

REMEDIATION IMPLEMENTATION PLAN

ARUNDEL ROAD, ANGMERING

FOR

REDROW HOMES LIMITED

ISSUE 1



TO BE APPROVED BY THE LOCAL PLANNING AUTHORITY PRIOR TO WORKS BEING UNDERTAKEN

46647-001

28 January 2022

REMEDIATION IMPLEMENTATION PLAN

ARUNDEL ROAD, ANGMERING

FOR

REDROW HOMES LIMITED

ISSUE 1

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APPENDICES

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- Appendix 2** Soil Assessment Values – Residential with Homegrown Produce & Commercial/Industrial Use
- Appendix 3** Imported Material Documentation Form

1.0 INTRODUCTION

This Implementation Plan has been produced by Eastwood & Partners (Consulting Engineers) Limited, on behalf of Redrow Homes Limited, for the site at Arundel Road, Angmering. The purpose of this document is to detail the procedures for the implementation and subsequent verification of remedial works to deal with contamination found within the ground at the site.

This is to ensure that upon completion of the residential and commercial development, the site can be shown to be suitable for its intended use and that it will not pose unacceptable risks to future receptors. This document therefore covers the protective measures to be installed during the construction phases of the development for a residential and commercial end use. It also covers the protective measures which will need to be put in place during construction to ensure that risks are not posed to off-site receptors.

This document is a working publication and may need to be updated, in agreement with the relevant regulatory bodies, at any stage during development dependent on what is encountered. This document is also subject to the approval of the regulatory parties; the Local Authority and your warranty provider. This version constitutes Issue 1. Please contact Eastwood & Partners if you are unsure of the current issue.

The role of 'Engineer' referred to in this document shall be taken to mean a suitably qualified Geo-environmental engineer employed by the developer for the purposes of checking compliance with the Implementation Plan, undertaking tests and verifications as necessary and preparing the Verification Reports as specified.

2.0 RATIONALE FOR REMEDIAL WORKS

The Site

The around 9-hectare site is located on the western side of Arundel Road, to the north of Angmering in West Sussex. It is centred on grid reference 506542, 105327.

The majority of the site is occupied by an arable agricultural field, with a residential property on the northeastern corner of the site. An industrial estate, including vehicle repair garages, PVC window manufacturing and caravan storage is present on the southeastern corner of the site. The majority of the buildings on the industrial have suspected cement bound asbestos roofing.

It is proposed that the majority of the site will be developed with low-rise residential properties with private gardens, with a 2 ha area of public open space (POS) on the southern quarter of the site, and a commercial area in the southeastern corner of the site.

Previous Investigations

RSK have previously completed a Phase 2 Geo-environmental and Geotechnical Site Investigation on the site, reference 52207 R01 (02), dated September 2020. A review of the RSK report is presented in our Site Investigation Review, dated October 2020.

In addition to the above report, a Preliminary Risk Assessment was produced by RSK in August 2017. This report was not made available for review, but was summarised within the Phase 2 site investigation report.

RSK's Phase 2 Site Investigation comprised the following:

- Twenty-five trial pits (TP1 to TP25) to a maximum depth of 3.6 m bgl, three of which were used for infiltration purposes.
- Nine window sample boreholes (WS1 to WS4, WS7, WS9 to WS12) to depths of between 3.45 m and 6.45 m below ground level (bgl), each installed with a gas and groundwater monitoring standpipe.

RSK also completed an updated Phase 2 Geo-environmental and Geotechnical Site Investigation on the site, reference 52207 R01 (04), dated December 2021, with the completed ground gas monitoring assessment.

Eastwood & Partners attended the site in March 2021, to install a further seven monitoring wells (WS1-WS7) across the agricultural field, for groundwater monitoring purposes.

Ground Conditions

Topsoil was encountered in the majority of exploratory holes and reached depths of up to 0.35 m. Made ground was encountered on the industrial estate and in the northeastern corner of the site, to a maximum depth of 0.5 m. The made ground was variable in composition, comprising clayey gravelly sand and gravelly clay, with fragments of brick, concrete and locally metal. The natural ground comprised predominantly cohesive soils, comprising soft silty slightly sandy clay, becoming firm and stiff with depth. Granular bands were encountered within this material in the centre of the site. The natural ground encountered is considered representative of Head deposits and the base of this strata was not proven in any of the exploratory holes (i.e. >6.45 m).

Chemical Testing Assessment

RSK tested seven samples of topsoil, ten samples of made ground and two samples of natural ground for a suite of contaminants including metals/metalloids, speciated polycyclic aromatic hydrocarbons (PAHs), pH, fractionated total petroleum hydrocarbons (TPH CWG) and benzene, toluene, ethylbenzene and toluene (BTEX) and methyl tert-butyl ether (MTBE). Three of the samples of topsoil and all of the samples of made ground were also screened for asbestos.

The results were compared with generic assessment criteria assuming a soil organic matter content of 1%.

RSK split the site into three different zones according to the proposed development layout of the site and adopted relevant assessment criteria relating to the proposed end uses. The extract from RSK report below, summarises the different zones. It should be noted that proposed development layout has been updated since the RSK report was issued, though the commercial area and POS on the northeastern corner of the site are broadly as detailed on the RSK zoning.

Zone 1 is located in the northern tip of the site that is subject to become public open space, and GAC values relating to the public open space scenario will be used to compare the results from the soil samples taken within that area.

According to proposed development plan, the area around the former Seven Acres Nursery (identified as **Zone 2**) is proposed to be a commercial development, therefore a commercial scenario GAC's will allow for accurate evaluation of contamination risk in this area.

The remainder of the site (**Zone 3**) is proposed for residential end-use, and thus relevant GAC values will be used to assess the soil collected within the area.

Topsoil

None of the samples of topsoil tested, recorded elevated concentrations above their respective assessment values, with respect to human health or phytotoxicity.

No asbestos fibres were recorded in any of the samples of topsoil analysed.

Made Ground

Three samples of made ground (WS1 at 0.1-0.2 m, WS3 at 0.2-0.3 m and WS7 at 0.1-0.2 m) recorded elevated concentrations of lead and PAHs (including benzo(a)pyrene, benzo(a)anthracene benzo(b)fluoranthene, and dibenzo(ah)anthracene) above the generic assessment values for residential development with home-grown produce.

The proposed commercial area (RSK Zone 2) also recorded elevated concentrations of a number of contaminants above the generic assessment values for residential development with home-grown produce. As this area is proposed for commercial use, the concentrations were compared to the less conservative commercial/industrial use assessment values.

A number of samples of made ground also recorded concentrations of arsenic, copper, lead, mercury and zinc above the phytotoxic assessment values.

No asbestos fibres were identified in any of the samples of made ground analysed.

Natural Ground

None of the samples of natural ground tested, recorded elevated concentrations above their respective assessment values, with respect to human health or phytotoxicity.

Remedial Proposals

For the proposed residential development area, where made ground is to remain at surface in gardens or soft landscaping areas, a minimum 600 mm thickness of clean capping is required.

For the proposed POS and commercial area, where made ground is to remain at surface in soft landscaping areas, a minimum 450 mm thickness of clean capping is required.

All gardens and areas of soft landscaping should be provided with a growing medium, which is at least 100 mm thick.

The estimated extent of made ground requiring capping below gardens and soft landscaping areas is detailed on the appended Remediation Plan, Drawing No. 46647/060A.

The topsoil is considered suitable for re-use in the development.

The suspected cement bound asbestos roofing sheets present on the structures, and any other asbestos containing materials/suspected asbestos containing materials, should be removed off-site with careful and appropriate disposal.

Construction Materials Assessment

Limited sulphate testing was undertaken, but this suggested that DS-1 AC-1 concrete would be suitable at the site i.e. no precautions are required.

The results of the chemical testing will need to be forwarded to the water company so that appropriate water supply pipes can be selected. It is possible that protective measures will be required for new drinking water supply pipes laid within the made ground.

Radon and Ground Gas

No radon protective measures are required.

There are no active or historical landfills recorded within 250 m of the site.

Deep made ground was not encountered on the site.

RSK reported that a possible quarry or pit was present in the northeast of the site, which was backfilled by 1979. RSK only recorded made ground to a depth of 0.3 m, in this area.

Due to the historically uses of the site, and the ground conditions encountered, a significant risk of ground gas is not expected.

RSK installed eight ground gas and groundwater wells (WS1 to WS4, WS7, WS9, WS10 and WS11) and undertook three rounds of gas monitoring over a twelve-day period in September 2020.

A summary of the gas monitoring results is given below:

- No detectable methane concentrations have been recorded;
- Carbon dioxide was recorded at concentrations of between 1.4% to 6.1%. Carbon dioxide concentrations exceeded 5% in four of the monitoring wells (WS3, WS4, WS9 and WS11) on three of the monitoring visits, with concentrations of between 5.1% to 6.1% recorded.
- No positive gas flow rates were recorded.

The NHBC traffic light system, as detailed in C665, uses “typical maximum concentrations” for initial screening purposes and risk-based gas screening values (GSVs) for consideration in scenarios where the typical maximum concentrations are exceeded.

Assuming a detection limit gas flow of 0.1 l/hr, gas screening values (GSVs) of 0.0 and 0.0061 l/hr have been calculated for methane and carbon dioxide, respectively. The carbon dioxide GSV of 0.0061 l/hr, equates to Green gas precautions in accordance with C665.

RSK classified the site as Characteristic Situation 1 (according to the modified Wilson & Card classification).

As detailed in C665, usually it is expected that a gas monitoring program should consist of a minimum of six rounds of gas monitoring across three months. Also, carbon dioxide concentrations exceeded the NHBC Traffic Light ‘Green’ ‘typical maximum concentration’ of 5% in four of the monitoring wells on three of the monitoring visits.

However, as ground gas monitoring was not considered necessary based on the conceptual site model (CSM), the monitoring undertaken can be considered as a screening exercise, with the monitoring results agreeing with the expected ground gas regime.

Given the carbon dioxide exceedances are only marginally, and not consistently elevated, that the flow rate is very low, with the GSV for carbon dioxide is 0.0061 l/hr, which is 125 times lower than the Amber 1 threshold concentration,; it is considered that the recorded maximum carbon dioxide concentration and flow rates are unlikely to be substantially exceeded, therefore it is considered, that characterisation of the site as NHBC Green would be appropriate. No gas precautions are therefore required.

3.0 REMEDIATION OBJECTIVES

The remedial objectives for this site are therefore:

1. To ensure that 600 mm of clean inert physically suitable material, including at least 100 mm of growing medium, is present within private gardens and areas of soft landscaping on the proposed residential development, where made ground remains.
2. To ensure that 450 mm of clean inert physically suitable material, including at least 100 mm of growing medium, is present within the POS area, where made ground remains.
3. To ensure that appropriate sulphate precautions and water supply pipes are installed*; and
4. Upon identification of any additional or unexpected contamination, a suitable strategy to determine any remedial action is to be in place.
5. No ground gas precautions are considered to be required.

*No further guidance with regards to this is considered necessary as part of this document.

The suspected cement bound asbestos roofing sheets present on the structures, and any other asbestos containing materials/suspected asbestos containing materials, should be removed off-site with careful and appropriate disposal.

To reduce the risks to construction workers, normal site procedures, such as the wearing of gloves when handling soils and the washing of hands prior to eating, should be implemented at all times.

4.0 WORKING METHOD

During the works, procedures to protect site neighbours, the environment and amenity, and to control dust, noise and odours should be put in place by the contractor, in addition to the required site health and safety procedures that apply. Control of surface runoff over areas of potentially contaminated ground should also be taken into consideration.

The procedures for implementation of the mitigation measures identified in Section 2, to ensure that the objectives detailed in Section 3 are met, are outlined in Sections 6 to 8. All remediation works are to be overseen by suitably experienced site staff. Periodic visits will be made by a suitably qualified independent consulting Engineer, to undertake the necessary verification works detailed.

5.0 GAS PROTECTIVE MEASURES

No ground gas protective measures are considered to be required.

6.0 IMPORTED MATERIALS

6.1 Sourcing of Material

The site won topsoil and natural ground is considered suitable for re-use in the development. However, if additional material is required, this will need to be imported.

Any topsoil and subsoil considered for importation should be from a source not expected to be contaminated and meet both physical and chemical criteria as detailed in the Sections 6.2 and 6.3. Testing will need to be carried out in accordance with Section 6.3.

Prior to importation, certification should be obtained from the supplier detailing the source site, its previous and current land use and relevant test results. A copy of this information should also be forwarded to the Engineer.

For imported materials, copies of the carrier's consignment notes should be retained with the documentation detailed in Section 6.4 and a copy forwarded to the Engineer. The soil should be stockpiled separately and away from areas designated for storing other materials or potential sources of contamination. Separate stockpiles should also be created for each different source. All stockpiles should be suitably quarantined and identified as such until deemed suitable for use.

The following soil handling procedures should also be adhered to:

- Topsoil and subsoil should not become mixed;
- Capping should not be laid during or immediately following heavy rain;
- Double handling of material should be avoided;
- Stockpiles of topsoil should be shaped to shed water;
- Topsoil stockpiles should be low and narrow to ensure that the core is within 1 m of the surface; and
- Over tracking by machinery used to place soils should be avoided.

Imported and site won stockpiles should not be mixed. Site won stockpiles considered as suitable for reuse in gardens and site won stockpiles considered to be impacted with contaminants must not be mixed.

6.2 Physical Requirements

Topsoil and subsoil should comprise clay or sand. Topsoil should have a maximum of 30% of fragments in excess of 2 mm, a maximum of 10% in excess of 20 mm and nothing greater than 50 mm. Subsoil should comprise clay or sand and should have a maximum of 65% of fragments in excess of 2 mm, a maximum of 60% in excess of 20 mm, a maximum of 40% in excess of 50 mm and only occasional pieces in excess of 100 mm.

Topsoil should be free of fragments of glass and wire or other potentially hazardous foreign material which could cause traumatic injury. Significant quantities of extraneous material such as brick and concrete should also not be present within the topsoil. Reasonable judgement should be taken with respect to their presence in subsoil. In addition, all materials should be free from propagules of aggressive weeds and bulk vegetative growth, in order to ensure negligible risk of subsequent weed problems.

6.3 Chemical Requirements

Testing should be carried out for the following general suite of contaminants:

Type of material	Frequency of testing	Testing schedule
Greenfield / Manufactured Soils	Minimum 3 Dependent on source and receptor between 1 per 50 m ³ and 1 per 250 m ³	Standard metals/metalloids PAHs (16 USEPA speciation) Asbestos pH SOM
Brownfield Soils	Minimum 6 Dependent on source and receptor between 1 per 50 m ³ and 1 per 100 m ³	Standard metals/metalloids PAHs (16 USEPA speciation) Asbestos TPH (CWG banded) pH SOM Any additional analysis dependant on the history of the donor site.

The sampling is to be undertaken by a suitably qualified Geo-environmental Engineer and depending on the source or variability of imported material, the Engineer may, at their discretion, request additional testing to be undertaken.

A table of assessment values is included in the Appendix.

If any of the assessment values are exceeded, the material shall be considered to be unsuitable unless further testing and risk assessment shows it to be satisfactory.

6.4 Documentation

Each stockpile of imported material should be given a clear reference number and designated sheet recording the following:

- Identification reference (e.g. Stockpile A, B, C etc.);
- Material type (e.g. Topsoil);
- Source site;
- The carrier's consignment note reference numbers;
- The approximate volume (or number of loads); and
- Which plots the material is to be used on and where (i.e. Plot number and landscaped area to the front or rear garden);

Each entry shall be signed and dated by the Site Manager or their assistant. A template is enclosed in the Appendix. These sheets should be available for inspection by the Engineer, Warranty Inspectors, Local Authority staff and others involved with this development. A copy should also be given to the Engineer when verification visits are made.

7.0 INSTALLATION AND VERIFICATION OF CAPPING

A 600 mm thick capping of clean, inert, physically suitable material, including at least 100 mm of growing medium, is required within private gardens and areas of soft landscaping on the proposed residential development, where made ground remains. A 450 mm thick capping of clean, inert, physically suitable material, including at least 100 mm of growing medium, is present within the POS area, where made ground remains. Verification visits will be required to verify the capping installed.

Where there is no made ground present, i.e. if there is undisturbed natural ground present at the surface, no capping is considered to be necessary, just the placement of a minimum 100 mm clean, suitable growing medium.

The submission of verification reports is covered in Section 9.

7.1 Capping Installation

The capping installation shall be undertaken by site staff in the following steps:

1. Establish the finished ground levels over each garden or landscaped area and from this determine the required level of the underside of the capping layer.
2. Where present ground levels are above the level of the underside of the cap, re-grading of the ground is to be undertaken to accommodate the cap. This excavated material may be placed in areas where ground levels are to be raised, such as beneath hard-standing or used to raise levels beneath other capped areas (see 3 below). Failing this the material can be removed from site (see 4 below).
3. Where the present ground levels are below the underside of the capping layer, the ground level may be made up to the underside of the capping layer using material from 2 (above) or imported material where no suitable fill exists.
4. All arisings shall be regarded as contaminated until proven otherwise. If they cannot be used on site, they are to be removed to a licensed waste management facility. The waste is to be taken by a registered waste carrier in accordance with the Waste Management Duty of Care Code of Practice. Copies of all waste transfer notices are to be retained.
5. Check the level of the ground surface to ensure that it is at the correct level for the underside of the capping.
6. Install subsoil, if required.

7. Install private services, where applicable. Where materials from above and below the capping are excavated these shall be kept separate. Capping materials can be reused but the material below the cap shall be placed as detailed in 3 or removed from site following the procedures set out in 4.
8. Place a minimum of 100 mm topsoil.

7.2 Verification of the Capping Installation

Upon completion of the capping, verification pits shall be dug by an independent Engineer to measure the thickness of topsoil and subsoil, where present.

Verification pits will be dug at a rate of 1 pit per 3 plots.

For larger landscaped areas, such as areas of public open space, pits will be dug at a rate of one pit per 300 m².

Each verification pit shall be photographed. The photograph will include reference of depth and location of the pit.

If the capping is deemed to be insufficient, the Site Manager will be informed and advised on how much more material is needed for the capping to be adequate. Verification of capping can only be carried out on areas where the capping has been completed. All gardens and landscaped areas which have had the capping layer completed will be digitally photographed by the Engineer.

A verification report is to be produced by the Engineer, which includes:

- The documentation detailed in Section 6.4;
- The chemical test results for imported subsoil and topsoil;
- Confirmation of the capping thicknesses and presence of the anti-dig and separation layer, including photographs of the verification pits with a scaled marker; and
- Confirmation of the physical suitability of the material.

The submission of verification reports is covered in Section 9.

8.0 AREAS OF UNEXPECTED CONTAMINATION

There is the potential for areas of unexpected contamination to be present as is the case with any 'brownfield' site. Any unusual, brightly coloured or significantly oily or odorous material should be considered in this category. Soils containing material suspected of containing asbestos or potentially combustible material should also be included.

If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination should stop, and visual and olfactory observations of the condition of the ground and the extent of contamination should be made. Notification shall be given to an independent consultant and the warranty provider and Local Authority not later than 24 hours after discovery. Should the contamination be likely to affect controlled waters the Environment Agency should also be informed.
2. During the presence of a suitably qualified engineer, investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, accurately delineate the area over which contaminated materials are present.
3. Should the consultant deem it appropriate, the affected material may be excavated and placed in a separate stockpile on a suitable impermeable surface. This should be suitably quarantined with no addition to or removal of the stockpile while chemical analysis is being undertaken. Alternatively, the material should remain in-situ until laboratory test results have been obtained.
4. The testing suite will be determined by the consultant on the basis of visual and olfactory observations.
5. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
6. If after testing the ground is found to be contaminated, the Local Authority and warranty provider shall be informed. After consultation with the Local Authority, and if necessary, the Environment Agency, materials should either be removed for disposal to a licensed waste management facility or remediated to agreed clean-up criteria. If the waste is removed, it should be taken by a registered waste carrier in accordance with the Waste Management Duty of Care Code of Practice. Copies of all waste transfer notices are to be retained.

A report will be prepared by the engineer and submitted to the Local Authority and where groundwater may potentially have been impacted, the Environment Agency.

9.0 COMPLETION DOCUMENTATION

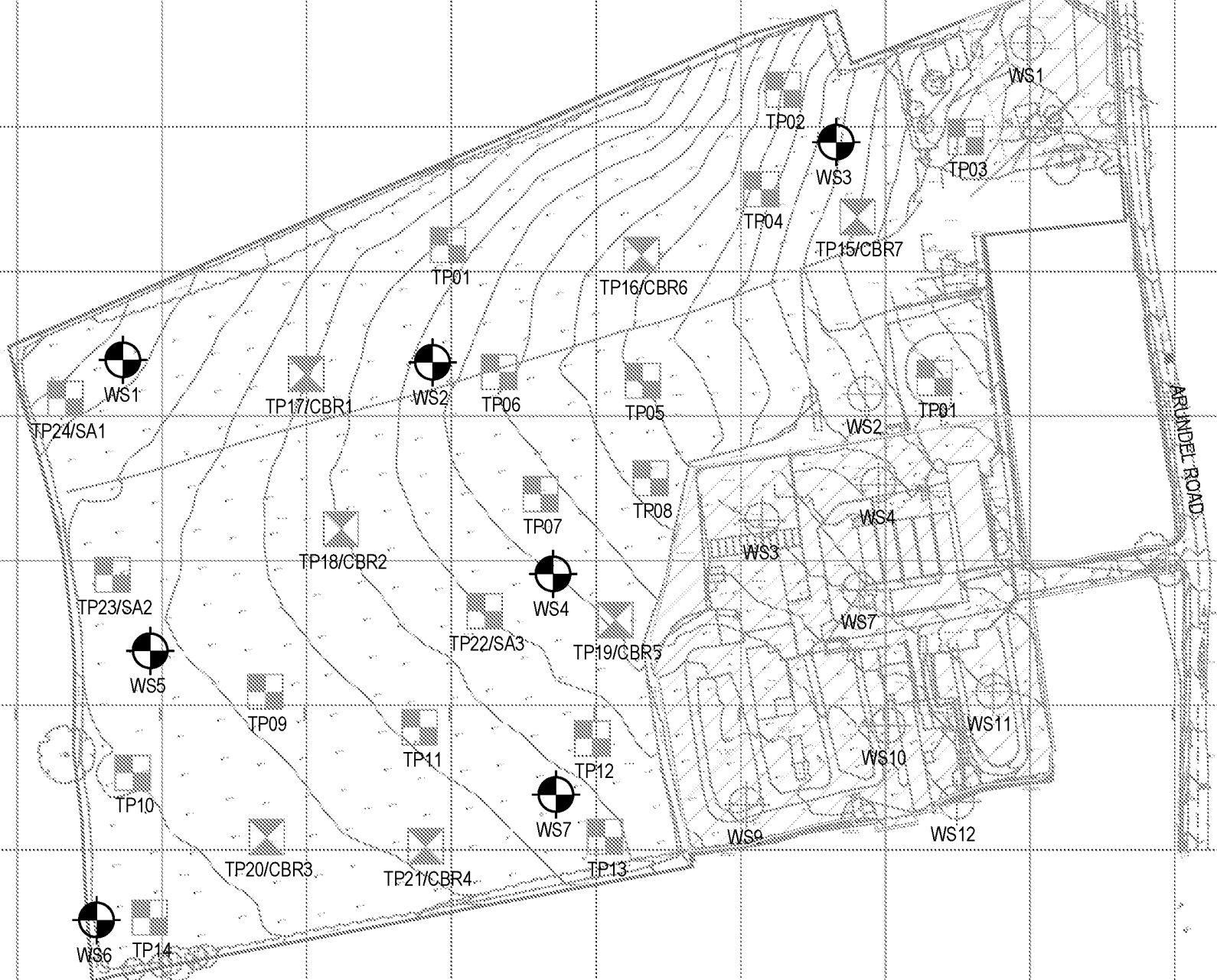
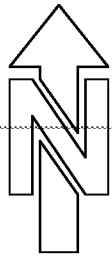
On completion of the verification works the appropriate verification documentation, detailing the works that have been completed in accordance with the agreed Implementation Plan, will be forwarded to the Local Authority and warranty provider. Should any remediation affecting controlled waters have been required and consequently undertaken, verification documentation will also need to be issued to the Environment Agency for their approval.

The verification report for the capping will include photographs of the capping materials within verification pits and of the landscaped areas, as well as the pertinent chemical test results.

Necessary changes to the agreed Implementation Plan, arising during the course of the works, are to be agreed in writing with the Local Authority and warranty provider prior to being undertaken on site.

Appendix 1

Remediation Plan, Drawing No. 46647/060A



INFORMATION WITHIN THIS DRAWING IS NOT NECESSARILY PRODUCED TO SCALE.
ALWAYS USE FIGURED DIMENSIONS AND CO-ORDINATES - IF IN DOUBT, ASK.

-  Approximate location of trial pit excavated by RSK in August 2020
-  Approximate location of trial pit with CBR excavated by RSK in August 2020
-  Approximate location of window sample borehole carried out by RSK in August 2020
-  Approximate location of window sample borehole carried out by Eastwood & Partners on 04.03.2021
-  Approximate extent of made ground requiring a clean capping layer.

A	First Issue.			
REV	DESCRIPTION	SIG	CHK	DATE

REDROW HOMES LTD

LAND OFF ARUNDEL ROAD,
ANGMERING

REMEDIATION PLAN

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SCALE WHEN PLOTTED AT A3 1:2000			DRAWING STATUS PRELIMINARY	
DRAWN TC	CHECKED CC	DATE 28.01.2022	DRAWING NUMBER 46647/060	REV A

Appendix 2

Soil Assessment Values – Residential with Homegrown Produce & Commercial/Industrial Use

Inorganic Compounds	Human Health - Residential with Homegrown Produce (mg/kg)
Arsenic	37
Cadmium	11
Chromium (III)	910
Chromium (VI)	6
Lead	200
Mercury	1.2
Nickel	180
Selenium	250
Copper	2400
Zinc	3700

Organic Compounds	Human Health - Residential with Homegrown Produce (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Naphthalene	2.3	5.6	13
Acenaphthene	210	510	1100
Acenaphthylene	170	420	920
Fluorene	170	400	860
Phenanthrene	95	220	440
Anthracene	2400	5400	11000
Fluoranthene	280	560	890
Pyrene	620	1200	2000
Benzo(a)anthracene	7.2	11	13
Chrysene	15	22	27
Benzo(b)fluoranthene	2.6	3.3	3.7
Benzo(k)fluoranthene	77	93	100
Benzo(a)pyrene	2.2	2.7	3.0
Dibenz(a,h)anthracene	0.24	0.28	0.3
Indeno(1,2,3-cd)pyrene	27	36	41
Benzo(g,h,i)perylene	320	340	350
Benzene	0.087	0.17	0.37
Toluene	130	290	660
Ethylbenzene	47	110	260
o-Xylene	60	140	330
m-Xylene	59	140	320
p-Xylene	56	130	310

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Prepared	CLC	Checked	CAT	Date	28.01.22	Job No	46647
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 Eastwood & Partners CONSULTING ENGINEERS St Andrew's House 23 Kingfield Road Sheffield S11 9AS	REDROW HOMES LIMITED ARUNDEL ROAD, ANGMERING ASSESSMENT CRITERIA – RESIDENTIAL WITH HOMEGROWN PRODUCE
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Contaminant	Phytotoxicity			
	pH 5.0 to 5.5	pH 5.5 to 6.0	pH 6.0 to 7.0	pH >7.0
Arsenic	50			
Cadmium	3			
Chromium	400			
Lead	300			
Mercury	1			
Nickel	50	60	75	110
Copper	80	100	135	200
Zinc	200	200	200	300

The assessment concentration for lead is the Category 4 Screening Level produced by Contaminated Land: Applications in Real Environments (CL:AIRE) and outlined in Appendix H of their report SP1010. The others have been taken from Nathanail, C. P., McCaffrey, C., Gillett, A., Ogden, R., and Nathanail, J., 2015, *'The LQM/CIEH S4ULs for Human Health Risk Assessment'*, Land Quality Press, Nottingham. The metals/metalloids are based on a sandy loam soil and 6% soil organic matter. The assessment values are not intended to be applied to individual sample results where materials are similar, as the levels of contaminants will have a natural variability across the site. Instead, the modified mean value should be compared with the assessment concentration.

The assessment values for phytotoxicity are the levels at which plant growth is thought to be affected. They are taken from the maximum permissible and advisable concentrations in soil after application of soil sludge given in the *'The Code of Good Agricultural Practice for the Protection of Soil'*, MAFF, 1998.

The assessment of sulphate, water soluble sulphate, elemental sulphur and sulphide is to determine the aggressive nature of the ground with respect to concrete and consequently the results are compared with BRE Special Digest 1:2005 *'Concrete in Aggressive Ground'*.

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 Eastwood & Partners CONSULTING ENGINEERS St Andrew's House 23 Kingfield Road Sheffield S11 9AS	REDROW HOMES LIMITED ARUNDEL ROAD, ANGMERING ASSESSMENT CRITERIA – RESIDENTIAL WITH HOMEGROWN PRODUCE
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TPH Fraction	Intended Land Use Residential (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Aliphatic EC 5-6	42	78	160
Aliphatic EC >6-8	100	230	530
Aliphatic EC >8-10	27	65	150
Aliphatic EC >10-12	130 (48) ^{vap}	330 (118) ^{vap}	760 (283) ^{vap}
Aliphatic EC >12-16	1100 (24) ^{sol}	2400 (59) ^{sol}	4,300 (142) ^{sol}
Aliphatic EC >16-35	65,000 (8.48) ^{f, sol}	92,000 (21) ^{f, sol}	110,000 ^f
Aliphatic EC >35-44	65,000 (8.48) ^{f, sol}	92,000 (21) ^{f, sol}	110,000 ^f
Aromatic EC 5-7	70	140	300
Aromatic EC >7-8	130	290	660
Aromatic EC >8-10	34	83	190
Aromatic EC >10-12	74	180	380
Aromatic EC >12-16	140	330	660
Aromatic EC >16-21	260 ^f	540 ^f	930 ^f
Aromatic EC >21-35	1,100 ^f	1,500 ^f	1,700 ^f
Aromatic EC >35-44	1,100 ^f	1,500 ^f	1,700 ^f

^f oral, dermal, and inhalation exposure compared with oral HCV

^{sol} S4UL presented exceeds the solubility saturation limit, which is presented in brackets

^{vap} S4UL presented exceed the vapour saturation limit, which is presented in brackets

The assessment criteria for each of the petroleum hydrocarbon fractions have been taken from Nathanail, C. P., McCaffrey, C., Gillett, A., Ogden, R., and Nathanail, J., 2015, 'The LQM/CIEH S4ULs for Human Health Risk Assessment', Land Quality Press, Nottingham. These are also all based on a sandy loam soil.

Within the Environment Agency Science Report P5-080/TR3, Askari, K. & Pollard, S., 2005 'The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils' it is stated that the assessment values should not be considered individually; instead the potential additive effects should be calculated. This is achieved by calculating an individual Hazard Quotient (HQ) for each fraction. The HQ is the proportion of the assessment concentration represented by the recorded concentration. The HQs are then added together to form a Hazard Index (HI) and where this exceeds unity a potential significant risk to human health may exist.

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	Intended Land Use				
	Commercial/Industrial End Use (mg/kg)				
Contaminant	Human Health	Phytotoxicity			
		pH 5.0-5.5	pH 5.5-6.0	pH 6.0-6.5	pH >7.0
Arsenic	640	50			
Cadmium	190	3			
Chromium (III)	8600	400			
Chromium (VI)	33	-			
Lead	1100-6000	300			
Mercury	25.8	1			
Nickel	980	50	60	75	110
Selenium	12,000				
Copper	68,000	80	100	135	200
Zinc	730,000	200	200	200	300

Notes:

The assessment concentrations for arsenic, cadmium, chromium (III), chromium (VI), copper, nickel, mercury, selenium and zinc are taken from Nathanail, C.P., McCaffrey, C., Gillett, A.G., Ogden, R.C., and Nathanail, J.F., 2015, 'The LQM/CIEH S4ULs for Human Health Risk Assessment', Land Quality Press, Nottingham. These are also all based on a sandy loam soil and 6% soil organic matter.

The assessment concentration for lead is the Category 4 Screening Level produced by Contaminated Land; Applications in Real Environments (CL:AIRE) and outlined in Appendix H of their report SP1010.

The threshold value is not intended to be applied to individual sample results where materials are similar, as the levels of contaminants will have a natural variability across the site. The modified mean value should instead be compared with the threshold value.

The assessment values for phytotoxicity are levels at which plant growth is thought to be affected. These are taken from the maximum permissible and advisable concentrations in soil after application of soil sludge given in the 'The Code of Good Agricultural Practice for the Protection of Soil', MAFF, 1998.

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Organic Compounds	Intended Land Use Commercial (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Naphthalene	190 (76.4) ^{sol}	460 (183) ^{sol}	1100 (432) ^{sol}
Acenaphthene	84000 (57.0) ^{sol}	97000 (141) ^{sol}	100000
Acenaphthylene	83000 (86.1) ^{sol}	97000 (212) ^{sol}	100000
Fluorene	63000 (30.9) ^{sol}	68000	71000
Phenanthrene	22000	22000	23000
Anthracene	520000	540000	540000
Fluoranthene	23000	23000	23000
Pyrene	54000	54000	54000
Benzo(a)anthracene	170	170	180
Chrysene	350	350	350
Benzo(b)fluoranthene	44	44	45
Benzo(k)fluoranthene	1200	1200	1200
Benzo(a)pyrene	35	35	36
Dibenz(a,h)anthracene	3.5	3.6	3.6
Indeno(1,2,3-cd)pyrene	500	510	510
Benzo(g,h,i)perylene	3900	4000	4000
Phenol	760	1500	3200
Benzene	27	47	90
Toluene	56000 (869) ^{vap}	110000 (1920) ^{vap}	180000 (4360) ^{vap}
Ethylbenzene	5700 (518) ^{vap}	13000 (1220) ^{vap}	27000 (2840) ^{vap}
o-Xylene	6600 (478) ^{sol}	15000 (1120) ^{sol}	33000 (2620) ^{sol}
m-Xylene	6200 (625) ^{vap}	14000 (1470) ^{vap}	31000 (3460) ^{vap}
p-Xylene	5900 (576) ^{sol}	14000 (1350) ^{sol}	30000 (3170) ^{sol}

^{sol} = S4ULs presented exceeds the solubility saturation limit, which is presented in brackets.

^{vap} = S4ULs presented exceeds the vapour saturation limit, which is presented in brackets.

The assessment criteria for the sixteen polycyclic aromatic hydrocarbon (PAH) species covered under the USEPA test have been taken from Nathanail, C.P., McCaffrey, C., Gillett, A.G., Ogden, R.C., and Nathanail, J.F., 2015, 'The LQM/CIEH S4ULs for Human Health Risk Assessment', Land Quality Press, Nottingham.. These are also all based on a sandy loam soil and 6% soil organic matter. This is also the case for phenol at 1% and 2.5% SOM. These are also all based on a sandy loam soil.

The assessment values for phenol (6% SOM) and the BTEX compounds are the Soil Guideline Values derived by DEFRA and Environment Agency using the 'Contaminated Land Exposure Assessment' model. These are outlined in the Environment Agency's Science Report series SC050021.

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TPH Fraction	Intended Land Use Commercial (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Aliphatic EC 5-6	3200 (304) ^{sol}	5900 (558) ^{sol}	12000 (1150) ^{sol}
Aliphatic EC >6-8	7800 (144) ^{sol}	17000 (322) ^{sol}	40000 (736) ^{sol}
Aliphatic EC >8-10	2000 (78) ^{sol}	4800 (190) ^{vap}	11000 (451) ^{vap}
Aliphatic EC >10-12	9700 (48) ^{sol}	23000 (118) ^{vap}	47000 (283) ^{vap}
Aliphatic EC >12-16	59000 (24) ^{sol}	82000 (59) ^{sol}	90000 (142) ^{sol}
Aliphatic EC >16-35	1,600,000	1,700,000	1,800,000
Aliphatic EC >35-44	1,600,000	1,700,000	1,800,000
Aromatic EC 5-7 (benzene)	26000 (1220) ^{sol}	46000 (2260) ^{sol}	86000 (4710) ^{sol}
Aromatic EC >7-8 (toluene)	56000 (869) ^{vap}	110000 (1920) ^{sol}	180000 (4360) ^{vap}
Aromatic EC >8-10	3500 (613) ^{vap}	8100 (1500) ^{vap}	17000 (3580) ^{vap}
Aromatic EC >10-12	16000 (364) ^{sol}	28000 (899) ^{sol}	34000 (2150) ^{sol}
Aromatic EC >12-16	36000 (169) ^{sol}	37000	38000
Aromatic EC >16-21	28000	28000	28000
Aromatic EC >21-35	28000	28000	28000
Aromatic EC >35-44	28000	28000	28000
Aliphatic + Aromatic EC >44-70	28000	28000	28000

^{sol} = S4ULs presented exceeds the solubility saturation limit, which is presented in brackets.

^{vap} = S4ULs presented exceeds the vapour saturation limit, which is presented in brackets.

The assessment criteria for each of the petroleum hydrocarbon fractions have been taken from Nathanail, C.P., McCaffrey, C., Gillett, A.G., Ogden, R.C., and Nathanail, J.F., 2015, 'The LQM/CIEH S4ULs for Human Health Risk Assessment', Land Quality Press, Nottingham.. These are also all based on a sandy loam soil.

Within the Environment Agency Science Report P5-080/TR3, Askari, K. & Pollard, S., 2005 '*The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils*' it is stated that the assessment values should not be considered individually; instead the potential additive effects should be calculated. This is achieved by calculating an individual Hazard Quotient (HQ) for each fraction. The HQ is the proportion of the assessment concentration represented by the recorded concentration. The HQs are then added together to form a Hazard Index (HI) and where this exceeds unity a potential significant risk to human health may exist.

Where only a TPH screen is undertaken, the assessment value used should be taken as the most onerous value given for individual carbon bands, as described above. This should be the assessment for Aliphatic band EC>8-10, assuming a SOM value of 1%. The assessment value should therefore be taken as 2,100 mg/kg.

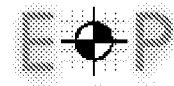
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Appendix 3

Imported Material Documentation Form



Imported Soil Documentation Form

Stockpile Identification Reference	
Material Type	
Source Site	
Consignment Note Reference Numbers	
Volume of Stockpile (or number of loads)	
Plots Material to be used in	

Signed _____

Position _____

Date _____