Remediation of former Painswick Gasworks. Verification report for Beech Cottage

Prepared for

Stroud District Council
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Report reference: 6819BR1, September 2008
Report status: Final

Confidential

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Remediation of former Painswick Gasworks.
Verification report for Beech Cottage

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1 INTRODUCTION

1.1 Background

ESI Ltd. (ESI) was commissioned by Stroud District Council (SDC) in July 2006 to undertake a contaminated land assessment of a former gas works site in Painswick, near Stroud. The purpose of this work was to assess the potential risks posed by the current land quality to any identified environmental receptors, including risks to human health.

The gas works site, which comprised a rectangular plot of land of approximately 1500 m^2, was operational from c. 1860 into the mid twentieth century. The site has been sequentially developed for housing over the last 30 years. Four residential dwellings, including associated gardens, currently occupy the entire site (see Figure 1.1).

As a result of site investigation and risk assessment works performed during July 2006 (ESI, 2006), a limited number of potential contaminants were identified within the sub surface soils including various polycyclic aromatic hydrocarbons (PAHs) and benzene. These substances were detected principally in the surficial and sub surface soils associated with Beech Cottage.

In response to the findings of the 2006 site investigation ESI was commissioned by SDC in February 2007 to undertake a phase of additional site investigation works at Beech Cottage with the objective of clarifying soil quality across the property and updating the existing human health risk assessment.

The follow-up site investigations were performed at Beech Cottage in March 2007 (ESI, 2007a); these included a programme of soil sampling and testing across accessible areas of the garden and driveway. Elevated PAHs, including benzo(a)pyrene (maximum concentration: 81.1 mg/kg; see Figure 1.2), were detected in the majority of soil samples taken from Beech Cottage, although principally within soil samples taken from the upper 0.5 m of the soil profile (note: no significant PAH concentrations were detected in the natural clay deposits underlying the sub surface soils/Made Ground). Elevated benzene concentrations (maximum soil concentration: 4.5 mg/kg) were detected at a number of sampling locations. Benzene was also detected at elevated concentrations (up to 1.3 mg/l) in several groundwater samples.

The updated human health risk assessment concluded that potentially significant risks to human health are associated with the occurrence of elevated benzo(a)pyrene (B(a)P) in surficial soils across a wide area of Beech Cottage garden. Note: the risks associated with observed benzene concentrations are less well defined and consequently other investigations into the presence and potential significance of any vapour exposure pathways have been implemented for the site, including indoor air monitoring.

Due to the occurrence of potentially harmful PAH concentrations (including benzo(a)pyrene) within the boundaries of Beech Cottage, the site has been determined as Contaminated Land by the SDC under Part IIA of the Environmental Protection Act 1990. As such, there is a requirement to undertake appropriate remediation in order to protect the health of current and future residents.

ESI completed an options appraisal for the Beech Cottage site in July 2007 (ESI, 2007b). This study identified the most appropriate remediation strategy for the site. Note: given the uncertainty regarding potential human health risks from benzene in sub surface soils and groundwater, the options appraisal considered only those options associated with remediating the proven significant pollutant linkage (i.e., that associated with elevated benzo(a)pyrene concentrations in surficial soils). The options appraisal identified the excavation and off-site removal of surficial soils to be the best practicable technique for remediating contaminated soils observed at Beech Cottage.

These works were initially undertaken between 14th and 21st May 2008. However, due to the placement of fill materials within the resulting excavations which were of inappropriate chemical quality, the remedial works were subsequently repeated between 11th and 15th August 2008.

1.2 Objectives

This Verification Report is intended to describe the technical elements of the remediation activities that were carried out between 14th – 21st May 2008 and 11th – 15th August 2008 at Beech Cottage (as described in the outline remediation design document (ESI Ltd, 2007c)) and to present soil quality data associated with validation sampling of the imported soils.

The document therefore provides an account of the remediation works performed and offers validation that the works were successfully completed.

1.3 Site setting and context

Beech Cottage is a semi-detached property located on the former site of the Painswick gas works. The cottage was developed between c. 1973 and c. 1989; three neighbouring residential properties were also constructed on the former gas works site over the last 30 years (see Figure 1.1).

The land directly to the rear and side of Beech Cottage (i.e. to the north-west and north-east) is currently occupied by a modest area of private woodland; the adjoining Grey Owl Cottage is located to the south west; and King Mill Lane runs in front of the property to the south east. The property itself is a two storey building of modern construction with a lawn to the side and rear. A gravel drive extends along the eastern side of the building.

The Beech Cottage land surface comprises building cover and associated hard standing, a gravel driveway and a garden comprising paved sections, lawn and flower beds; the garden to the rear of the property includes a narrow raised tier which is supported by a retaining wall of approximately one metre in height. Current ground elevations across the Beech Cottage property range from 88.5 m AOD at the ground level of the property itself to 89.8 m AOD on the raised garden tier to the rear of the cottage. Selected photographs of Beech Cottage are presented in Appendix A.

The surface cover is typically underlain by a modest thickness of topsoil/Made Ground and subsequently by an unproven thickness of firm brown clay. The surface of the clay is typically encountered within 0.4 m of the ground surface both beneath the driveway and across the rear of the garden (i.e. along the raised section to the rear of Beech Cottage). However, in the south eastern corner of the 'lower' garden, in excess of 2.5 m of Made Ground, comprising loose dark brown/black gravelly sand and sandy gravel with some concrete, brick and wood, has been observed above the clay.

Published geological mapping suggests that the clay horizon encountered beneath the site is associated with land slipped material (colluvium). The colluvium is locally underlain by the Upper Lias deposits which comprise fine-grained clays/silts and are considered to form an aquiclude.

Shallow 'groundwater' was observed within three site investigation holes positioned in the centre/front of the property during March 2007. It is probable that the observed 'groundwater' represents local ponding of infiltrated rainwater; this may well be a seasonal effect, occurring during the wetter winter months and disappearing during summer. Any groundwater flow is likely to be heavily constrained by the low permeability of the clays.

2 OUTLINE REMEDIATION METHODOLOGY

2.1 Remediation objectives

Based on the information derived from site investigation works (ESI, 2006 and 2007a) the primary risk identified at Beech Cottage relates to the exposure of historic gasworks contamination to current residents. The significant pollutant linkage identified from the risk assessment is presented in Table 2.1.

Table 2.1 Significant pollutant linkages

Pollutant	Pathway(s)	Receptor	Grounds for determination
Benzo(a)pyrene	- Dermal contact - Ingestion - Inhalation of dust - Ingestion of site grown vegetables	Humans (residents of Beech Cottage) and pet animals	Significant risk of significant harm

Hence, a source-pathway-receptor linkage has been proven for the site, requiring suitable remediation.

An appraisal of potential remediation options has identified the excavation and off site removal of surficial soils to be the best practicable technique for addressing the significant pollutant linkage (ESI, 2007b). The extent of the remediation excavations were based on the soil quality results from both the initial and follow-up site investigations (ESI, 2006 and 2007a). It is noted that areas of the site covered by hard standing (including the house structure and also the associated driveway) or ground materials that lie within 1.5 m of Beech Cottage itself (a protective zone around the house is required to prevent structural damage to the property during the remediation works) were not identified for excavation as part of this phase of remediation.

The depth of the excavations required to enable effective remediation were informed by the BRE Guidance on Cover Systems for Land Regeneration (BRE, 2004) plus the observed ground conditions and soil quality results derived from previous site investigations. The following issues were therefore taken into consideration when deriving a suitable excavation depth:

- Earthworm activity is typical within the top 300 mm of soil.
- Burrowing animals typically operate within the top 500 mm, with the exception of rabbits and badgers, which are unlikely to be encountered within residential environments.
- Double digging of gardens is unlikely to exceed 600 mm.
- The average depth of undisturbed ground in gardens is 460 mm.
- Plant roots in soils tend to remain within soils containing nutrients and moisture. In addition penetration of plant roots can be restricted by compacting soils and using root restricting membranes.
- Fieldwork observations indicate that clay is routinely encountered at a depth of between 0.1 and 0.3 m bgl on the raised garden tier to the rear of Beech Cottage, whereas the depth to clay is typically greater across the main garden area to the side of the property.
- Soil quality data indicate that no elevated B(a)P concentrations were detected in soil samples taken from the clay deposits along the raised garden tier to the rear of Beech Cottage.

Based on the considerations listed above, the following excavation depths were specified:

- Removal of all topsoil/Made Ground on the raised garden tier to the rear of Beech Cottage (the average thickness of Made Ground across this area is of the order 0.2 m); subsequent removal of a 0.1 m thickness of 'natural' clay underlying the Made Ground.
- Removal of all soils in the raised flower bed directly to the rear of the property.
- Removal of soils to a depth of 0.6 m across the main garden area to the side of the property. Note: deeper excavation would be required across the main garden area should any gross contamination be identified during the excavation works. The extent of any such excavation would be determined during the remedial works, based on risk assessment and cost benefit analysis.

All soils were to be replaced with inert sub-soils and topsoil materials of suitable physical and chemical composition.

2.2 Roles and responsibilities

The Client (SDC) was responsible for the appointment of all third party contractors and liaison with the residents of Beech Cottage and other local homeowners.

The remediation works were performed by Churngold Remediation Ltd (Churngold). Churngold were responsible for devising detailed method statements to ensure that the remediation objectives were met in a safe and timely manner. Churngold performed all site works including excavation, waste disposal, backfilling and reinstatement in accordance with the outline remediation design and associated method statements.

All site excavation and backfilling activities were designed and supervised by ESI. ESI's primary responsibilities were to:

- Ensure all excavations were performed in accordance with the agreed remediation design.
- Assess any requirement for additional excavations beyond the standard excavation depths.
- Perform routine air quality monitoring using a portable photo-ionisation detector (PID) to assess the concentration of volatile organic compounds during the excavation.
- Undertake validation sampling of infill materials.
- Produce a concise remediation validation/verification report.

3 REMEDIATION WORKS

The main tasks involved in the remediation works included:

- vegetation clearance and salvage
- services inspection
- excavation
- waste disposal
- importing materials and backfilling
- validation of imported materials
- landscaping.

The primary focus of the works was to replace the in situ soils within the main garden area to a depth of 600 mm plus those soils across the raised tier to the rear of the property to a 300 mm depth.

3.1 Initial site remediation (May 2008)

The impacted soils at Beech Cottage were initially remediated between 14th and 21st May 2008. Details of the works undertaken during this time are presented below. Selected photographs taken during the initial remediation works are presented in Appendix A.1.

3.1.1 Site clearance and security

On commencement of the site operation a fence panel was removed from the front of the property along the boundary with King Mill Lane to permit ready access to the main garden area.

The initial site clearance works involved the removal of all temporary above ground structures (including garden furniture and plant pots, but excluding all retaining/garden walls and the garden shed positioned in the north-west corner of the site; it is noted that soil quality results for this area of the garden indicate B(a)P concentrations which do not pose human health risks) to a temporary storage location within the property boundaries.

Plants and shrubs that had been identified by the current residents for retention (these were tagged by the residents) were removed and taken to temporary storage locations (both on and off site). All other plants were removed from the working area with roots attached (the plant roots were stripped of soil prior to removal from the garden). All removed vegetation was shredded and transported off site to a licensed facility for recycling/composting. Several larger shrubs and trees were cut back leaving only roots and limited above ground growth in place.

Subsequent clearance work involved the removal of surface paving to enable subsequent excavation. A circular cement slab paving feature was removed from the south-eastern corner of the garden; this was stored for re-use. A second area of paving to the rear of the main/lower garden was also partially removed; the paved section in the north east corner of the garden was retained due to anticipated difficulties in removing this paving without damaging the associated retaining walls and steps.

The extent of the paving materials to be removed was agreed between ESI, Churngold and SDC during the remediation works.

To provide adequate site security, temporary fencing was erected around the garden at the end of each working day.

3.1.2 Service inspection

Knowledge and experience gained from ESI's previous site investigations, alongside contemporary service plans, indicated there were no current below ground services within the proposed excavation areas.

Over head power lines were present at the front of the property; appropriate care was taken to avoid these cables during the remediation works.

During excavation a small number of defunct pipes were found and these were carefully exposed and inspected before continuing work.

No manhole chambers were located in the vicinity of the remediation works.

3.1.3 Excavation

The objective of the excavation works was to remove impacted soils from across the garden area to agreed depths which would either eliminate all contaminated material (as was the case across the raised garden tier to the rear of the property) or leave only limited material in place at a safe depth. As such, soil was removed from the upper garden tier typically to a 0.3 m depth, whereas soils across the main garden were taken down to approximately 0.6 m bgl (although a shallow dig was permitted in certain parts of the main garden - see below); the extent of the excavations is shown on Figure 2.1.

The remediation works were carried out using a 360^0 tracked excavator for soil excavations and a wheeled backhoe digger for loading the soil from the garden onto a lorry positioned on the adjacent highway. Due to the restricted area of land at Beech Cottage the material generated from the excavation works was loaded onto the lorry at regular intervals throughout the excavation process (there was insufficient space to enable stockpiling of materials on-site for any length of time).

Manual excavation was used to remove the residual soil next to retaining walls, boundary fences and walls, and around the roots of in situ trees and scrubs. This ensured the maximum amount of potentially impacted soil was removed and also minimised the disturbance to retaining walls and other boundary walls and fences as a consequence of mechanical excavation.

Given the absence of any excavations in direct proximity to Beech Cottage itself, no specific vibration controls were considered necessary. Regardless, care was taken during all excavation activities to minimise vibrations and thus potential damage to built structures. Furthermore, due caution and appropriate working methods were employed by Churngold when excavating adjacent to retaining walls, in order to minimise any disturbance to these structures. It is noted that the retaining wall between the driveway and the main (lower) garden dig was compromised before the work had started (i.e., the wall was leaning in towards driveway and was visibly cracked at various points) and that it sustained further cracking during the works. Parts of the wall were reinstated following the completion of the initial remediation works.

Wet weather during the initial stages of the excavation works meant that ground conditions were typically wet and during the remaining time the exposed soils remained sufficiently moist that no dust suppression was necessary. Plastic sheeting was laid down in the drive way to prevent the spread of soil and to enable easy cleanup at the end of each day. The road at the front of the property was swept clean and any soil returned to the dig at the end of each working day and after each period of loading soil for off site removal.

In total, approximately 60 m^3 of soil was removed from the garden of Beech Cottage during the initial remediation works.

Working hours on site were within the normal working day (9m to 5 pm) and the noise disruption caused by the machinery and lorries was minimised as the work was periodic.

All excavation activities were supervised by ESI. ESI also undertook on-site vapour measurements with a photo ionisation detector (PID) and maintained a record of olfactory and visual observations throughout the site works.

During the excavation within the main garden area a structure typical of a historical gas holder was uncovered at a depth of 0.1 to 0.2 m below the existing ground level (this feature is shown on historical mapping of the site). The structure comprised a circular wall, of 6 to 7m diameter, built from brick and Oolitic limestone. Remnants of a former steel riveted tank were found within this structure. The soil condition and profile outside of this structure was similar to that encountered in the upper garden, whereas soils within the structure included assorted Made Ground likely associated with former gas works activities.

Upon the discovery of the gas holder structure and observations on the ground conditions, discussions were held between SDC, Churngold and ESI. It was decided to carry on the excavation within the structure as to the agreed specifications and remove the brickwork and associated material down to at least 600 mm bgl. Outside of the structure, where reduced thicknesses of Made Ground were encountered, subsurface soils were removed to between 300 and 400 mm bgl.

A small diameter metal pipe was found in the west end of the upper garden tier immediately adjacent to the raised flow bed/planter. Two further pipes (a silt-filled ceramic pipe and another metal pipe) were encountered directly to the north of the gas holder structure. These pipes were all removed along with the surrounding soil during the excavation works.

No significant shallow groundwater was encountered during the excavation. However, some localised ponding of shallow water was found within the gas holder structure.

3.1.4 Waste disposal

All waste management activities were carried out in compliance with current waste management legislation including Duty of Care for waste handling. Churngold were responsible for all waste classification and disposal activities.

The soil generated from the excavation required no sorting, other than the separation of soils from both the broken out materials associated with the former gas holder structure and remnant plant roots (which were sent for composting where possible).

All waste materials were transported by registered carriers to suitably licensed disposal sites. The wastes were transported by road; all vehicles leaving the site were fitted with sheeting to prevent losses during transit.

3.1.5 Importing materials and backfilling

Churngold sourced topsoil material for the backfilling of the site excavations from an unspecified green field location. ESI inspected the backfill material on arrival to site; the material appeared to be of a suitable granular composition with minimal waste materials/foreign objects and an absence of large stones.

Prior to placing the backfill material a root restricting membrane was fitted at the base of the excavation; this membrane was a white fabric which also acted as a marker layer.

The backfill material was placed over the root restricting membrane in a number of layers. Each layer was compacted using the excavator bucket and finished off with a manual roller.

On completion of backfilling, ESI undertook validation soil testing as described in Section 4.1. The results of this testing can be seen in Appendix B.1.

3.1.6 Landscaping

Following the placement, compaction and levelling of the imported topsoil, the site was landscaped with turf in accordance with the requirements of Stroud District Council. Note: this work was undertaken prior to the laboratory analyses of the validation soil samples.

3.1.7 Site measurements and observations

PID measurements were routinely taken in and around the excavation by placing the PID meter close to the exposed soils directly following the removal of the overlying materials; all readings registered a concentration of zero parts per million with regard to volatile organic compounds.

No appreciable dust was generated as a consequence of the excavation and backfilling activities. This was in part a reflection of the wet weather encountered during the first few days of the remedial works.

3.2 Secondary site remediation (August 2008)

Due to the failure of the imported soils used during the initial remedial works (as described in Section 3.1) to meet the required soil quality criteria (as set out in the remediation design document; ESI, 2007c), all remediation activities were repeated. Details of the validation results from the initial remediation works are presented in Section 4.2.

The secondary remediation works followed the same scope as undertaken during the initial works. The secondary remediation was completed between 11th and 15th August 2008. Details of the works undertaken during this time are presented below. Selected photographs taken during the secondary remediation works are presented in Appendix A.2.

3.2.1 Site clearance and security

Site clearance activities were repeated as per the initial remedial works, including the temporary removal of paving slabs from the circular patio in the main garden.

A fence panel was removed from the front of the property along the boundary with King Mill Lane to provide access to the garden area. Temporary fencing was erected around the site at the end of each working day in order to protect members of the public from site works and also to prevent unauthorised site access.

3.2.2 Excavation

Excavation was once again the primary soil remediation method undertaken. Due to the restricted area of land at Beech Cottage the material generated from the excavation was loaded onto a lorry at regular intervals throughout the excavation process (there was insufficient space to enable stockpiling of materials on-site for any length of time).

The objective of the excavation works was to remove all imported materials associated with the initial remediation; this was achieved by excavating all soils residing above the root restricting membrane placed in May 2008.

All excavations were completed using the same equipment as employed for the initial remediation works. Due caution and appropriate working methods were employed by Churngold when excavating adjacent to retaining walls, in order to minimise any disturbance to these structures. It is noted that the retaining wall between the driveway and the main (lower) garden excavation was compromised during previous works but no further damage was sustained during the secondary works.

3.2.3 Waste disposal

All waste disposal activities were handled by Churngold as per the initial remediation works.

3.2.4 Importing materials and backfilling

Churngold provided replacement topsoil material for backfilling on site. This material was sampled by Churngold prior to delivery to site to ensure appropriate chemical quality. The analytical results from this preliminary sampling are presented in Appendix B.2.

Once imported to site, ESI inspected the backfill material to ensure appropriate physical properties; the material appeared to be of a suitable granular composition with minimal waste materials/foreign objects and an absence of large stones.

The backfill material was placed over the existing root restricting membrane in sequential layers. Each layer was compacted using a mechanical compactor prior to the placement of the subsequent materials.

Following the placement of all fill materials ESI undertook validation testing in accordance with the remediation specification (see Section 4.2). The results of this testing can be seen in Appendix B.3.

Due to inclement weather during the secondary period of works, some shallow pools of rainwater formed at the base of the excavation within the main/lower garden. The imported material was backfilled over these localised pools. Upon completion, it was noted by all parties that there was some differential settlement of the imported material, possibly resulting from the ponded rainwater. Following this, the decision was made to leave a small quantity of the remaining imported material in the garden as a stockpile to remedy any settlement issues occurring between completion of the works and commencement of the landscaping activities.

3.2.5 Landscaping

Following the placement, compaction and levelling of the imported topsoil, the site was landscaped with turf in accordance with the requirements of Stroud District Council.

3.2.6 Site measurements and observations

PID measurements were routinely taken in and around the secondary excavation by placing the PID meter close to the exposed soils directly following the removal of the overlying materials; all readings registered a concentration of zero parts per million with regard to volatile organic compounds.

No appreciable dust was generated as a consequence of the secondary excavation and backfilling activities.

4 VALIDATION OF IMPORTED MATERIALS

4.1 Initial remediation works (May 2008)

4.1.1 Methodology

Due to the absence of space for stockpiling of imported materials, all imported fill was validated following final placement. Eight validation samples were taken; three were taken from the imported soils on the raised garden tier and a further five from the main garden area. Initially three of these samples were scheduled for laboratory analysis; one from the upper garden (81902) and two from the lower main garden (81905 and 81906); resulting in an initial analysis frequency of approximately one sample per 20 m^3 of imported soil. The approximate position of the validation samples is shown on Figure 4.1. The remaining five samples (81901, 81903, 81904, 81907 and 81908) were initially placed 'on hold' but were subsequently analysed for selected heavy metals in response to the results derived from the initial three samples (see Section 4.1.2).

The imported material was found to be generally homogeneous and thus single bulk samples were taken from each sampling location in accordance with best practice sampling techniques. In the upper garden tier, soil validation samples were taken using a hand trowel from a depth of approximately 0.1 m bgl. In the main garden area, samples were taken from depths of up to 0.3 m bgl.

All soil samples were placed into clean sampling containers; all sampling tools were cleaned between each sampling location.

The initial three soil samples were analysed for the determinands listed in Table 4.1. The five additional samples were subsequently tested only for those heavy metals listed in Table 4.1.

All laboratory analyses were undertaken by Alcontrol Laboratories, a UKAS registered analytical laboratory. All sampling and subsequent analysis were documented and managed under full Chain of Custody procedures.

Table 4.1 Contamination limits for imported materials

Parameter	Units	Screening value	Comment
Asbestos	/	None visible	
Arsenic (total)	mg/kg	20[1]	
Cadmium	mg/kg	2[1]	Based on pH of 2
Chromium	mg/kg	130[1]	
Copper	mg/kg	130[2]	
Cyanide (total)	mg/kg	66[2]	
Lead (total)	mg/kg	450[1]	
Mercury	mg/kg	8[1]	
Nickel (total)	mg/kg	50[1]	
Selenium	mg/kg	35[1]	
Zinc	mg/kg	580[2]	
pH	pH units	> 5	
Phenol (total)	mg/kg	307[2]	Based on 5% SOM
TPH (C>10-C28, DRO)	mg/kg	130[2]	Based on 5% SOM
Benzo(a)pyrene	mg/kg	1.1[3]	
PAH	mg/kg	17[2]	Based on 5% SOM

[1] Soil Guideline Values

[2] ESI soil screening values

[3] SSAC derived by ESI for Beech Cottage (ESI, 2007a)

4.1.2 Validation results

The laboratory results associated with the validation of the initial remediation are presented in Appendix B.1.

All validation sample results were assessed against the screening values documented in Table 4.1. These values represent threshold soil concentrations above which there is a potential risk to human health. The screening values are based on an assumed residential land use type (including consumption of home grown vegetables), and are sourced from either published Soil Guideline Values (SGVs) or Generic Soil Screening Values (GSSVs) as derived by ESI (ESI, 2007a).

The laboratory results for the three initial validation soil samples (81902, 81905 and 81906) showed that all measured concentrations were below the respective screening values with the exception of arsenic (for which the analytical range was 34 to 49 mg/kg) and chromium (160 to 180 mg/kg).

In response the elevated arsenic and chromium concentrations measured in the initial soil samples, the remaining five 'on hold' samples (81901, 81903, 81904, 81907 and 81908) were analysed for heavy metals only. The analytical results for the additional five samples also showed elevated arsenic (35 to 49 mg/kg) and chromium (150 to 190 mg/kg) soil concentrations.

The validation sampling therefore indicated that the imported soils did not meet the remediation criteria specified in the outline remediation design (ESI, 2007c). As such, these soils were considered to be unfit for purpose. SDC instructed Churngold to repeat the remediation activities in agreement with the specifications presented in the outline remediation design document (ESI, 2007c). Details of the resulting secondary remediation works are presented in Section 3.2.

4.2 Secondary remediation works (August 2008)

4.2.1 Methodology

As part of the secondary remediation works, Churngold arranged for analytical testing of the chosen fill materials prior to the transportation of these materials to site. A single sample was taken (SM1).

Further validation of the imported soil quality was conducted as per the initial remediation works, following the final placement of soils. Initially, eight validation samples were taken; three were taken from the imported soils on the raised garden tier and five from the main garden area. Following discussion with SDC, a further three samples were taken from the stockpile left on site to remedy any settlement issues identified at the time of final landscaping (see Section 3.2.4). Five of these samples were scheduled for analysis; one from the upper garden (01811), two from the lower main garden (01813 and 01817) and two from the stockpiled materials (01819 and 01820). This resulted in a sampling frequency of approximately one sample per 10 to 15 m^3 of imported soil. The approximate position of the validation samples is shown on Figure 4.2. The remaining six samples were put 'on hold' (note: there was no subsequent requirement to schedule these samples for testing).

The imported material was found to be generally homogeneous and thus single bulk samples were taken from each sampling location in accordance with best practice sampling techniques. All soil validation samples were taken using a hand trowel from depths of up to 0.3 m bgl.

All soil samples were placed into clean sampling containers; all sampling tools were cleaned between each sampling location.

The five soil validation samples were analysed for the determinands listed in Table 4.1. All laboratory analyses were undertaken by Alcontrol Laboratories, a UKAS registered analytical

laboratory. All sampling and subsequent analysis were documented and managed under full Chain of Custody procedures.

4.2.2 Validation results

The laboratory results associated with the sampling performed by Churngold are presented in Appendix B.2. The results for sample SM1 indicate that the imported materials are of a suitable chemical quality for use within Beech Cottage garden (i.e., all measured concentrations are below the adopted screening values presented in Table 4.1).

The laboratory results associated with the formal validation of the secondary remediation are presented in Appendix B.3. All validation sample results were once again assessed against the screening values documented in Table 4.1.

The laboratory results for the five validation soil samples (01811, 01813, 01817, 01819 and 01820) showed that all measured concentrations were below the respective screening values, indicating the suitability of the imported soils for use within a residential garden setting.

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FIGURES

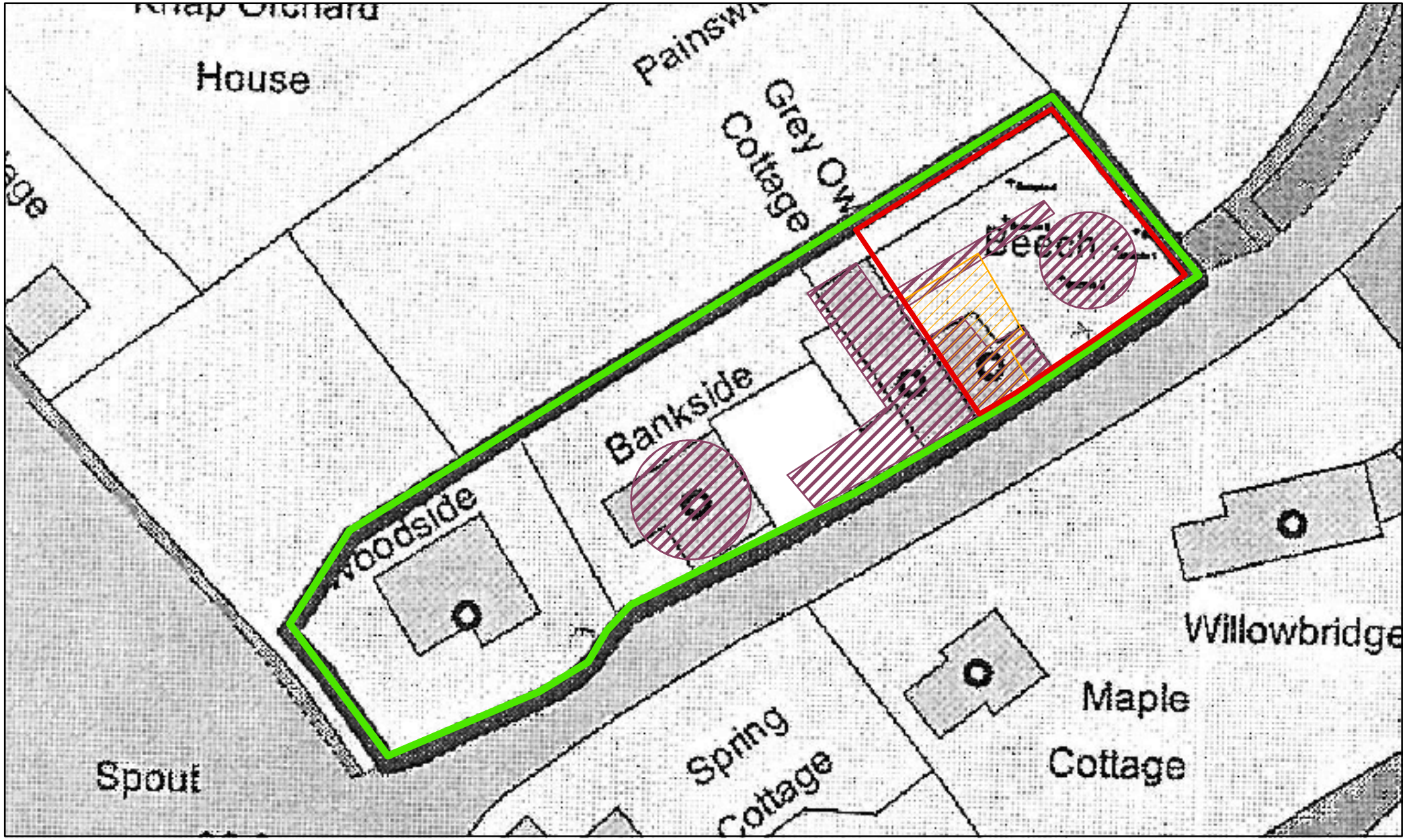

Figure 1.1
Site Setting

Location of former gas works structures
Indicative extent of former gas works
Beech Cottage land boundary
Footprint of Beech Cottage

Date: June 2008	Drawn: PCB
Scale: NTS	Checked: AJS
Original: A4	Revision: 1
File Reference: O:\6819a\reports\ Figure 1.1.mxd	

esi soil & groundwater

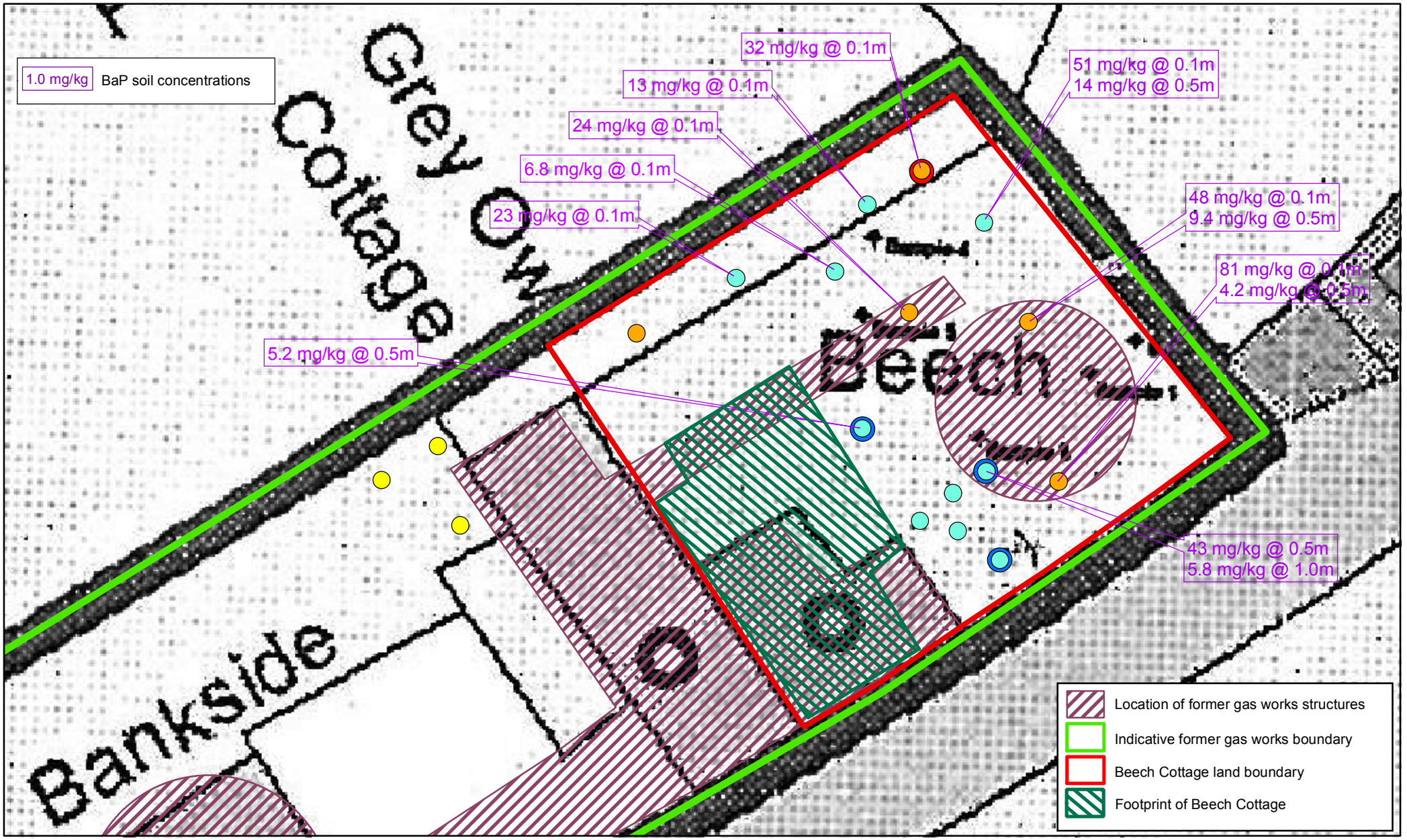

Figure 1.2
Contaminant distribution:
benzo (a) pyrene

SI works : 2006
- Grab sample locations
- Grab sample/geoprobe locations
- Soil gas monitoring locations

SI works : 2007
- Grab sample/geoprobe locations
- Soil gas monitoring locations

Date: June 2008	Drawn: PCB
Scale: NTS	Checked: AJS
Original: A4	Revision: 1
File Reference: O:\6819a\reports\ Figure 1.2.mxd	

esi soil & groundwater

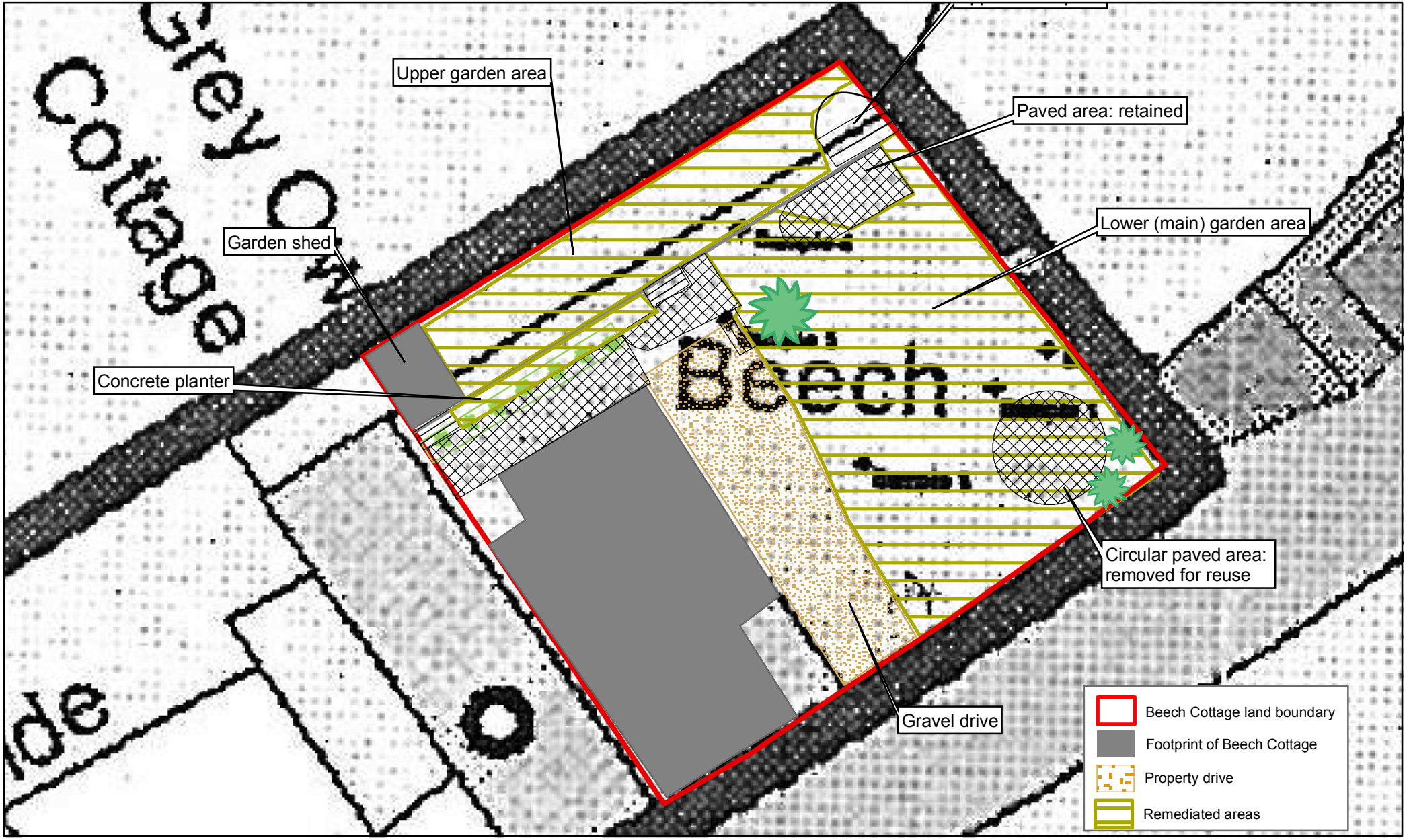

Figure 2.1
Excavated areas

Date: June 2008	Drawn: PCB
Scale: NTS	Checked: AJS
Original: A4	Revision: 1
File Reference: O:\6819a\reports\ Figure 4.1.mxd	

esi soil & groundwater

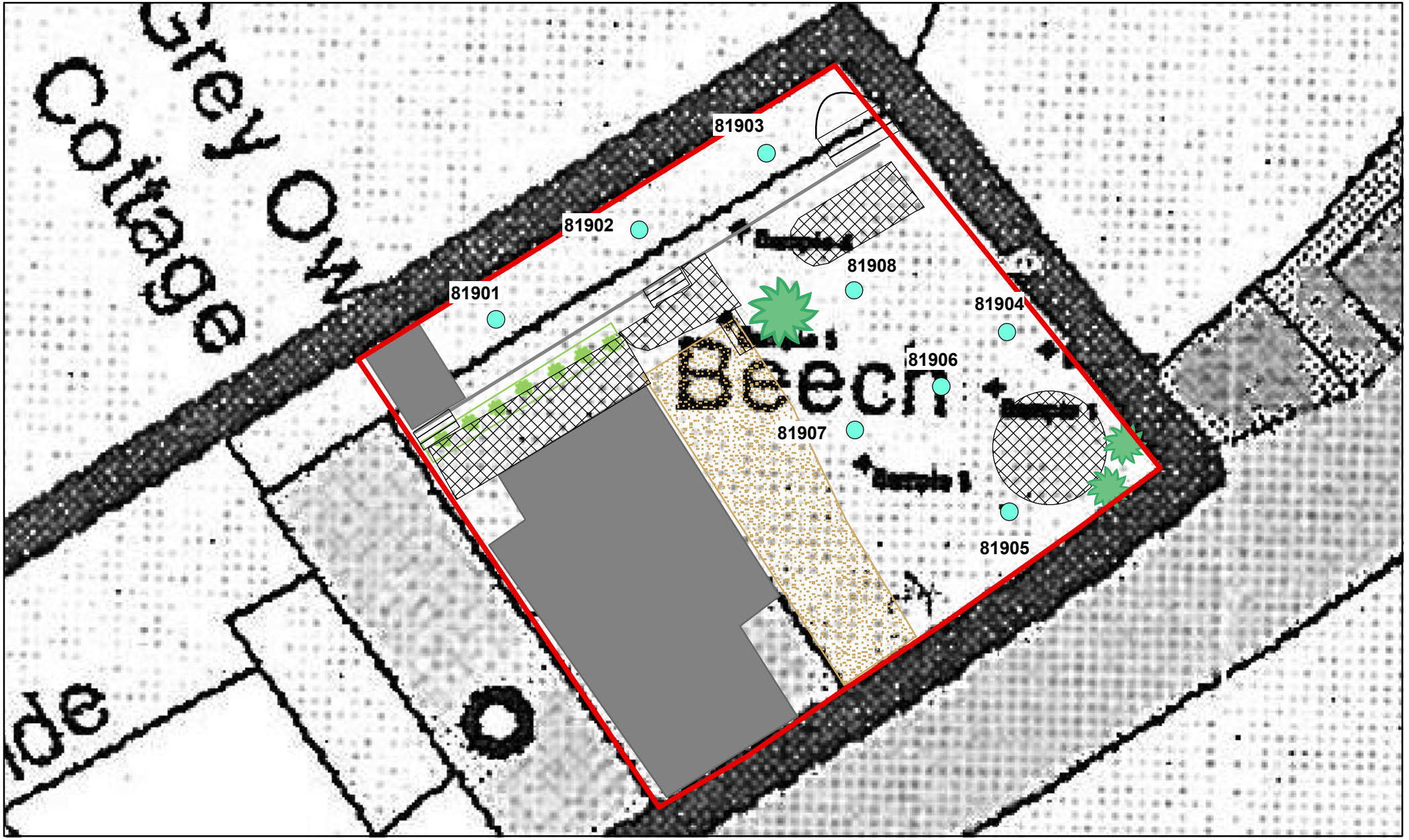

Figure 4.1
Validation sample locations: initial remediation works (May 2008)

Validation sample locations

Date: June 2008	Drawn: PCB
Scale: NTS	Checked: AJS
Original: A4	Revision: 1
File Reference: O:\6819a\reports\ Figure 4.1.mxd	

esi soil & groundwater

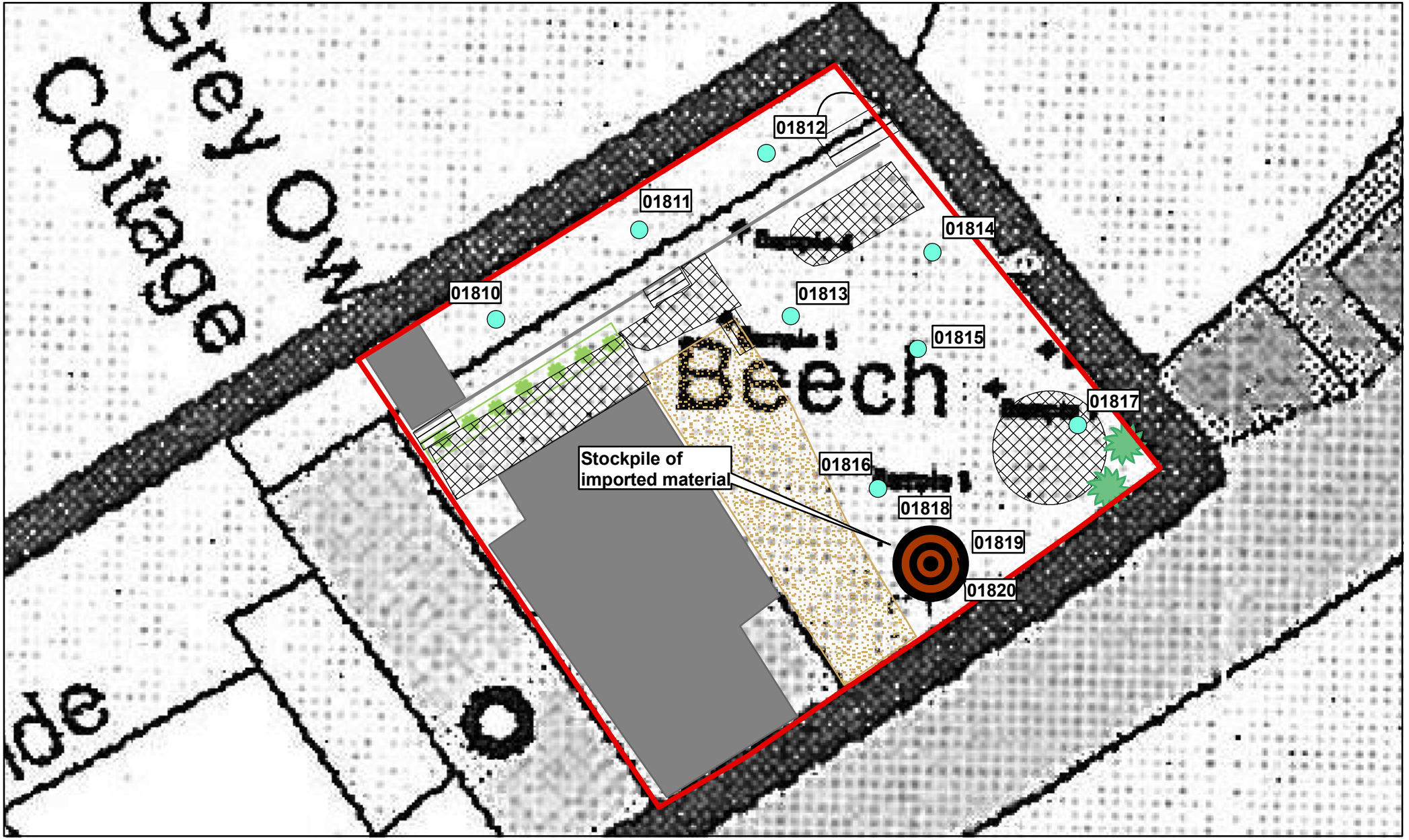

Figure 4.2
Validation sample locations: secondary remediation works (August 2008)

Validation sample locations

Date Aug 2008	Drawn SJC
Scale NTS	Checked AJS
Original A4	Revision 1
File Reference O:\6819b\reports\ Figure 4.1.mxd	

esi soil & groundwater

APPENDIX A
Site photographs

Appendix A.1 Initial remediation works (May 2008)

Photograph 1: Beech Cottage main garden: prior to remediation (July 2006)

Photograph 2: Beech Cottage main garden during works (May 2008)

Photograph 3: Beech Cottage main garden after backfill (May 2008)

Photograph 4: Beech Cottage raised garden area to rear of property: prior to remediation (July 2006)

Photograph 5: Beech Cottage raised garden area during works (May 2008)

Photograph 6: Beech Cottage raised garden after excavation (May 2008)

Photograph 7: Beech Cottage raised garden area after backfill (May 2008)

Photograph 8: Raised flower bed to rear of property (March 2007)

Photograph 9: Raised flower bed after excavation (May 2008)

Photograph 10: Raised flower bed after backfill (May 2008)

Photograph 11: View of main garden and driveway: prior to remediation (March 2007)

Photograph 12: View of main garden and driveway during works (May 2008)

Photograph 13: View of main garden and driveway after backfill (May 2008)

Appendix A.2 Secondary remediation works (August 2008)

Photograph 1: Beech Cottage main garden at start of works (August 2008)

Photograph 2: Beech Cottage raised garden at start of works (August 2008)

Photograph 3: Depth of excavation in main garden; 400mm (August 2008)

Photograph 4: Beech Cottage main garden during excavation (August 2008)

Photograph 5: Section of patio left during works (August 2008)

Photograph 6: New root restriction membrane installed during back fill (August 2008)

Photograph 6: Beech Cottage main garden during backfill (August 2008)

Photograph 7: Beech Cottage raised garden area after backfill (August 2008)

Photograph 8: North east corner of property after backfill (August 2008)

Photograph 9: Main garden after backfill including stockpile of material kept for future levelling works (August 2008)

APPENDIX B
Soil quality data

Appendix B.1 Validation sample results: initial remediation works (May 2008)

ALcontrol Laboratories Analytical Services
Sample Descriptions

Job Number: 08/09326/02/01
Client: ESI Ltd
Client Ref : 6819a

Grain sizes

<0.063mm	Very Fine
0.1mm - 0.063mm	Fine
0.1mm - 2mm	Medium
2mm - 10mm	Coarse
>10mm	Very Coarse

Sample Identity	Depth (m)	Colour	Grain Size	Description	Batch
81902sn	-	Dark Brown	0.1mm - 0.063mm	Silty Clay Loam with some Stones	1
81905sn	-	Dark Brown	0.1mm - 0.063mm	Silty Clay Loam with some Stones	1
81906sn	-	Dark Brown	0.1mm - 0.063mm	Silty Clay Loam with some Vegetation	1

* These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials-whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.
Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.
[1] Sample Description supplied by client

Validated ✓
Preliminary

ALcontrol Laboratories Analytical Services
Table Of Results

[#] ISO 17025 accredited
[M] MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/09326/02/01 **Matrix:** SOLID
Client: ESI Ltd **Location:** Painswick
Client Ref. No.: 6819a **Client Contact:** Andy Singleton

Sample Identity	81902sn	81905sn	81906sn							Method Code	LoD/Units
Depth (m)	-	-	-								
Sample Type	SOLID	SOLID	SOLID								
Sampled Date	21.05.08	21.05.08	21.05.08								
Sample Received Date	22.05.08	22.05.08	22.05.08								
Batch	1	1	1								
Sample Number(s)	**4-6**	**13-15**	**16-18**								
Arsenic	37	34	49							TM129[#M]	<3.0 mg/kg
Cadmium	0.8	0.7	0.6							TM129	<0.3 mg/kg
Chromium	160	170	180							TM129[#M]	<4.5 mg/kg
Copper	30	26	29							TM129[#M]	<6 mg/kg
Lead	55	50	58							TM129[#M]	<2 mg/kg
Mercury	<0.6	<0.6	<0.6							TM129[#M]	<0.6 mg/kg
Nickel	44	40	50							TM129[#M]	<0.9 mg/kg
Selenium	<3	<3	<3							TM129[#M]	<3 mg/kg
Zinc	170	170	180							TM129[#M]	<2.5 mg/kg
Phenols Monohydric	<0.15	<0.15	<0.15							TM062[#M]	<0.15 mg/kg
Total Cyanide	<1	<1	<1							TM153[#M]	<1 mg/kg
pH Value	7.65	7.69	7.69							TM133[#M]	<1.00 pH Units
EPH (DRO) (C10-C40)	350	300	310							TM061[#M]	<35 mg/kg
EPH (DRO) (C10-C40) % Surrogate Recovery	110	110	96							TM061[#M]	%
EPH C10-26	130	87	80							TM061[#]	<35 mg/kg
EPH >C26-40	220	210	230							TM061[#]	<35 mg/kg

All results expressed on a dry weight basis.

Date 11.06.2008

Validated ✓
Preliminary

ALcontrol Laboratories Analytical Services
Table Of Results

[#] ISO 17025 accredited
[M] MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/09326/02/01 **Matrix:** SOLID
Client: ESI Ltd **Location:** Painswick
Client Ref. No.: 6819a **Client Contact:** Andy Singleton

Sample Identity	81902sn	81905sn	81906sn							Method Code	LoD/Units
Depth (m)	-	-	-								
Sample Type	SOLID	SOLID	SOLID								
Sampled Date	21.05.08	21.05.08	21.05.08								
Sample Received Date	22.05.08	22.05.08	22.05.08								
Batch	1	1	1								
Sample Number(s)	**4-6**	**13-15**	**16-18**								
PAH by GCMS											
Naphthalene	97	68	68							TM074[#M]	<10 ug/kg
Acenaphthylene	46	30	40							TM074[#M]	<5 ug/kg
Acenaphthene	78	56	47							TM074[#M]	<14 ug/kg
Fluorene	83	55	46							TM074[#M]	<12 ug/kg
Phenanthrene	630	440	390							TM074[#M]	<21 ug/kg
Anthracene	190	130	130							TM074[#M]	<9 ug/kg
Fluoranthene	1500	1000	1100							TM074[#M]	<25 ug/kg
Pyrene	1200	860	910							TM074[#M]	<22 ug/kg
Benz(a)anthracene	600	590	510							TM074[#M]	<12 ug/kg
Chrysene	670	560	610							TM074[#M]	<10 ug/kg
Benzo(b)fluoranthene	1500	1000	900							TM074[#M]	<16 ug/kg
Benzo(k)fluoranthene	530	330	490							TM074[#M]	<25 ug/kg
Benzo(a)pyrene	730	630	640							TM074[#M]	<12 ug/kg
Indeno(123cd)pyrene	520	380	320							TM074[#M]	<11 ug/kg
Dibenzo(ah)anthracene	180	130	110							TM074[#M]	<8 ug/kg
Benzo(ghi)perylene	660	480	430							TM074[#M]	<10 ug/kg
PAH 16 Total	9300	6800	6700							TM074[#M]	<25 ug/kg

All results expressed on a dry weight basis.

Date 11.06.2008

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/09326/02/01
Client: ESI Ltd
Client Ref. No.: 6819a

Report Key :

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}

NDP	No Determination Possible	*	Subcontracted test
NFD	No Fibres Detected	»	Result previously reported (Incremental reports only)
#	ISO 17025 accredited	M	MCERTS Accredited
PFD	Possible Fibres Detected	EC	Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	ISO 17025 Accredited	MCERTS Accredited	Wet/Dry Sample [1]	Surrogate Corrected
TM061	Method for the Determination of EPH,Massachusetts Dept.of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)	✓		DRY	
TM061	Method for the Determination of EPH,Massachusetts Dept.of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)	✓	✓	DRY	
TM062	MEWAM BOOK 124 1988.HMSO/ Method 17.7, Second Site property, March 2003	Determination of Phenolic compounds by HPLC with electro-chemical detection	✓	✓	WET	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓		DRY	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓	✓	DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer			DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓	✓	DRY	
TM133	BS 1377: Part 3 1990	Determination of pH in Soil and Water using the GLpH pH Meter	✓	✓	WET	
TM153	Method 4500A,B,C, I, M AWWA/APHA, 20th Ed., 1999	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate using the "Skalar SANS+ System" Segmented Flow Analyser	✓	✓	WET	

[1] Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/09326/02/01
Client: ESI Ltd
Client Ref. No.: 6819a

Summary of Coolbox temperatures

Batch No.	Coolbox Temperature (°C)
1	12.6

ALcontrol Laboratories

Extractable Petroleum Hydrocarbons (EPH) By GC-FID

Carbon Range C10-C40

Job Number : 08/09326/02/01
Client : ESI Ltd
Client Ref : 6819a
Matrix [Units] : SOLID [mg/kg]

All results expressed on a dry weight basis.

Sample No	Sample Identity	Depth	EPH	Interpretation
4	81902sn	-	350	PAHs/bitumen tar/humic acids
13	81905sn	-	300	PAHs/bitumen tar/humic acids
16	81906sn	-	310	PAHs/Bitumen/Tar/Carboxylic acids

Extractable Petroleum Hydrocarbons (formally Diesel Range Organics) :- Any compound extractable in n-hexane within the carbon range C10-C40, includes Aliphatic (Min Oil), Aromatic (PAHs) and naturally occurring compounds.

ALcontrol Laboratories Analytical Services
Sample Descriptions

Job Number: 08/09326/02/01
Client: ESI Ltd
Client Ref : 6819a

Grain sizes

<0.063mm	Very Fine
0.1mm - 0.063mm	Fine
0.1mm - 2mm	Medium
2mm - 10mm	Coarse
>10mm	Very Coarse

Sample Identity	Depth (m)	Colour	Grain Size	Description	Batch
81901sn	-	Brown	0.1mm - 0.063mm	Loam (topsoil) with some Vegetation	1
81903sn	-	Brown	0.1mm - 0.063mm	Loam (topsoil) with some Stones	1
81904sn	-	Brown	0.1mm - 0.063mm	Loam (topsoil) with some Stones	1
81907sn	-	Brown	0.1mm - 0.063mm	Clay Loam with some Stones	1
81908sn	-	Brown	0.1mm - 0.063mm	Clay Loam with some Vegetation	1

* These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials-whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.
Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.
[1] Sample Description supplied by client

Validated ✓
Preliminary

ALcontrol Laboratories Analytical Services
Table Of Results

[#] ISO 17025 accredited
[M] MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/09326/02/01 **Matrix:** SOLID
Client: ESI Ltd **Location:** Painswick
Client Ref. No.: 6819a **Client Contact:** Andy Singleton

Sample Identity	81901sn	81903sn	81904sn	81907sn	81908sn					Method Code	LoD/Units
Depth (m)	-	-	-	-	-						
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID						
Sampled Date	21.05.08	21.05.08	21.05.08	21.05.08	21.05.08						
Sample Received Date	22.05.08	22.05.08	22.05.08	22.05.08	22.05.08						
Batch	1	1	1	1	1						
Sample Number(s)	**1-3**	**7-9**	**10-12**	**19-21**	**22-24**						
Arsenic	41	46	35	49	38					TM129[#M]	<3.0 mg/kg
Cadmium	0.4	0.4	0.3	0.3	0.4					TM129	<0.2 mg/kg
Chromium	180	190	150	180	180					TM129[#M]	<4.5 mg/kg
Copper	23	26	26	25	25					TM129[#M]	<6 mg/kg
Lead	53	52	51	57	51					TM129[#M]	<2 mg/kg
Mercury	<0.4	<0.4	<0.4	<0.4	<0.4					TM129[#M]	<0.4 mg/kg
Nickel	45	49	44	46	47					TM129[#M]	<0.9 mg/kg
Selenium	<3	<3	<3	<3	<3					TM129[#M]	<3 mg/kg
Zinc	180	180	160	170	190					TM129[#M]	<2.5 mg/kg

All results expressed on a dry weight basis.

Date 16.06.2008

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/09326/02/01
Client: ESI Ltd
Client Ref. No.: 6819a

Report Key :

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}

NDP	No Determination Possible	*	Subcontracted test
NFD	No Fibres Detected	»	Result previously reported (Incremental reports only)
#	ISO 17025 accredited	M	MCERTS Accredited
PFD	Possible Fibres Detected	EC	Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	ISO 17025 Accredited	MCERTS Accredited	Wet/Dry Sample [1]	Surrogate Corrected
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer			DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓	✓	DRY	

[1] Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/09326/02/01
Client: ESI Ltd
Client Ref. No.: 6819a

Summary of Coolbox temperatures

Batch No.	Coolbox Temperature (°C)
1	12.6

Appendix B.2 Analytical results for imported soils: information supplied by Churngold prior to commencement of secondary remediation works (August 2008)

ALcontrol Laboratories Analytical Services
Sample Descriptions

Job Number: 08/13113/02/01
Client: Churngold Remediation Ltd
Client Ref : SC329R

Grain sizes

<0.063mm	Very Fine
0.1mm - 0.063mm	Fine
0.1mm - 2mm	Medium
2mm - 10mm	Coarse
>10mm	Very Coarse

Sample Identity	Depth (m)	Colour	Grain Size	Description	Batch
SM1	-	Dark Brown	0.1mm - 0.063mm	Sandy Loam with some Stones	1

* These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials-whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.
Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.
[1] Sample Description supplied by client

Validated ✓
Preliminary

ALcontrol Laboratories Analytical Services
Table Of Results

[#] ISO 17025 accredited
[M] MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/13113/02/01 **Matrix:** SOLID
Client: Churngold Remediation Ltd **Location:** Not Specified
Client Ref. No.: SC329R **Client Contact:** Tony Field

Sample Identity	SM1									Method Code	LoD/Units
Depth (m)	-										
Sample Type	SOLID										
Sampled Date	30.07.08										
Sample Received Date	01.08.08										
Batch	1										
Sample Number(s)	1										
Arsenic	5									TM129[#M]	<3.0 mg/kg
Cadmium	0.3									TM129	<0.2 mg/kg
Chromium	17									TM129[#M]	<4.5 mg/kg
Copper	<6									TM129[#M]	<6 mg/kg
Lead	15									TM129[#M]	<2 mg/kg
Mercury	<0.4									TM129[#M]	<0.4 mg/kg
Nickel	11									TM129[#M]	<0.9 mg/kg
Selenium	<3									TM129[#M]	<3 mg/kg
Zinc	40									TM129[#M]	<2.5 mg/kg
Phenols Monohydric	<0.15									TM062[#M]	<0.15 mg/kg
Total Cyanide	<1									TM153[#M]	<1 mg/kg
Asbestos Presence Screen	No Fibres Detected									TM001	NONE
pH Value	8.05									TM133[#M]	<1.00 pH Units
EPH (DRO) (C10-C40)	130									TM061[#M]	<35 mg/kg
EPH (DRO) (C10-C40) % Surrogate Recovery	99									TM061[#M]	%

All results expressed on a dry weight basis.

Date 07.08.2008

Validated ✓
Preliminary

ALcontrol Laboratories Analytical Services
Table Of Results

[#] ISO 17025 accredited
[M] MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/13113/02/01 **Matrix:** SOLID
Client: Churngold Remediation Ltd **Location:** Not Specified
Client Ref. No.: SC329R **Client Contact:** Tony Field

Sample Identity	SM1									Method Code	LoD/Units
Depth (m)	-										
Sample Type	SOLID										
Sampled Date	30.07.08										
Sample Received Date	01.08.08										
Batch	1										
Sample Number(s)	1										
PAH by GCMS											
Naphthalene	48									TM074[#M]	<10 ug/kg
Acenaphthylene	16									TM074[#M]	<5 ug/kg
Acenaphthene	29									TM074[#M]	<14 ug/kg
Fluorene	35									TM074[#M]	<12 ug/kg
Phenanthrene	210									TM074[#M]	<21 ug/kg
Anthracene	39									TM074[#M]	<9 ug/kg
Fluoranthene	300									TM074[#M]	<25 ug/kg
Pyrene	260									TM074[#M]	<22 ug/kg
Benz(a)anthracene	140									TM074[#M]	<12 ug/kg
Chrysene	170									TM074[#M]	<10 ug/kg
Benzo(b)fluoranthene	220									TM074[#M]	<16 ug/kg
Benzo(k)fluoranthene	120									TM074[#M]	<25 ug/kg
Benzo(a)pyrene	120									TM074[#M]	<12 ug/kg
Indeno(123cd)pyrene	83									TM074[#M]	<11 ug/kg
Dibenzo(ah)anthracene	33									TM074[#M]	<8 ug/kg
Benzo(ghi)perylene	120									TM074[#M]	<10 ug/kg
PAH 16 Total	1900									TM074[#M]	<25 ug/kg

All results expressed on a dry weight basis.

Date 07.08.2008

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/13113/02/01
Client: Churngold Remediation Ltd
Client Ref. No.: SC329R

Report Key :

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}

NDP	No Determination Possible	*	Subcontracted test
NFD	No Fibres Detected	»	Result previously reported (Incremental reports only)
#	ISO 17025 accredited	M	MCERTS Accredited
PFD	Possible Fibres Detected	EC	Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	ISO 17025 Accredited	MCERTS Accredited	Wet/Dry Sample [1]	Surrogate Corrected
TM001	In - house Method	Screening of Soils for Fibres			WET	
TM061	Method for the Determination of EPH,Massachusetts Dept.of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)	✓	✓	DRY	
TM062	MEWAM BOOK 124 1988.HMSO/ Method 17.7, Second Site property, March 2003	Determination of Phenolic compounds by HPLC with electro-chemical detection	✓	✓	WET	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓		DRY	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓	✓	DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer			DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓	✓	DRY	
TM133	BS 1377: Part 3 1990	Determination of pH in Soil and Water using the GLpH pH Meter	✓	✓	WET	
TM153	Method 4500A,B,C, I, M AWWA/APHA, 20th Ed., 1999	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate using the "Skalar SANS+ System" Segmented Flow Analyser	✓	✓	WET	

[1] Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/13113/02/01
Client: Churngold Remediation Ltd
Client Ref. No.: SC329R

Summary of Coolbox temperatures

Batch No.	Coolbox Temperature (°C)
1	18

ALcontrol Laboratories

Extractable Petroleum Hydrocarbons (EPH) By GC-FID

Carbon Range C10-C40

Job Number : 08/13113/02/01
Client : Churngold Remediation Ltd
Client Ref : SC329R
Matrix [Units] : SOLID [mg/kg]

All results expressed on a dry weight basis.

Sample No	Sample Identity	Depth	EPH	Interpretation
1	SM1	-	130	PAHs/Humic Acids

Extractable Petroleum Hydrocarbons (formally Diesel Range Organics) :- Any compound extractable in n-hexane within the carbon range C10-C40, includes Aliphatic (Min Oil), Aromatic (PAHs) and naturally occurring compounds.

Appendix B.3 Validation sample results: secondary remediation works (August 2008)

ALcontrol Laboratories Analytical Services
Sample Descriptions

Job Number: 08/13894/02/01
Client: ESI Ltd
Client Ref : 6819B

Grain sizes

<0.063mm	Very Fine
0.1mm - 0.063mm	Fine
0.1mm - 2mm	Medium
2mm - 10mm	Coarse
>10mm	Very Coarse

Sample Identity	Depth (m)	Colour	Grain Size	Description	Batch
01811	00.30	Brown	0.1mm - 0.063mm	Sandy Clay Loam with some Stones	1
01813	00.30	Brown	0.1mm - 2mm	Sandy Clay Loam with some Stones	1
01817	00.30	Brown	0.1mm - 2mm	Sandy Clay Loam with some Stones	1
01819	00.10	Brown	0.1mm - 2mm	Sandy Clay Loam with some Stones	1
01820	00.10	Brown	0.1mm - 2mm	Sandy Clay Loam with some Stones	1

* These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials-whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.
Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.
[1] Sample Description supplied by client

Validated ✓
Preliminary

ALcontrol Laboratories Analytical Services
Table Of Results

[#] ISO 17025 accredited
[M] MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/13894/02/01 **Matrix:** SOLID
Client: ESI Ltd **Location:** Not Specified
Client Ref. No.: 6819B **Client Contact:** Andy Singleton

Sample Identity	01811	01813	01817	01819	01820					Method Code	LoD/Units
Depth (m)	00.30	00.30	00.30	00.10	00.10						
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID						
Sampled Date	13.08.08	14.08.08	14.08.08	14.08.08	14.08.08						
Sample Received Date	15.08.08	15.08.08	15.08.08	15.08.08	15.08.08						
Batch	1	1	1	1	1						
Sample Number(s)	**4-6**	**10-12**	**21-23**	**26-28**	**29-31**						
Arsenic	5	6	5	5	5					TM129[#M]	<3.0 mg/kg
Cadmium	0.3	0.3	0.3	0.3	0.3					TM129	<0.2 mg/kg
Chromium	99	14	14	13	13					TM129[#M]	<4.5 mg/kg
Copper	11	9	10	9	10					TM129[#M]	<6 mg/kg
Lead	13	260	13	14	13					TM129[#M]	<2 mg/kg
Mercury	<0.4	<0.4	<0.4	<0.4	<0.4					TM129[#M]	<0.4 mg/kg
Nickel	13	9.8	10	9.6	9.7					TM129[#M]	<0.9 mg/kg
Selenium	<3	<3	<3	<3	<3					TM129[#M]	<3 mg/kg
Zinc	36	34	35	34	35					TM129[#M]	<2.5 mg/kg
Phenols Monohydric	<0.15	<0.15	<0.15	<0.15	<0.15					TM062[#M]	<0.15 mg/kg
Total Cyanide	<1	<1	<1	<1	<1					TM153[#M]	<1 mg/kg
pH Value	8.18	8.17	8.11	8.10	8.15					TM133[#M]	<1.00 pH Units
EPH (DRO) (C10-C40)	130	150	180	180	160					TM061[#M]	<35 mg/kg
EPH (DRO) (C10-C40) % Surrogate Recovery	89	110	110	110	110					TM061[#M]	%
EPH C10-20	<35	<35	<35	<35	<35					TM061[#]	<35 mg/kg
EPH >C20-30	44	57	68	68	64					TM061[#]	<35 mg/kg
EPH >C30-40	58	69	80	86	77					TM061[#]	<35 mg/kg

All results expressed on a dry weight basis.

Date 22.08.2008

Validated ✓
Preliminary

ALcontrol Laboratories Analytical Services
Table Of Results

[#] ISO 17025 accredited
[M] MCERTS accredited
* Subcontracted test
» Shown on prev. report

Job Number: 08/13894/02/01 **Matrix:** SOLID
Client: ESI Ltd **Location:** Not Specified
Client Ref. No.: 6819B **Client Contact:** Andy Singleton

Sample Identity	01811	01813	01817	01819	01820					Method Code	LoD/Units
Depth (m)	00.30	00.30	00.30	00.10	00.10						
Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID						
Sampled Date	13.08.08	14.08.08	14.08.08	14.08.08	14.08.08						
Sample Received Date	15.08.08	15.08.08	15.08.08	15.08.08	15.08.08						
Batch	1	1	1	1	1						
Sample Number(s)	**4-6**	**10-12**	**21-23**	**26-28**	**29-31**						
PAH by GCMS											
Naphthalene	28	310	230	170	240					TM074[#M]	<10 ug/kg
Acenaphthylene	6	8	16	9	7					TM074[#M]	<5 ug/kg
Acenaphthene	17	110	290	150	120					TM074[#M]	<14 ug/kg
Fluorene	23	58	190	78	66					TM074[#M]	<12 ug/kg
Phenanthrene	110	300	1100	280	300					TM074[#M]	<21 ug/kg
Anthracene	20	47	210	45	40					TM074[#M]	<9 ug/kg
Fluoranthene	160	240	1000	280	220					TM074[#M]	<25 ug/kg
Pyrene	130	200	730	250	190					TM074[#M]	<22 ug/kg
Benz(a)anthracene	91	110	330	130	99					TM074[#M]	<12 ug/kg
Chrysene	100	150	390	160	130					TM074[#M]	<10 ug/kg
Benzo(b)fluoranthene	200	220	600	260	200					TM074[#M]	<16 ug/kg
Benzo(k)fluoranthene	64	75	170	82	57					TM074[#M]	<25 ug/kg
Benzo(a)pyrene	93	71	260	110	69					TM074[#M]	<12 ug/kg
Indeno(123cd)pyrene	51	62	190	88	56					TM074[#M]	<11 ug/kg
Dibenzo(ah)anthracene	16	20	67	20	19					TM074[#M]	<8 ug/kg
Benzo(ghi)perylene	69	79	220	120	75					TM074[#M]	<10 ug/kg
PAH 16 Total	1200	2100	6000	2200	1900					TM074[#M]	<25 ug/kg

All results expressed on a dry weight basis.

Date 22.08.2008

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/13894/02/01
Client: ESI Ltd
Client Ref. No.: 6819B

Report Key :

Results expressed as (e.g.) 1.03E-07 is equivalent to 1.03×10^{-7}

NDP	No Determination Possible	*	Subcontracted test
NFD	No Fibres Detected	»	Result previously reported (Incremental reports only)
#	ISO 17025 accredited	M	MCERTS Accredited
PFD	Possible Fibres Detected	EC	Equivalent Carbon (Aromatics C8-C35)

Note: Method detection limits are not always achievable due to various circumstances beyond our control.

Summary of Method Codes contained within report :

Method No.	Reference	Description	ISO 17025 Accredited	MCERTS Accredited	Wet/Dry Sample [1]	Surrogate Corrected
TM061	Method for the Determination of EPH,Massachusetts Dept.of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)	✓		DRY	
TM061	Method for the Determination of EPH,Massachusetts Dept.of EP, 1998	Determination of Extractable Petroleum Hydrocarbons by GC-FID (C10-C40)	✓	✓	DRY	
TM062	MEWAM BOOK 124 1988.HMSO/ Method 17.7, Second Site property, March 2003	Determination of Phenolic compounds by HPLC with electro-chemical detection	✓	✓	WET	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓		DRY	
TM074	Modified: US EPA Method 8100	Determination of Polynuclear Aromatic Hydrocarbons (PAH) by GC-MS. MCERTS Accreditation on Soils for Naphthalene except when Kerosene present.	✓	✓	DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer			DRY	
TM129	Method 3120B, AWWA/APHA, 20th Ed., 1999 / Modified: US EPA Method 3050B	Determination of Metal Cations by IRIS Emission Spectrometer	✓	✓	DRY	
TM133	BS 1377: Part 3 1990;BS 6068-2.5	Determination of pH in Soil and Water using the GLpH pH Meter	✓	✓	WET	
TM153	Method 4500A,B,C, I, M AWWA/APHA, 20th Ed., 1999	Determination of Total Cyanide, Free (Easily Liberatable) Cyanide and Thiocyanate using the "Skalar SANS+ System" Segmented Flow Analyser	✓	✓	WET	

[1] Applies to Solid samples only. **DRY** indicates samples have been dried at 35°C. **NA** = not applicable.

ALcontrol Laboratories Analytical Services
Table Of Results - Appendix

Job Number: 08/13894/02/01
Client: ESI Ltd
Client Ref. No.: 6819B

Summary of Coolbox temperatures

Batch No.	Coolbox Temperature (°C)
1	12.4

ALcontrol Laboratories

Extractable Petroleum Hydrocarbons (EPH) By GC-FID

Carbon Range C10-C40

Job Number : 08/13894/02/01
Client : ESI Ltd
Client Ref : 6819B
Matrix [Units] : SOLID [mg/kg]

All results expressed on a dry weight basis.

Sample No	Sample Identity	Depth	EPH	Interpretation
4	01811	00.30	130	biodegraded diesel / humic acids
10	01813	00.30	150	possible biodegraded diesel / possible PAHs/ humic acids
23	01817	00.30	180	possible biodegraded diesel /PAHs/ humics
26	01819	00.10	180	possible biodegraded diesel / possible PAHs/ humic acids
29	01820	00.10	160	possible biodegraded diesel /PAHs/ humics

Extractable Petroleum Hydrocarbons (formally Diesel Range Organics) :- Any compound extractable in n-hexane within the carbon range C10-C40, includes Aliphatic (Min Oil), Aromatic (PAHs) and naturally occurring compounds.