BAE SYSTEMS Environmental

Stage 1 Site Investigation Outline Strategy

Bishopton

Redrow Group and BAE Systems Property Investments Ltd

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DOCUMENT CONTROL

ORIGINATOR	CHECKED BY	AUTHORISED BY
Paul Harris BSc (Hons) PGDip FGS	Alison McKay BSc (Hons) CSci CChem MRSC	Alison McKay BSc (Hons) CSci CChem MRSC
Senior Geo-environmental Engineer	Site Assessment Manager	Site Assessment Manager

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EMS 54524

INVESTORS IN PEOPLE

BAE Systems Environmental, Station Road, Bishopton, Renfrewshire. PA7 5NJ. United Kingdom.
Telephone: +44 (0) 1505 832025 Fax: +44 (0) 01505 832052 http://www.baesystems.com/propertyandenvironmental

Registered in England & Wales No 2863702. Registered Office BAE SYSTEMS Properties Limited Warwick House PO Box 87 Farnborough Aerospace Centre Farnborough Hampshire GU14 6YU

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APPENDICES

1. INTRODUCTION

1.1. BACKGROUND

The former Royal Ordnance Factory in Bishopton ceased production in 2002 and proposals have been prepared by BAE Systems (the owners) and Redrow, (development partner in the project), to bring the site back into beneficial use. It is proposed to regenerate and remediate the site using redevelopment as the enabler.

The regeneration plan for the Site is outlined in a report prepared by Cass Associates 'Landuse Proposals, revision A, October 2003' and includes the redevelopment of the Site for mixed-use development including residential, commercial, employment, community and open space end uses. The Core Development Area, which occupies approximately 24% of the site area, is situated in the north-eastern part of the Site, adjacent to existing Bishopton village. A copy of the proposed Landuse Plan is provided in Appendix 1 for information.

In view of the sites historic use as an explosives factory for more than 80 years, it is considered that remediation will be required in order to make the site suitable for its new use(s). In addition, there is a requirement for land contamination issues to be assessed and appropriately addressed as a material planning consideration. It is therefore necessary to present a remediation strategy to support the application for outline planning for the redevelopment.

1.2. SCOPE AND OBJECTIVES

In order to gain sufficient information to develop the remediation strategy, it is necessary to conduct preliminary intrusive investigations at the Site. BAE Systems Environmental has been commissioned as environmental consultant in relation to the assessment of land contamination issues to support the regeneration of the Site. It is proposed to undertake a phased approach to assessment of land contamination issues at the site with a broad based Stage 1 investigation being undertaken to support the outline planning application with further investigations to be undertaken to support full planning thereafter.

Therefore, the principal objectives of the Stage 1 Site Investigation are:

- to provide sufficient information for the development of a robust preliminary remediation strategy.
- to support the Environmental Statement and Environmental Impact Assessment in the Outline Planning Application;

In order to achieve these objectives, we propose to conduct a scope of works in order to

- Provide information on the nature and extent of contamination, concentrating on identified potential sources of contamination
- To provide a degree of confidence that unexpected or unknown contamination sources are detected
- Develop an initial conceptual site model

- Identify actual or potential pollutant linkages
- Inform the remediation plan
- Identify requirements for further investigations

The main investigation will follow the gaining of an outline planning consent and will include:

- Further intrusive works to determine if potential pollutant linkages actually exist
- Risk assessment to determine their significance

This document details an outline scope and methodology for the Stage 1 investigation. It also describes the investigation rationale, which is based upon the overall objectives outlined above.

2. SITE DETAILS

2.1. BACKGROUND

A Desk Study for Potential Contamination was completed by BAE SYSTEMS Environmental Services in August 2002 (Report No. A138-00-R1-1). The report describes the Site and its surroundings, history, hydrology, geology and hydrogeology.

This section provides a summary of the desk study; reference should be made to the report for further details.

2.2. DESCRIPTION

The Site is roughly rectangular in shape and occupies an area of approximately 996 hectares (ha). The land surrounding the Site is predominantly agricultural, being a mix between arable, pasture and woodland.

Some 766 ha of the Site is securely fenced and contains the former RO factory. The 230 ha of land between the factory fence and the Site boundary is predominantly arable and pasture land, except for Barochan Moss, a large area of afforested peat.

Georgetown, a First World War (WWI) munitions filling factory, occupies approximately 194 ha in the southern part of the Site, within the factory fence. The vast majority of buildings associated with the Georgetown factory were demolished shortly after the Second World War (WWII) and the area is now predominantly wooded.

2.3. GEOLOGY

Made ground is known or suspected to be present in significant thicknesses at a number of locations within the Site. The principal areas of made ground are associated with the area known as Boghall Dump, tipped boiler ash, the picrite lagoons and the burning grounds.

Higher ground in the northern part of the Site is formed by volcanic rocks of Upper Carboniferous age overlain by discontinuous glacial till deposits of up to 5 to 10 m thickness.

The central and southern areas are underlain by glaciomarine silts and glacial till which thicken towards the south to greater than 30 m. The solid geology of these areas comprises interbedded sandstone, mudstone, limestone and coal of Upper Carboniferous age underlying the glacial deposits. Peat accumulations are evident on low lying land in the east and west of the Site.

2.4. HISTORY

Prior to development the Site was predominantly agricultural land.

The industrial history of the Site can be divided broadly into two eras, the first being the construction of the Scottish Filling Factory (Georgetown) soon after the outbreak of WWI.

Georgetown was an ordnance filling factory located in the southern part of the Site and closed soon after WWI.

The RO factory was built around WWII over much of the remainder of the Site and also occupies the northern part of Georgetown. The major function of the factory was the production of gun and rocket propellant for the armed services, and was in use until production ceased in 2002.

The factory was conceived as three self-sufficient propellant factories (I, II and III), each having its own boiler house, nitroglycerine, nitrocellulose and acids production sections. Tetryl was manufactured in factories II and III.

Although the layout of the factory has remained largely unchanged since it was built, the range in activities carried out at the factory has varied over the years. Of particular note was the manufacture of picrite and the breakdown of surplus ammunition. Other processes included the manufacture of RDX, Ball Powder, ammonium perchlorate and Combustible Charge Containers (CCCs), and the filling of ordnance with phosphorus.

2.5. POTENTIAL CONTAMINATION SOURCES

The desk study identified a number of historical activities and processes that constitute or may have given rise to potential contamination sources. Based on a review of available information, the report established the likely locations and nature of potential contamination.

The historical activities were identified as potentially giving rise to the following potential contaminants: -

- Metals and semi-metals
- Acids and alkalis
- Various organic compounds – including solvents, oils, fuels and PAHs
- Explosives residues – including NG, NC, picrite, tetryl, RDX and TNT
- Explosive devices
- PCBs
- Asbestos

2.6. EXISTING INVESTIGATION DATA

There is already some data in relation to land contamination at the site which has been gathered through a series of investigations as detailed in the following paragraphs. It is not intended to duplicate the existing information but to supplement it through the Stage 1 investigation.

Between 1989 and 1996 environmental investigations were carried out by Aspinwall and RO Environmental Services Group (RO ESG, now BAE Systems Environmental), as follows:

- Aspinwall, 'Investigation into the Location of the Picrite Lagoons', 1989.
- RO ESG, 'Analysis of Groundwater for Contamination', 1995.
- RO ESG, 'Preliminary Ground Investigation for Contamination at the Burning Grounds', 1995.
- RO ESG, 'Site Investigation and Remediation Strategy – Georgetown', 1996.

Since the desk study was produced in 2002, exploratory investigations have been carried out by BAE Systems Environmental in areas of the Site that were considered to be of potential immediate concern. In addition, a programme of environmental monitoring was carried out during 2002 and early 2003. The relevant reports are:

- 'Ground Investigation at Boghall', A182-0M-R3, November 2002.
- 'Ground Investigation at the Picrite Lagoons', A182-0K-R3, February 2003.
- 'Environmental Monitoring Report – 2002/3', P501-0C-R2, April 2003 (in preparation).

In March 2003 a preliminary geotechnical investigation was carried out in the Core Development Area. Soil samples were taken from the starter pits of approximately 90 No. boreholes, and a proportion were analysed for a range of potential contaminants.

3. INVESTIGATION RATIONALE

3.1. INTRODUCTION

The primary purposes of the Stage 1 Site Investigation are:

- to provide sufficient information for the development of a robust preliminary remediation strategy.
- to support the Environmental Statement and Environmental Impact Assessment in the Outline Planning Application;

In general terms, these objectives will be achieved by characterising the potential contamination sources and their related pathways and receptors as identified by the desk study. In addition, the investigation must also provide a degree of confidence that any unexpected or unknown potential contamination sources are detected.

The investigation of the Site has been planned and will be conducted in accordance with the guidance and recommendations given in several current UK industry guidance documents, namely

- BS10175:2001 – 'Investigation of Potentially Contaminated Sites'
- BS5903:1999, 'Code of Practice for Site Investigation'
- EA Technical Report P5-066/TR, Secondary Model for the Development of Appropriate Soil Sampling Strategies for Land Contamination'
- EA Technical Report P5-056/TR, 'Technical Aspects of Site Investigation'.
- BS ISO/5667-18 'Guidance on sampling groundwater from contaminated sites'.
- CLR 11 - 'Model Procedures for the Management of Land Contamination'.
- Environment Agency report - 'Guide to Good Practice for the Development of Conceptual Models and the Selection and Application of Mathematical Models of Contaminant Transport Processes in the Subsurface'.

As mentioned previously, the investigation will seek to supplement the existing information gained through previous targeted investigations and monitoring.

Using the terminology of the guidance, the work carried out to date can be considered *Exploratory Investigations*, used 'to estimate any immediate environmental risk and to generate preliminary gas and groundwater data'.

The proposed works outlined in this document correlate with *Stage I* of the *Main Investigation* in the current guidance, being an investigation 'carried out at a relatively broad level to obtain a general picture of the likely nature and scale of contamination and associated risks'. The outcome of the Stage 1 Investigation will be to develop the conceptual site model, identify actual or potential pollutant linkages and provide a preliminary assessment of the associated risks. For health and safety reasons, this investigation will not include intrusive investigations within buildings or

structures as these have yet to be decontaminated. Details of the requirements for the Stage ll investigation will also be developed.

It is intended that *Stage 2* of the *Main Investigation* and any *Supplementary Investigation* will be undertaken as required after gaining an Outline Planning Consent.

Stage 2 investigations will be carried out to focus-in on areas of potential concern and/or provide a greater degree of confidence on the status of identified potential contamination sources, particularly in the Core Development Area. The ultimate aim of this phase will be to confirm the existence of potential pollutant linkages and determine their significance.

Supplementary investigations may include long-term water quality monitoring and more intensive sampling (beneath drains and steam mains, for example) for the purposes of the detailed design of remediation works.

3.2. NUMBER AND LOCATION OF EXPLORATORY POINTS

For the purposes of this investigation, the Site has been divided into 18 No. zones based on former factory production sections and the boundary of the Core Development Area.

A plan showing the zones is presented in Appendix 2 together with a table giving a description of each zone, its approximate area, nominal grid spacing and proposed number of exploratory points.

The majority of exploratory points are positioned on a targeted grid. Zones have been assigned nominal grid spacing and then exploratory point locations adjusted relative to identified potential contamination sources and likely areas of accumulation of contaminants. Areas where potential contamination is more likely to be present include adjacent to process buildings and materials storage areas. For this reason, a separate surface sampling exercise will be undertaken outside a proportion of process buildings.

The philosophy adopted for determining the grid spacing to be applied in this Stage 1 Site Investigation has been to firstly consider the historic activities carried out in the area. This allows an assessment to be made on the likelihood of contamination being present in the zone. A secondary consideration was whether the zone was within the development zone or not. As the Landuse plan is yet to be finalised (through the master planning process), we have not distinguished at this time between areas of differing proposed land use e.g. residential versus commercial. Therefore, the investigation design is independent of the proposed land use and so in the event that they were to change significantly, we believe that there will still be sufficient information gained in the Stage 1 Site Investigation to meet the objectives outline in section 1.2.

Shallow groundwater is anticipated to flow in a 45° angle to the direction of surface water flow. Positioning of some boreholes has therefore been such that shallow groundwater can be intercepted between suspected sources of contamination and the nearest surface water. The borehole locations have also been targeted to intercept groundwater in areas where pollution is most likely based upon the potential sources identified in Appendix 12 of the desk study report. As such, their

positioning seeks to establish the worst case scenario in terms of background groundwater quality.

More detailed information on the rationale behind exploratory point spacing in each zone is given in the following sections. A plan showing the approximate locations of proposed exploratory points is presented in Appendix 3.

3.2.1. Zones A, B & C – Nitroglycerine Sections (Factories I, II & III)

Process buildings in nitroglycerine sections are generally well spaced, so a grid spacing of 150 m has been selected. The spacing has been increased to 100 m in Zone A because it is partly within the outline of the Core Development Area.

The nitroglycerine sections are located on generally higher steeply sloping ground so access to much of these areas will be limited. It will be necessary to replace a number of trial pits with hand-augered samples.

Potential contamination sources in these zones include process buildings, acid tanks and solvent tanks (in Ball Powder Section, Zone A). Boghall Dump, the Vegetation Tip and Burning Ground 16/007J in Zone C were investigated by BAE Systems Environmental in 2002 (see Section 2.6).

3.2.2. Zones D, E & F – Nitrocellulose Sections (Factories I, II & III)

These zones are characterised by large closely spaced process buildings and have been assigned a nominal grid spacing of 75 m for Zones D & E inside the Core Development Area, and 100 m for Zone F outside the Core Development Area.

Zones D and F include the adjacent acids sections. Zone D also includes the Ammonium Perchlorate, Demolition Guncotton and Lead Salts sections.

Nitrocellulose production buildings in Zone E were converted to white phosphorus filling and the manufacture of Combustible Charge Containers in the 1960s. (The adjacent former acids section is included in Zone J.)

A number of acids and nitrocellulose buildings in Zone F were reused for ammunition breakdown (including Lance missile).

Specific potential contamination sources in these sections include process buildings, acid tanks, settling lagoons and burning grounds.

3.2.3. Zones G, H & I – Gun and Rocket Propellant (Factories I, II & III)

A maximum grid spacing of 175 m has been chosen for these zones to reflect the wide spacing of process buildings associated with propellant manufacture. Exploratory point in Zone G will be approximately 75 m apart because it is in the Core Development Area.

Potential contamination sources in these zones are generally restricted to individual process buildings and solvent storage, athough a number of buildings in Zone I were used for ammunition storage prior to breakdown.

3.2.4. Zones J & K – Tetryl/RDX A & B (Factories II & III)

Both zones have been assigned a grid spacing of 85 m because of the generally closely spaced process buildings and number of specific potential contamination sources. Tetryl/RDX A (including the Picrite Section) is partly within the Core Development Area, but the buildings in this area are predominantly widely spaced magazines.

The potential for explosive devices is considered to be greatest in Zone K because this section was used for ammunition breakdown from the late 1950s. As part of the Stage I investigation it is proposed to carry out a limited search for explosive devices in certain parts of Zone K and selected storage areas in Zone I.

Potential contamination sources include process buildings, acid tanks, effluent lagoons, an ash dump and the main coal store

3.2.5. Zone L – Main Burning Grounds and Sewage Works

A ground investigation was conducted at the main burning ground in 1995 but, because the burning grounds have been used since then, a number of trial pits and boreholes are proposed for this investigation.

A grid spacing of 100 m has been applied to Zone L. Proposed exploratory points are concentrated in the southern part, near the burning grounds, scrap compounds, coal store, ash dumps, and areas of apparently disturbed ground. The woodland to the north of the zone is not thought to have been used by the factory and fewer exploratory points are proposed accordingly.

3.2.6. Zone M – Administration, Laboratories and Works Department

Zone M is outside explosives manufacturing/processing sections and includes the main administration building, laboratories, works department, Dargavel ponds and the Stores Yard.

A grid spacing of 125 m is deemed sufficient to characterise this Zone for the purposes of the Stage I Site Investigation

Particular potential contamination sources in this zone include, laboratory stores, hydraulic oil tanks, fuel USTs, a burning ground, laundry, and possible former mineral workings. Where necessary, additional boreholes and trial pits have been positioned to characterise these.

3.2.7. Zone O – Picrite Lagoons

This area encompasses the picrite lagoons and a large area of woodland outside the Core Development Area. The picrite lagoons were investigated in late 2002.

A number of hand augers are proposed in the woodland to provide background natural soil chemistry data.

Two exploratory points are proposed within burning ground 16/007B.

3.2.8. Zone P – Agriculture Inside Factory Fence

A grid spacing of 250 m has been chosen because of the lack of identified potential contamination sources. The samples in this zone will generally be taken to confirm the absence of contamination.

3.2.9. Zone Q – Georgetown, AFV Depot, Rail and Road Magazines

Zone Q was the subject of an extensive ground investigation in 1995. The investigation comprised 193 No. trial pits, 20 N. boreholes and 32 No. probeholes.

The 1995 investigation is considered to represent an adequate initial characterisation of this area of the Site and, therefore, extensive investigation of Zone Q is not deemed necessary.

However, a small number of potential contamination sources were identified by the 2002 desk study that were not adequately addressed during the 1995 investigation. These are areas of tipping at Nethermill Station and next to the Refuse Incinerator, and a suspected fuel tank in the AFV Depot. These areas will be subject to investigation during the Stage 1 Site Investigation.

3.2.10. Zone R – Land Outside Factory Fence

Like Zone P, the desk study identified these areas as being agricultural land throughout the factory's history. Zone R includes agricultural land to the north of the factory, Barochan Moss and Barochan Hill to the west, Gladstone Hill to the east, and the large car park outside the main gate. These areas are within the ownership of BAE Systems but are outside the factory fence. As such, these areas will be subject to investigations on a 350m grid spacing to confirm the absence of contamintion.

3.2.11. Steam Pipe Runs

The factory was served by a network of above ground lagged steam pipes. Generally, these have been removed from redundant areas of the factory and through a program of removal over the past 10 years.

Rhodar Ltd conducted a survey of the pipework in February 2002. The purpose of the survey was to identify if and where asbestos lagged pipes were used throughout the site and to quantify the lengths of pipework. Following the survey, Rhodar Ltd. prepared a report detailing their findings and the analysis of materials found.

The survey was an extensive investigation of all areas of the site. A number of samples were collected of representative materials thought to contain asbestos. Where similar materials were found in many areas, these were not routinely sampled, and the report is based on the analysis of the representative sample collected. Analysis of any material sampled was conducted by an independent UKAS accredited laboratory.

The report confirmed the presence of asbestos in lagging on much of the external pipework, the vast majority of which has since been removed using appropriate methodologies (the remainder is to be removed along with asbestos within buildings during the decontamination and remediation of the site).

In view of the above, it is considered that the potential exists for historic releases of asbestos containing materials in the vicinity of the steam pipework across the entire site as a result of accidental damage or even during the application process.

Approximately 45km of steam pipe is recorded in plans with a further 10km estimated in factory 3 (there are no plans for this area). In the absence of particular

guidance on this issue, it is considered that an appropriate investigation strategy for the steam pipe runs is to undertake investigations in the vicinity of a proportion of pipework. This would be in addition to general screening for asbestos that will be conducted on all samples submitted to the laboratory for chemical testing (approx 1200no).

The overall purpose of this phase of the investigation is to:

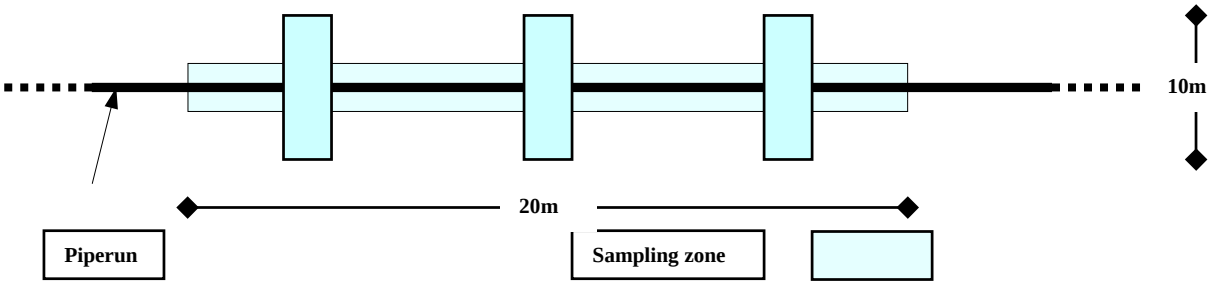
- Establish if asbestos is dispersed in soils beneath piperuns
- Furthermore to gain some information on the likely extent of such contamination

The method to be employed is to undertake a phased approach where in the first instance, sampling will be undertaken beneath 20no lengths of pipework (nominal 20m lengths) to test for bulk asbestos identification. Composite sampling (composite of 5no) along the length of the selected piperun will be employed for this phase to increase the probability of detecting asbestos fibres. This is considered an appropriate method as it is the presence and not quantity that is being determined in this phase. It is proposed to take 20 no. of these 20m lengths of piperun, at different locations across the site, which are considered to be representative of the various scenarios as follows:

- Pipework now completely removed
- Pipework in place but with non asbestos lagging (assumed to have replaced asbestos lagging)
- Pipework in place but stripped previously
- Pipework of varying diameter

Intensive sampling and analysis for bulk id will be undertaken at 3 locations where a positive result is returned from the initial exercise as follows;

- 3 cross sections perpendicular to the piperun will be taken to depth of 300mm bgl and to a distance of 5m either side of the piperun as shown pictorially below:



- Discrete sampling at each cross section at ground level, 0.1m and 0.3m at 3m and 5m distance from the piperun on each side (a total of 21 samples per cross section making a total of 63 samples per 20m length of piperun)

In consideration of the overall objectives of the Stage 1 investigation, it is considered that the scope of works outlined above will be sufficient in order to assess whether or not asbestos is of concern beneath piperuns and to allow a strategy to be developed for future investigations and remediation. If no asbestos is found in the initial phase then consideration will be taken in terms of the benefit to be gained by increasing certainty through inspection of other areas. Such considerations will be undertaken in consultation with the regulatory authorities

3.2.12. Outside Process Buildings

In addition to the sources identified in the desk study, there is also the possibility that contamination exists associated with process buildings at the site. In consideration of the objectives of this phase of investigation, it is considered that the most likely place for such contamination to exist would be in areas adjacent to entrances and exits to process buildings. The principal contaminant of concern in these areas is considered to be explosives residues, non-explosive additives and feedstocks. We therefore will undertake an additional hand sampling exercise from such areas at 85no process buildings that are thought to be representative of the many process buildings at the site (with a bias on the selection of those where there is the highest probability of finding such residues). The selection of buildings will be made based on our knowledge of the site operations and our experience in investigating similar sites.

3.2.13. Narrow Gauge Railway Inspection

Narrow gauge trucks were used to transport raw materials (acetone, acid etc.), intermediaries (paste, dough etc.) and final products. Spillages of these materials are likely to have occurred in individual production sections. Trial pits have been positioned specifically to investigate such areas. In addition there is a requirement to understand the nature and extent of propellant contamination in these areas.

The most likely place for propellant to be found is in the gun propellant sections and in the areas of the rail and road magazines. Indeed some has been observed at surface in gun propellant areas. It is therefore assumed that some remediation will be required in the areas of gun propellant along the narrow gauge tracks. Notwithstanding this, a proportion of the track within these sections will be visually inspected for propellant ‘granules’. There is approximately 34km of track in these areas and it is proposed to inspect approximately 5km to confirm the hypothesis that there is a general issue with propellant on tracks in these areas.

The possibility of propellant being present on track out with the gun propellant sections is considered to be much less based on what is known about the factory, its layout and processes. We will therefore inspect a proportion of the remaining track, which amounts to approximately 30km. Visual inspection will be undertaken of 50% of the track out with gun propellant in representative areas i.e. approximately 15km.

3.2.14. Geophysical Survey

Zone K includes the Ammunition Breakdown Section where various types of ordnance were dismantled and the explosive components removed.

An electromagnetic survey is proposed across this area to detect buried ordnance. To aid interpretation of the data obtained from the Ammunition Breakdown Section, a control site will be used where buried ordnance is not expected to be found.

A selection of anomalies from the survey will then be excavated.

4. METHODOLOGY

4.1. EXPLORATORY HOLES

4.1.1. Trial Pits

It is anticipated that the majority of exploratory points will be trial pits (approximately 450 no.), formed by conventional JCB types mechanical back-hoe excavator to a maximum depth of 4.5 m. The appropriateness of trial pits will be subject to access and reinstatement considerations. These will be used to confirm the ground conditions and allow the recovery of samples for chemical testing.

A separate trial pitting exercise will be undertaken to assess the risk of asbestos being dispersed in soils in the vicinity of steam pipes as described in section 3.2.16.

4.1.2. Boreholes

Drilling techniques will be employed to investigate the vertical extent of both made ground and natural deposits to inform the conceptual site model. Approximately 37no. boreholes will be drilled and fitted with dual purpose gas and groundwater monitoring installations. The monitoring wells will be designed so that they can be used over an extended period to allow groundwater monitoring to continue during any subsequent ground investigation and/or remediation phase.

Given the anticipated ground conditions, the majority of the boreholes will be formed by cable percussive methods to design depths of between 4 and 30 metres. Cable percussion boreholes will be followed on by rotary drilling in five holes to confirm solid geology and allow deeper groundwater installations to be constructed in the geology encountered.

Boreholes will be distributed fairly evenly around the site to provide geological and hydrogeological information. Additional boreholes will be targeted to certain areas of the site, such as adjacent to former fuel and solvent tanks.

All boreholes will be drilled using ‘clean drilling’ methods and in accordance with the BDA Guidance Notes for the Safe Drilling of Landfills and Contaminated Land. The drilling contractor chosen for the project will be BDA accredited. In addition, all siteworks will be fully supervised by a suitably qualified and experienced engineer.

4.1.3. Groundwater Monitoring Wells

Upon completion of the boreholes, combined gas and groundwater monitoring wells will be installed comprising combined gas and groundwater monitoring wells. The boreholes will be formed using clean drilling techniques to target the groundwater within the anticipated drift deposits and bedrock. Slotted, filter wrapped 50 mm diameter HDPE pipes with 10 mm inert gravel surround will be used to provide appropriate response zones.

The location of the response zone will depend upon the depth of groundwater encountered, ground conditions and other factors, such as identified or suspected contamination. Each response zone will be designed so as not to span boundaries between potentially contaminated soils, such as Made Ground and uncontaminated natural soils. As far as possible, response zones will be placed to intercept

continuous groundwater horizons beneath the site but some discontinuous (perched) horizons may be intercepted.

Where multiple groundwater units are encountered, duel installations will be constructed.

4.1.4. Hand Augering

Where access prevents the use of mechanical excavators and drilling rigs, exploratory points will be formed by hand auger techniques to approximate depths of between 0.5 - 1 m. To minimise disruption, this technique will also be used in areas of leased land which are in crop at the time of the investigation.

4.1.5. Hand Sampling

Hand sampling will be undertaken of surface and near surface materials as appropriate. This is likely to include sampling of bulk or stockpiled materials such as potential asbestos containing materials, ash stockpiles, drum contents etc.

In addition, a separate exercise of surface sampling outside a proportion of process buildings will be undertaken.

4.1.6. Surveying

The location of each exploratory point will be determined to National Grid Coordinates and its height relative to Ordnance Datum.

4.2. SAMPLING

4.2.1. General

All sampling and sitework will be conducted in general accordance with the following documents, with other guidance followed as appropriate: -

- BS10175:2001 – 'Investigation of Potentially Contaminated Sites'
- BS5903:1999, 'Code of Practice for Site Investigation'
- EA Technical Report P5-066/TR, Secondary Model for the Development of Appropriate Soil Sampling Strategies for Land Contamination'
- EA Technical Report P5-056/TR, 'Technical Aspects of Site Investigation'.
- BS ISO/5667-18 'Guidance on sampling groundwater from contaminated sites'.

The general methodologies within these documents will be followed in terms of sampling procedures to ensure sample integrity, measures to prevent cross contamination, etc and therefore these have not been reproduced in this report.

Each sample will be taken for a specific purpose, either to determine the nature of contamination or for example, to confirm that underlying strata may be regarded as uncontaminated. Samples will be representative of the location and depth from

which the sample is recovered and any specific observations will be noted by the Site Engineer.

Specific objectives of the sampling programme will be:

- To refine the initial conceptual site model
- To investigate potential pollutant linkages
- to assess the spatial and vertical distribution of contamination
- to obtain background concentrations of relevant contaminants in relatively undisturbed site soils and strata.

4.2.2. Soil Samples For Analytical Testing

Soil samples for descriptive and testing purposes will be taken at near surface, 0.3m, 0.5 m, 1.0 m, and each metre to the base of the trial pit or borehole. Additional samples will be collected where a change of strata is encountered or potentially contaminated materials, by visual or olfactory evidence, are identified.

Soil samples will be placed immediately into 1 litre amber glass jars and uniquely labelled. The sample jar will contain a Teflon liner in the cap to mitigate the loss of volatile compounds. Where possible, the sample jar will be filled to the brim to prevent the formation of a head space. Other sample containers may be used dependent upon the exact testing requirements and the advice of the laboratory will be gained to ensure appropriate sample containers are used.

An integral part of the sampling regime will be to ensure the quality and maintain integrity of the sample obtained. We will also ensure samples are not affected by soil or water falling from shallow depths.

Soil samples will be stored on site under controlled conditions before transportation to the laboratory under a strict chain of custody regime.

4.2.3. Groundwater Sampling

Groundwater monitoring of the boreholes will be conducted on 2 separate occasions to allow for differences in sampling and water level fluctuation due to infiltration. The first monitoring event will occur approximately one week after completion of site works with the second a week later. Where possible, at least one sample will be taken from each monitoring well installed during the investigation. Dependent on the analytical results, approximately half of the monitoring wells will be sampled on a second occasion.

Groundwater samples will be sampled with reference to the protocols detailed in BS ISO/5667-18 ‘Guidance on sampling groundwater from contaminated sites’. Installations will be such that groundwater samples can be recovered from each unit encountered.

Within each borehole installation, a dedicated HDPE sampling tube and foot valve will be installed (Waterra system). The system will be dedicated to each borehole and will not be removed once installed, thus preventing the potential for cross contamination.

Purging of groundwater within each borehole will be conducted using the dedicated pipe and foot valve. Three volumes of water will be removed from the standpipe prior to sampling to ensure that only fresh groundwater is sampled. Where the borehole does not yield three volumes it will be pumped to effective dryness and sampled once the water level has recovered. Prior to purging, the static groundwater level will be established by the use of an electronic dip meter with interface probe.

Once purging is completed and the groundwater level recovered, sampling will be conducted using the dedicated sampling tube or disposable bailer.

Where the presence of free product is suspected then an oil water interface meter will be used and the sampling protocol for such groundwaters will be altered such that the sample(s) obtained reflect the objectives of the investigation.

Parameters such as pH, temperature and conductivity will be measured in situ using hand held probes to establish stable chemical conditions.

As part of BAE Systems Environmental BSI ISO 9001 accreditation, before use all field equipment will be quality checked in accordance with the manufacturer's recommendations.

Procedures will be followed to mitigate the potential for cross contamination. Probes will be washed in distilled water before taking measurements in each subsequent sample.

The analytical laboratory will provide a selection of containers dependent upon the parameters proposed for testing. These containers will contain appropriate preservatives, where necessary, to maintain sample integrity.

Water samples will be stored on site in a refrigerator before transportation to the laboratory under a strict chain of custody regime.

4.2.4. Gas Monitoring

Measurements of common constituents of soil gas i.e. methane (CH_4), carbon dioxide (CO_2), oxygen (O_2) and hydrogen sulphide (H_2S) will be conducted within the standpipes on four occasions and in differing atmospheric conditions (including at least one at low atmospheric pressure conditions. Gas flow measurements will also be recorded. At present, it is not anticipated that sampling and laboratory analysis of soil gas samples collected from the standpipes will be carried out.

4.3. WORKING PRACTICES

4.3.1 CDM Regulations

The Stage 1 Site Investigation will be managed in accordance with the requirements of the Construction (Design and Management) Regulations 1994. BAE Systems Environmental has considerable experience in the capacity of designer, planning supervisor and principal contractor in the implementation of site investigation work and will provide the services necessary to comply with the CDM regulations.

4.3.2 Environment

All site works will be planned and implemented to minimise the effect on the environment. Pollution prevention measures will be employed as required and with regard to relevant SEPA pollution prevention guidance notes.

A spill kit will be kept with the supervising engineer, close to each exploratory hole location being excavated, to minimise any impact on the environment from accidental leakages of spillages from the plant and equipment being used.

Any refuelling activities of plant and equipment will be conducted in a designate area on site with suitable containment.

The site works will be conducted between the hours of 8 am and 6 pm during local light hours, Monday to Friday.

4.2.3 Services

BAE Systems Environmental will follow the guidance and requirements given in the HSE publications HS (G) (6) and HS (G) 47 to detect and avoid services. Factory service plans have been obtained and inspection pits will be dug at the location of each cable percussive borehole under the supervision of BAE Systems Environmental personnel.

4.2.4 Site Induction

At the start of the project, and whenever new personnel are to work on the project, all personnel will undergo a suitable site induction regarding health and safety and procedures, particular requirements for working at the Bishopton site (due t the current explosives licence) and to mitigate harm to the environment. All Site Personnel / Site Visitors will acknowledge receipt of the Site Induction in writing.

4.2.5 Quality, Health and Safety Issues

The works outlined above will be undertaken based upon the guidance within BS 10175:2000 ‘Code of Practice for the Investigation of Potentially Contaminated Land’ and with regard to other guidance considered to be good practice such as:

- A Guide for Safe Working on Contaminated Sites, CIRIA R132.
- Protection of Workers and the general public during the development of contaminated land Health and Safety Executive, 1991.

The general methodologies within these documents will be followed in terms of sampling procedures to ensure sample integrity, measures to prevent cross contamination, etc and therefore these have not been reproduced in this proposal.

We propose to use subcontractors for the drilling and trial pitting and some analysis. As part of our Quality Management procedures, subcontractors and suppliers are individually assessed to ensure that they meet the required quality, safety and environmental standards. All drillers used will be BDA accredited.

Detailed protocols (Method Statement and Health and Safety Plans including Risk Assessments and COSHH forms) for the works will be produced prior to the commencement of the site works.

5. LABORATORY TESTING

BAE Systems Environmental possesses its own modern, well equipped laboratory specialising in the quantitative analysis of soil and water samples for a wide range of conventional contaminants and covers the analysis of defence related contaminants which many other laboratories do not.

Our laboratory holds UKAS accreditation for the majority of analytical tests including explosives to the new BS EN ISO/IEC 17025 (UKAS Testing 1764) and has recently achieved MCERTS accreditation for many of the tests including explosives, sulphur, TPH and PAH. In addition, the laboratory participate in proficiency testing schemes including CONTEST.

It is propose that the majority of soils testing will be undertaken by our own laboratory with subcontract work (including waters) being undertaken by one of our approved suppliers.

The exact analytical suite for each sample will be decided upon whilst on site dependent on the following:

- the former activities carried out in the zone as a whole;
- the presence of nearby contamination sources such as tanks, ash dumps and steam mains; and,
- any observations made during excavation or sampling.

The substance tested will include any or all of the following:

Explosives		
• Nitrocellulose	• Nitroglycerine	• Picric acid
• HMX	• TNT	• 2,6-DNT
• RDX	• PETN	• 2,4-DNT
• EGDN	• HNS	
• Tetryl	• Picrite	
Metals, semi-metals, non metals		
• Arsenic	• Zinc	• Vanadium
• Cadmium	• Boron	• Tin
• Chromium	• Barium	• Molybdenum
• Lead	• Antimony	• Calcium*
• Mercury	• Aluminium	• Sodium*
• Selenium	• Magnesium	• Phosphorus
• Copper	• Molybdenum	• Nickel
• Beryllium	• Potassium*	• Sulphur
• Boron (WS)	• Iron*	
Inorganics		
• Sulphide	• Sulphate	• Chloride*

• Nitrate*	•	•
Organics		
• PAHs (speciated)	• TPH (speciated)	• SVOCs
• VOCs	• PCBs	• Dioxins and Furans
• Pesticides		
Other		
• Asbestos (presence/absence/id/quantification to levels of 0.001%)	• pH	• TOC*
• COD/BOD*	• Alkalinity*	• Ammoniacal nitrogen*
•		

*water analysis only

It is envisaged that approximately 2 No. samples will be analysed from each trial pit and 3 No. from each borehole. In addition, a number of hand samples and samples specifically sampled for asbestos content will be scheduled.

As a minimum, every sample of Made Ground will be tested for explosives prior to analysis for conventional contaminants. This will ensure that further analysis can be carried out safely as well as determining the extent of any potential explosives contamination at the Site.

The majority of soil samples will be analysed for suite of metals, pH, PAHs, asbestos and a range of inorganic species. Analysis for metals such as barium, phosphorus, vanadium, molybdenum and tin will be carried out on a proportion of samples dependant on the location of the sample and any observations made. Analysis for organics such as TPH, VOCs, SVOCs and PCBs will be carried out on the same basis.

Analysis of soil leachate will be carried out on approximately 20% of samples. These samples will generally be chosen at random so as to be representative of the various types of material encountered. Some may be scheduled due to particularly high ash content.

At least one water sample from each monitoring well will be analysed for the suite of determinands listed in the previous table. A second sample will be taken from a proportion of monitoring wells and tested for a suite dependant on the results of the first sample.

6. REPORTING

The ground investigation data will be reported as follows and will be available in hard copy as well as in electronic format. Much of the information can be made available in ArcView GIS format such that the raw data can be easily accessed and manipulated as may be required/desirable by the regulators.

A comprehensive factual report will be prepared with general introduction and description of the rationale behind the investigation design and description of the site works. Each zone will then be reported as a separate section with a summary of overall ground conditions also included.

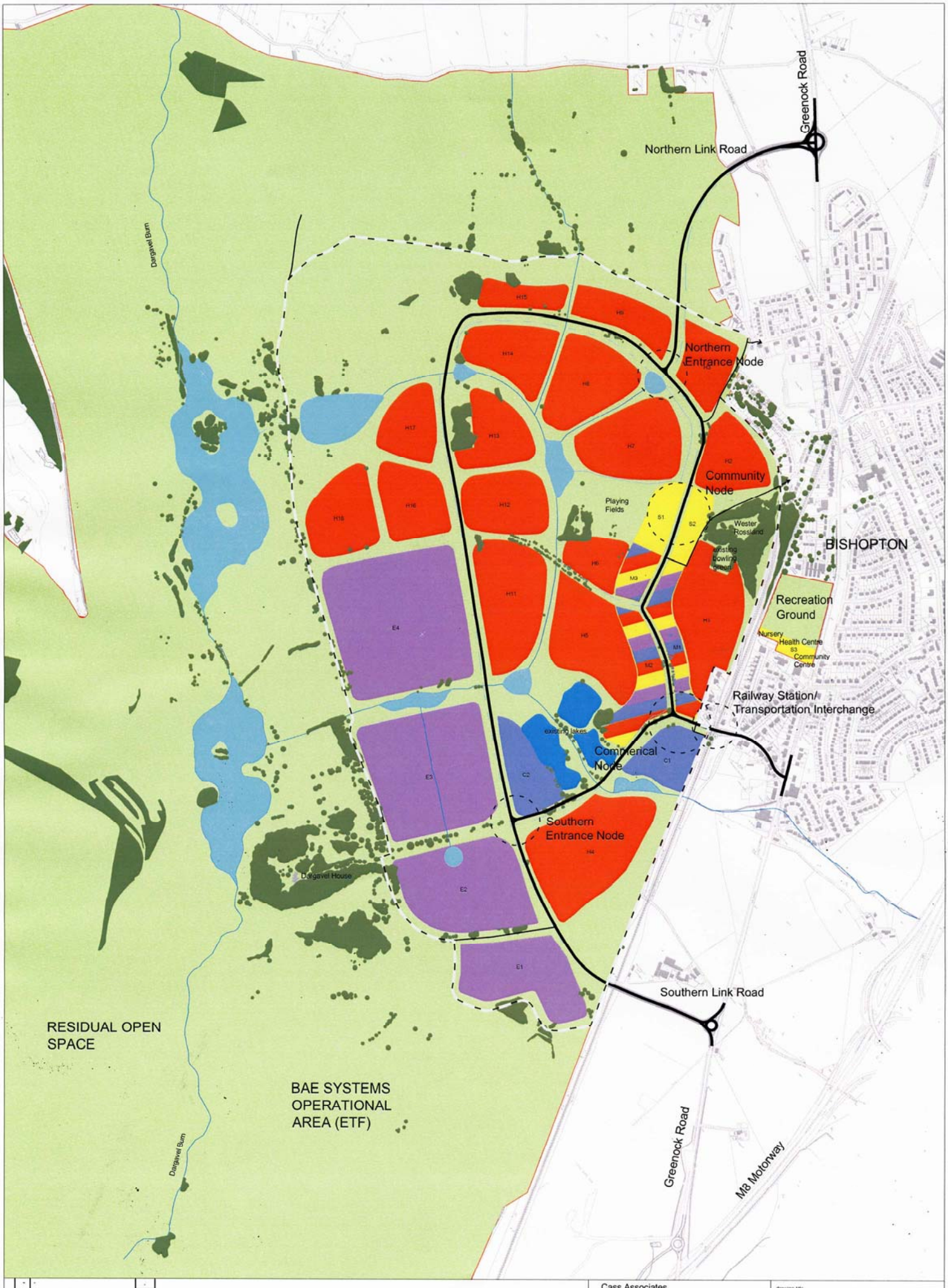
The interpretative report will be prepared based on the results of the investigation together with the existing data derived from previous targeted investigations. The data will be presented such as to provide a detailed initial conceptual model of the Site highlighting identified/potential sources, pathways and receptors. A tier 1 assessment of results will be undertaken using either published or derived assessment criteria with a view to establishing the presence of pollutant linkages. Justification will be provided for the use of assessment criteria and where such criteria have been derived by BAE Systems Environmental, information will be made available to the regulatory authorities in relation to how they have been formulated. The assessment criteria used will be agreed with the regulatory authorities. A preliminary assessment of the significance of the identified pollutant linkages will be undertaken and the key risk drivers for redevelopment will be highlighted.

An assessment will be made of the additional works required in the main investigation such that the significance of identified pollutant linkages can be assessed and quantified. The scope of additional works to be undertaken beneath structures upon completion of decontamination and demolition phases will also be presented.

Appropriate remedial treatment options will be assessed based upon the preliminary assessment of key risk drivers derived from the Stage 1 Site Investigation. This will allow development of the outline remediation strategy to support the planning application.

Appendix 1

Proposed Land Use Plan



REVISIONS

- Housing
- Commercial
- Community
- Employment
- Development Boundary
- Distribution Road
- Local Access
- Water

Cass Associates
Studio 104 The Tea Factory
82 Wood Street Liverpool L1 4 DQ
Tel 0151 707 0110 Fax 0151 707 0332
Email: all@cassassociates.co.uk

ROYAL ORDNANCE BISHOPTON
PLANNING

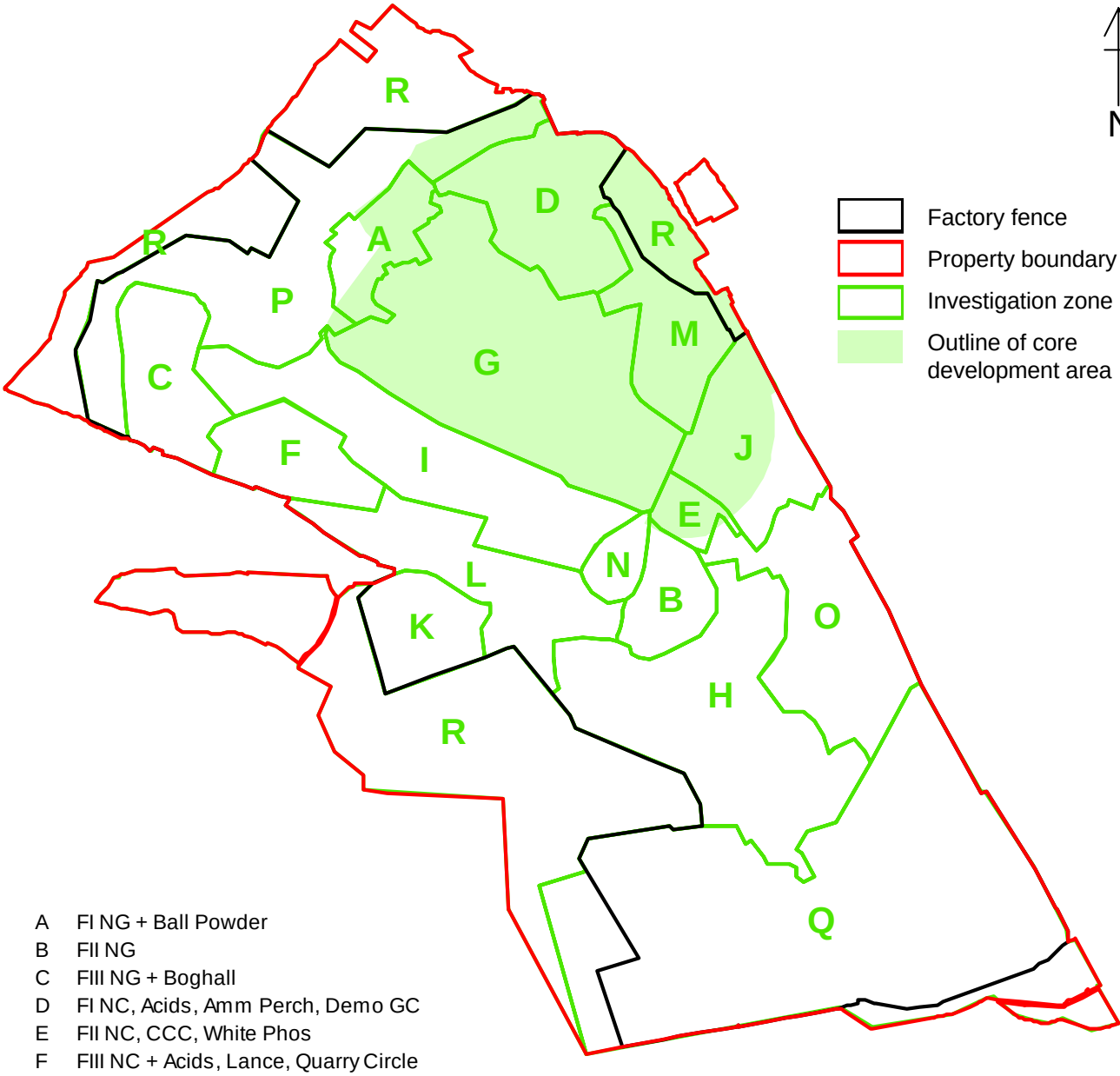
drawing title: Landuse Plan

scale 1:10000@A3
date 28.09.04
drn CC

715/14
REVISION

Appendix 2

Site Investigation Zones



A FI NG + Ball Powder
B FII NG
C FIII NG + Boghall
D FI NC, Acids, Amm Perch, Demo GC
E FII NC, CCC, White Phos
F FIII NC + Acids, Lance, Quarry Circle
G FI/III GP in Development Zone
H FII RP + ETF
I FI/III GP outside Dev Zone
J Picrite, RDX/Tetryl A, FII Acids
K Ammo Bdown, RDX/Tetryl B
L Main Burning Ground
M Admin, Lab, Works Dept
N Dargavel House
O Picrite Lagoons
P Agriculture inside Factory Fence
Q Georgetown
R Outside factory fence

FIGURE TITLE :

Site Investigation Zones

PROJECT :

Stage I Site Investigation Bishopton

REPORT NUMBER :

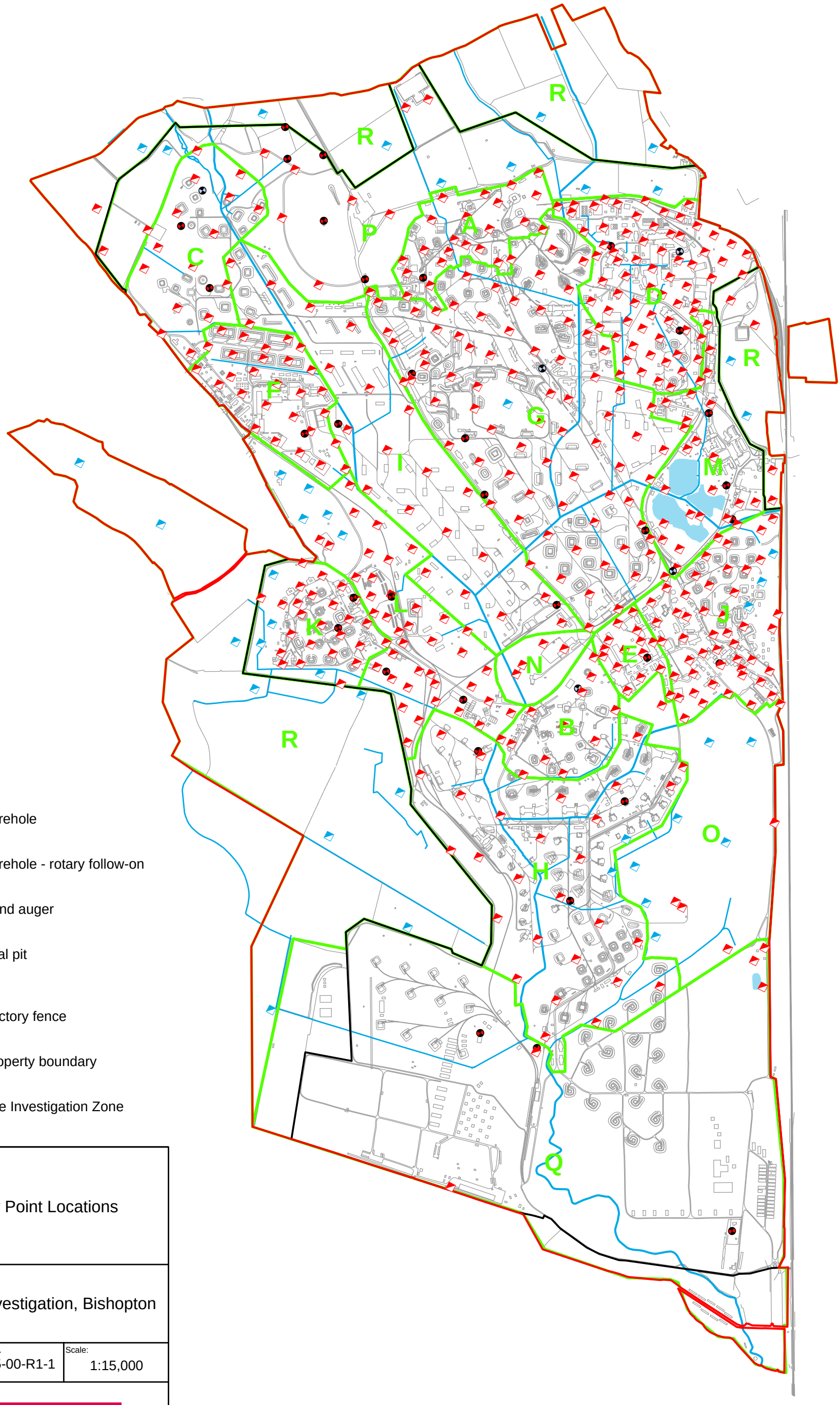
A385-00-R1-A

BAE SYSTEMS

Zone			Within Core	Grid	No. of Trial pits		No. of
	Description	Area (ha)	Dev. Area	Spacing (m)	Calculated	Actual	BHs
A	FI NG + Ball Powder	17	Partly	100	20	23	1
B	FII NG	15	No	150	9	10	1
C	FIII NG + Boghall	26	No	150	15	15	3
D	FI NC, Acids, Amm Perch, Demo GC	36	Wholly	75	71	69	3
E	FII NC, CCC, White Phos	7	Partly	75	15	15	1
F	FIII NC + Acids, Lance, Quarry Circle	21	No	100	26	28	1
G	FI/III GP in Development Zone	100	Wholly	125	72	77	4
H	FII RP + ETF	80	No	175	31	31	3
I	FI/III GP o/s Dev Area	58	No	175	23	22	2
J	Picrite, RDX/Tetryl A, FII Acids	31	Partly	85	49	50	1
K	Ammo Bdown, RDX/Tetryl B	20	No	85	32	29	2
L	Main Burning Ground	40	No	100	47	45	3
M	Admin, Lab, Works Dept	24	Wholly	125	19	22	4
N	Dargavel House	7	No	150	5	4	0
O	Picrite Lagoons	49	No	200	16	13	0
P	Agriculture inside Factory Fence	69	Partly	250	14	15	5
Q	Georgetown	196	No	NA	0	5	3
R	Outside factory fence	198	Partly	350	20	21	0
Total		**995**			**484**	**494**	**37**

Appendix 3

Exploratory Point Location Plan



Borehole

Borehole - rotary follow-on

Hand auger

Trial pit

Factory fence

Property boundary

Site Investigation Zone

Figure Title:

Exploratory Point Locations

Project:

Stage I Site Investigation, Bishopton

Project No:	Report No.	Scale:
A385-00	A385-00-R1-1	1:15,000

BAE SYSTEMS

BAE Systems Environmental
Westcott, Aylesbury, Bucks, HP18 0NP
Tel. 01296 652124 Fax. 01296 652121