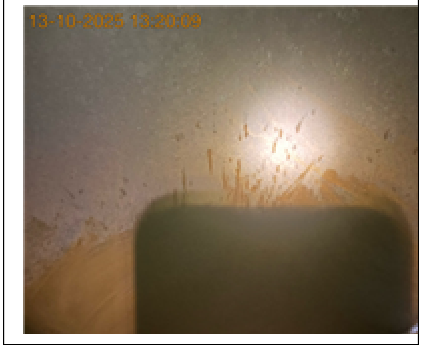
Tank cleaning certificate for Wyndham Place - Former Petrol Station

Section 1 – Tank Details

Tank Identification? Tank 7 - 8819 litre diesel

Has the Tank been cleaned to the correct standard? Yes

Tank / lid photographs:



Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? No

Are there any other issues to raise in regard to the fuel infrastructure?

No\

Is there another tank to report on? Yes

JWH Tanks
Weaver Street, Leeds, LS4 2AU
Tel: 0113 263 5163
Fax: 0113 263 5164
Email: info@jwhtanks.co.uk

Tank Cleaning Report Certificate

Job Ref:	62562
Date:	13/10/2025

Section 1 – Tank Details

Tank Identification? Tank 8 - 17460 litre diesel

Site Location? Wyndham Place - Former

Has the Tank been cleaned to the correct standard? Yes

Please provide pictures of internals

Section 2 – Tank Inspections/Issues

Are there any potential issues with corrosion within the tank? No

Are there any other issues to raise in regard to the tank internals? *Leave blank if Not Applicable.*

(2 x 8730 litre diesel - cut baffle)

Is there another tank to report on? Yes

DISCLAIMER: Please note, this tank cleaning report must only be used for hot works if in conjunction with a valid gas free certificate.

Appendix E Unexpected and unforeseen contamination protocol

Due to the development history of the site, the potential exists for encountering materials that were not recorded during the original ground investigations. Outside of the known areas of contamination, any significant quantities of suspected oily or odorous material, significant ashy soils and/or unusual brightly coloured or asbestos containing materials should be considered as possibly contaminated.

All relic underground structures and services will require appropriate management and decommissioning to reduce the potential for additional contamination of soils and groundwater during the works. Furthermore, given the potential presence of unidentified sources of contamination existing within discrete areas across the site it is recommended that a watching brief be adopted by a suitably qualified Geo-environmental Engineer or Consultant for all excavation activities and during the removal of relic underground structures.

Should any previously unidentified material suspect of being contaminated be encountered during the development of the site (by visual or olfactory means), then the following protocol should be implemented.

- Site activities in the immediate vicinity shall cease and an independent Geo-environmental Engineer or Consultant should be contacted (if not on-site already) and provided with a summary of the observations made.
- The Local Authority should be contacted.
- Should there be a perceived risk to Controlled Waters, the EA should also be contacted.
- The Geo-environmental Engineer or Consultant should undertake appropriate investigations to establish the extent of the materials in question. Depending upon the extent and volume of material present, the materials may be removed and temporarily stockpiled (on heavy grade polythene sheeting to prevent leaching/runoff) to enable activities to continue.
- The Geo-environmental Engineer or Consultant should identify an appropriate suite of chemical testing and agree this with the relevant regulator(s).
- The resultant chemical analyses shall be compared with the appropriate criteria for the land use in question. The findings and recommendations shall be discussed and agreed with the relevant regulator(s).
- Updates will be made to this Remediation Strategy and Verification Plan, if required. In the majority of cases it would be proposed that unexpected contamination is dealt with via independent correspondence, but on occasion it may be necessary to revisit and update this document.
- Prior to implementing any amendments to the Remediation Strategy and Verification Plan, the relevant regulator(s) shall be consulted and the amendments agreed in writing.

Part A. Notification Details

The Hazardous Waste Regulations 2005 Consignment Note

Consignment no: WYNPLA/00221
Consignment type: Hazardous

L.I.S GROUP

The waste below is to be removed from JWH @ Wyndham Police
Producer address: Wyndham Place, Egremont, CA22 2DY
Contact details
JWH @ Wyndham Police -
jack@jwhtanks.co.uk

The waste will be taken to L.I.S Group
Disposal point address Unit 11 Haydock Lane, Haydock Industrial Estate, St Helens, Merseyside, WA11 9UY, EP3835PU
Contact details
Lisa Marlett 01942 722244
lisa@lisgroup.co.uk

Part C: Carriers Certificate

Third party consignment note code
Collection date: October 13, 2025
Single/multiple collection: Single
Collection number:
Round number:

Vehicle registration or non-mode of transport: WJ70BMV
Trailer registration:
Carrier: Kevin Sherlock
Carrier address:
Unit 11 Haydock Lane, Haydock Industrial Estate, St Helens, Merseyside, WA11 9UY
Carrier/Broker registration no/reason for exemption:

Carrier Signature 13/10/2025 11:24

Part D: Consignor's Certificate

Consignor name: John hinchliffe
On behalf of: JWH @ Wyndham Police
Consignor address:
Wyndham Place Egremont CA22 2DY

I certify that the information in A, B and C has been completed and is correct, that the carrier is registered or exempt and was advised of the appropriate precautionary measures. All of the waste is packaged and labelled correctly and the carrier has been advised of any special handling requirements.
I confirm that I have fulfilled my duty to apply the waste hierarchy as required by Regulation 12 of the waste(England and Wales) Regulations 2011.

Customer Signature - 13/10/2025 11:28

Part E: Consignee Certificate

Consignee Name:
Consignee Address:
L.I.S Group
Unit 11 Haydock Lane, Haydock Industrial Estate, St Helens, Merseyside, WA11 9UY

Vehicle Registration (or non-mode of transport) WJ70BMV

Where The Consignment Forms Part Of A Multiple Collection, As Identified In Part C, I Certify That The Total Number Of Consignments Forming The Collection Are:

I certify that waste permit / exempt waste operation number EP3835PU authorises the management of the waste described in B at the address given in Part A.

Disposal Signature -

Disposal Signature Date & Time -

Part B: Description Of The Waste

Process giving rise to waste:

SIC Code: 47.30

1	Description: Interceptor Liquids						
UN:	Shipping: Interceptor Liquids	UN Class:	Packing Group:	Tunnel Codes:			
EWC: 13 05 07	Special handling:	**Waste QTY (kg): 6000**	Physical: Liquid	Haz: HP7,HP10,HP11,HP14	Container Types: Bulk	Container(s):	Unit Weight:
Component: Interceptor Liquids	Concentration: <1-10%						

2	Description: Interceptor Sludges						
UN:	Shipping: Interceptor Sludges	UN Class:	Packing Group:	Tunnel Codes:			
EWC: 13 05 02	Special handling:	**Waste QTY (kg): 2000**	Physical: Sludge	Haz: HP7,HP10,HP11,HP14	Container Types: Bulk	Container(s):	Unit Weight:
Component: Interceptor Sludges	Concentration: <1-10%						

Part E: Consignee Certificate - Extended Waste List

Note number: WYNPLA/00221

Note type: Hazardous

Job reference:

	EWC Code	Finished Qty (kg)	R or D Code	Accepted
1	13 05 07	**6000**		Accepted
2	13 05 02	**2000**		Accepted

Company Details

L.I.S Group
Unit 11 Haydock Lane
Haydock Industrial Estate
St Helens
Merseyside
WA11 9UY

Lisa Marlett
01942 722244
lisa@lisgroup.co.uk
GB 3762932

PART A - NOTIFICATION DETAILS

1 . Consignment code: 62609	**2. Premises Code (If applicable):** WYNDHA

3. Waste decribed below to be removed from (Name, Address, Telephone & Email)
Wyndham Place - Former Petrol Station, Wyndham Place, Egremont CA22 2DY, ,

4. Waste will be taken to: J W Hinchliffe Ltd, Weaver Street, Leeds, West Yorkshire, LS4 2AU

5. The waste producer was (if different from 3):

PART B - DESCRIPTION OF WASTE

1. Process giving rise to the waste was: Tank Cleaning	**2. SIC CODE:** 43120

3. Waste Details (Information to be completed for each EWC code collected)

Description of Waste	EWC Code	Quantity (KG)	Components of the waste and their concentrations mg/kg or %	Physical Form	Hazard Codes	Container type Number & Size
Waste Containing Oil	160708	600	> 1% Hydrocarbons	Sludge	HP3	IBC x 1 - 1000L
Waste Fuel Oil	130701	800	>99% Oil	Liquid	HP14	IBC x 1 - 1000L

The information below is to be completed for each EWC code

EWC Code	**Description for carriage (**UN Number, Proper Shipping name, UN Class & Packing Group)	Special handling requirements
160708		PPE
130701	UN1202 - Fuel Oil - Class 3 - Packing Group III	PPE

PART C - CARRIERS CERTIFICATE

If more than one carrier is used, a schedule should be attached. If a schedule is attached, tick here	
I certify that I today have collected the consignment and that the details in A3, A4 & B3 are correct. I have been informed of any special handling requirements.	
Where this note comprises part of a multiple collection, the round number and collection number are	

Driver's name: John Hinchliffe

On Behalf of: J W Hinchliffe Ltd, Weaver Street, Leeds, LS4 2AU - Tel: 0113 263 5163
Email: enquiries@jwhtanks.co.uk

Carrier Reg: CB/DU93436

Vehicle Registration: BG71 YYC

Date:14/10/2025	**Time**:12:03

Drivers Signature:
John Hinchliffe

PART D - CONSIGNORS CERTIFICATE

I certify that the information in A, B & C has been completed and is attached. If a schedule is attached, tick here. correct. The carrier is registered or exempt and was advised of the I certify that I today have collected the consignment and appropriate precautionary measures. All of the waste is labelled and that the details in A3, A4 & B3 are correct. I have been packaged correctly, and the carrier has been advised of any special informed of any special handling requirements. handling requirements. Where this note comprises part of a multiple collection, I have fulfilled my duty to apply the waste hierarchy as required by the round number and collection number are: Regulation 12 of the Waste (England & Wales) Regulations 2011.

Consignor Name:Trevor

On Behalf of:
Wyndham Place - Former Petrol Station, Wyndham Place, Egremont CA22 2DY

Telephone (If provided) :

Email:

Date:14/10/2025	**Time**:12:03

Consignor Signature:

PART E - CONSIGNEE CERTIFICATE (Complete for each EWC collected)

EWC code	Quantity Received (KG)	EWC code accepted / rejected	Waste management operation (R or D code)
160708	600	Accept	D15
130701	800	Accept	R13

I received the waste at the address given in A4 on:

Date & Time : 15/10/2025 09:00
Vehicle Reg: BG71 YYC

I certify that the waste management license / permit **65133** authorises the management of the waste described in B at the address given in A4.

If the consignment forms a multiple collection, the total number of consignments are:

Name: Jack Hartley

On behalf of: J W Hinchliffe Ltd , Weaver Street, Leeds, LS4 2AU

Tel: 01132635163

Email: enquiries@jwhtanks.co.uk

Date & Time : 15/10/2025 09:00

Signature –

Appendix F Remedial Target Values

Validation targets for tank and associated infrastructure works

Table F.1: Remedial Target Values for soils during tank removal works

Contaminant	Human Health GAC (mg/kg)	Level 3 Soil Target (mg/kg)	RTV (mg/kg
Aliphatic >EC$_5$-EC$_6$	3,200	1.98E+06	**3,200**
Aliphatic >EC$_6$-EC$_8$	7,800	9.55E+06	**7,800**
Aromatic >EC$_8$-EC$_{10}$	3,500	1.38E+18	**3,500**
Aromatic >EC$_{10}$-EC$_{12}$	16,000	8.99E+17	**16,000**
Aromatic >EC$_{12}$-EC$_{16}$	36,000	3.07E+19	**36,000**
Naphthalene	1,600	5.55E+16	**1,600**
Benzene	27	4.18E+12	**27**
Toluene	56,000	1.47E+00	**1.47**
Ethylbenzene	5,700	7.81E+17	**5,700**
m-&p-xylene	5,900	1.30E+00	**1.30**
o-xylene	6,600	1.12E+18	**6,600**

Import frequencies for imported soils

To confirm the suitability of the materials, validation testing will be required following importation to site. All validation testing will be undertaken by a suitably qualified engineer, with the analysis to be completed by an appropriate laboratory (MCERTS and UKAS accredited). In addition, the samples will also be subject to suitable handling protocols to ensure data quality. Further details on the testing frequency and testing suites for different material types are provided in Table F.2.

Table F.2: Import criteria for naturally occurring soils

Contaminant	Proposed import criteria (mg/kg)	Justification
Virgin Quarried Material	1 or 2 depending on type of stone utilised to confirm inert nature of material	Standard metals/metalloids (include as a minimum As, Cd, Cr, Cr (VI), Cu, Hg, Ni, Pb, Se and Zn).
Crushed hardcore, stone, brick (excluding asphalt)	Minimum 1 per 500m^3	• Standard metals/metalloids • PAH (16 USEPA) • TPH CWG • Asbestos Screen Any additional analysis dependant on history of donor site.
Greenfield / Manufactured Soils	Minimum 3 or 1 per 250m^3 (whichever is greater)	• Standard metals/metalloids • PAH (16 USEPA) • TPH CWG • pH, TOC and SOM Asbestos Screen
Brownfield / Screened Soils	Minimum 6 or 1 per 100m^3 (whichever is greater)	• Standard metals/metalloids • PAH (16 USEPA) • TPH CWG • pH, TOC and SOM • Asbestos Any additional analysis dependant on history of donor site.

Chemical limits for imported topsoil and subsoil

Table F.3 sets out the chemical criteria for imported naturally occurring soils (i.e. topsoil and subsoil). These limits are based on the principles of (1) the protection of human health and the environment, (2) the practicality of sourcing soils with chemical concentrations that are below naturally occurring regional levels, (3) not introducing new chemical hazards to the site by importing soil containing chemical concentrations significantly elevated compared to existing site and regional concentrations, and (4) balancing chemical limits with other considerations such as visual and olfactory contamination.

Table F.3: Import criteria for naturally occurring soils

Contaminant	Human Health [1] / Phytotox [2] GAC	Site-Specific RTV	Max Site Concentration	Import RTV
Arsenic	640 / 250	N/A	47	**47**
Cadmium	410	N/A	1.3	**1.3**
Chromium (III)	8,400 / 400	N/A	46	**46**
Chromium (VI)	49	N/A	1.8	**1.8**
Copper	68,000 / 200	N/A	100	**100**
Lead	2,300	N/A	550	**550**
Mercury, inorganic	1,100	N/A	0.9	**0.9**
Nickel	980 / 110	N/A	140	**110**
Selenium	12,000	N/A	8.6	**8.6**
Zinc	730,000 / 300	N/A	290	**290**
Acenaphthene	110,000	N/A	1.8	**1.8**
Acenaphthylene	110,000	N/A	1.2	**1.2**
Anthracene	540,000	N/A	1.8	**1.8**
Benz(a)anthracene	170	N/A	4.1	**4.1**
Benzo(a)pyrene	77	N/A	3.5	**3.5**
Benzo(b)fluoranthene	44	N/A	4.2	**4.2**
Benzo(g,h,i)perylene	3,900	N/A	1.5	**1.5**
Benzo(k)fluoranthene	1,200	N/A	2.0	**2.0**
Chrysene	350	N/A	4.0	**4.0**
Dibenz(ah)anthracene	3.5	N/A	0.37	**0.37**
Fluoranthene	23,000	N/A	9.0	**9.0**
Fluorene	71,000	N/A	7.8	**7.8**
Indeno(1,2,3-c,d)pyrene	500	N/A	1.5	**1.5**
Naphthalene	1,800	5.55E+16	0.45	**0.45**
Phenanthrene	23,000	N/A	9.5	**9.5**
Pyrene	54,000	N/A	7.2	**7.2**
Benzene	27	4.18E+12	0.005	**0.005**
Toluene	56,000	1.47E+00	0.005	**0.005**
Ethylbenzene	5,700	7.81E+17	0.005	**0.005**
m-&p-xylenes	5,900	1.30E+00	0.005	**0.005**
o-xylene	6,600	1.12E+18	0.005	**0.005**
Sum of total petroleum hydrocarbons	N/A	N/A	-	**250 [3]**
Asbestos	N/A	N/A	-	**No visible ACM. <LoD [4]**

Notes:
All values in mg/kg.
[1] *Commercial, conservatively based on 1% SOM.*
[2] *RTV protective of phytotoxic risks, applicable to upper 300mm of landscape fill only.*
[3] *A limit of 250mg/kg has been applied represent 'clean' soils and to prevent odorous or visually oily materials.*
[4] *Below the quantifiable limit of detection (<0.001%).*

Chemical limits for the reuse of site-won materials

Table F.3 sets out the chemical criteria for re-use of soils (i.e. topsoil and subsoil). These limits are based on the same principles as importing soils, without the need to consider not introducing new chemical hazards to the site as any concentrations are already present at their existing levels.

Table F.3: Criteria for the reuse of site-won materials

Contaminant	Human Health [1] / Phytotox [2] GAC	Site-Specific RTV	Reuse RTV
Arsenic	640 / 250	N/A	**250**
Cadmium	410	N/A	**410**
Chromium (III)	8,400 / 400	N/A	**400**
Chromium (VI)	49	N/A	**49**
Copper	68,000 / 200	N/A	**200**
Lead	2,300	N/A	**2,300**
Mercury, inorganic	1,100	N/A	**1,100**
Nickel	980 / 110	N/A	**110**
Selenium	12,000	N/A	**12,000**
Zinc	730,000 / 300	N/A	**300**
Acenaphthene	110,000	N/A	**110,000**
Acenaphthylene	110,000	N/A	**110,000**
Anthracene	540,000	N/A	**540,000**
Benz(a)anthracene	170	N/A	**170**
Benzo(a)pyrene	77	N/A	**77**
Benzo(b)fluoranthene	44	N/A	**44**
Benzo(g,h,i)perylene	3,900	N/A	**3,900**
Benzo(k)fluoranthene	1,200	N/A	**1,200**
Chrysene	350	N/A	**350**
Dibenz(ah)anthracene	3.5	N/A	**3.5**
Fluoranthene	23,000	N/A	**23,000**
Fluorene	71,000	N/A	**71,000**
Indeno(1,2,3-c,d)pyrene	500	N/A	**500**
Naphthalene	1,800	5.55E+16	**1,800**
Phenanthrene	23,000	N/A	**23,000**
Pyrene	54,000	N/A	**54,000**
Benzene	27	4.18E+12	**27**
Toluene	56,000	1.47E+00	**56,000**
Ethylbenzene	5,700	7.81E+17	**5,700**
m-&p-xylenes	5,900	1.30E+00	**5,900**
o-xylene	6,600	1.12E+18	**6,600**
Sum of total petroleum hydrocarbons	N/A	N/A	**250** [3]
Asbestos	N/A	N/A	**No visible ACM. <LoD** [4]

Notes:
All values in mg/kg.
1 Commercial, conservatively based on 1% SOM.
2 RTV protective of phytotoxic risks, applicable to upper 300mm of landscape fill only.
3 A limit of 250mg/kg has been applied represent 'clean' soils and to prevent odorous or visually oily materials.
4 Below the quantifiable limit of detection (<0.001%).

The soil saturation limit has been rejected as an appropriate criterion option for the import and reuse RTV selection as the soil saturation limits for petroleum hydrocarbon fractions and PAHs tend to be unnecessarily low.

The criteria are subject to review and amendment should any of the values prove impractical to achieve or define soil that is otherwise unsuitable for use based on wider project suitability requirements.

These criteria are to initially act as a trigger (if exceeded) for further consideration of where the site-won material proposed for reuse is to be placed as part of the materials management strategy. An exceedance does not necessarily mean that the site-won material cannot be reused on-site, however, this may need to be beneath cover, buildings or hardstanding for example.

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