

# BAE SYSTEMS Environmental Outline Remediation Strategy

Bishopton

Redrow Group & BAE Systems Property Investments Ltd

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# Outline Remediation Strategy

## Bishopton

### Redrow Group & BAE Systems Property Investments Ltd

#### DOCUMENT CONTROL

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INVESTORS IN PEOPLE

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## **1. INTRODUCTION**

### **1.1. Instruction**

BAE Systems Property Investments Ltd and Redrow Group entered into a legal agreement in relation to the redevelopment of the former Royal Ordnance site in Bishopton.

Under the agreement, on 15 June 2004 BAE Systems Property Investments Ltd appointed BAE Systems Environmental (a trade name of BAE Systems Properties Ltd) to act as Remediation Consultants for the project.

The scope of this commission was to undertake preliminary site investigations and develop an outline remediation strategy.

### **1.2. Context and Objectives**

The former Royal Ordnance factory in Bishopton ceased manufacturing in 2002 and proposals were prepared by BAE Systems (the owners) and Redrow (development partner in the project) to bring the Site back into beneficial use. It was proposed to regenerate and remediate the Site using redevelopment as the enabler. The extent of the Site is shown in Figure 1.

The regeneration plan for the Site is outlined in the Masterplan Statement (Cass Associates, 2006) and includes mixed-use development including residential, commercial, employment, community and recreational open space end uses (Figure 2). The Core Development Area occupies approximately 24% of the Site area, and is situated in the north-eastern part of the Site, adjacent to the existing Bishopton village. An area in the south-east of the Site will be retained by BAE Systems for the continued operation of the Environmental Test Facility (Retained Land). The majority of the remainder of the Site is planned as Recreational Open Space (ROS), although the exact uses and management plan for this area is in development.

In view of the Site's 80 year industrial history, remediation is required in order to make the Site suitable for its proposed next 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 an outline remediation strategy to support the application for outline planning for the redevelopment. This has been informed by the undertaking of various site investigations and subsequent quantitative risk assessments as detailed in reports prepared by BAE Systems Environmental 2006.

### **1.3. Remediation Strategy Overview**

This document presents the outline remediation strategy proposed to ensure that the Site is suitable for its proposed new use(s) as detailed in the Masterplan Statement (CASS, 2006). It provides broad principles to be applied in the remediation in terms of the methods to be employed and general requirements for mitigation of ecological disturbance and health, safety and environmental controls to be employed during the works.

In view of the scale of the remediation, a detailed planning application will also be made to Renfrewshire Council a few months after the outline planning application has been submitted. This will be supported with a Draft Detailed Remediation Strategy at that

time in terms of the phasing of the works, estimates of quantities of materials involved and confirmation of the actual working practices and procedures to be employed. The final Detailed Remediation Strategy will be completed following the undertaking of further site investigations and will be agreed with the Local Authority prior to implementation of the plan. This approach has been agreed with the local authority.

#### **1.4. Remediation Strategy Basis**

Remediation in this context is in its widest sense and includes preventing or minimising, remedying or mitigating the effects of the contamination, or monitoring of the condition of the land. The Outline Remediation Strategy for the Site is based on the findings of the Generic Quantitative Risk Assessment Report (BAE Systems Environmental, 2006) where risks were identified to human health and the water environment (as a result of land contamination) that require remediation. This report should therefore be read in conjunction with the following documents:

- Preliminary Risk Assessment for Land Contamination, Desk Study, Bishopton (BAE Systems Environmental 2005)
- Stage 1 Site Investigation Outline Strategy, (BAE Systems Environmental, 2005)
- Factual Report, Bishopton, (BAE Systems Environmental, 2006)
- Generic Quantitative Risk Assessment Report (GQRA), Bishopton, (BAE Systems Environmental, 2006)

It should be noted that there is a further stage of intrusive investigation planned to take place following the gaining of outline planning consent (although this may be brought forward as enabling works as described in section 7.2). These works are designed to further delineate contamination sources, assess the significance of identified pollutant linkages and to fill data gaps as detailed in the GQRA report. The details of the proposed works can be found in the following document:

- Stage 2 Site Investigation Outline Strategy, (BAE Systems Environmental, in preparation)

The findings from the Stage 2 Site Investigation will allow the development of a detailed remediation strategy.

In addition to land contamination issues, a significant proportion of the Site buildings have been used for explosive processes which may have resulted in:

- accretions of explosives in floor and wall cracks, ducts, and drains.
- explosive dusts deposited on surfaces.
- absorption of explosive liquids and vapours by building materials.
- the presence of traces of explosive materials in disused plant within buildings.

However, there is a number of other above ground issues that also require remediation.

There are also a high proportion of buildings that also contain asbestos containing materials that will require removal. The proposals to deal with these particular contamination issues are also included in this report.

The strategy has been developed in accordance with the guidance provided in CLR11 Model Procedures for the Management of Land Contamination (DEFRA and Environment Agency 2004.). This document is considered to represent UK industry good practice.

## 1.5. Remediation Strategy Objectives

In preparing the Remediation Strategy, a number of key objectives have been taken into consideration. These can be split between management objectives and technical objectives as follows:

### ***Management objectives***

- To produce a remediation strategy that can be agreed with all key stakeholders
- To meet all regulatory requirements applicable to the development on contaminated land i.e. PAN33 (Scottish Executive 2000) and to consider the views of key stakeholders on how unacceptable risks should be managed.
- To meet all regulatory requirement during the implementation of the remediation options
- To avoid unacceptable health and safety and environmental impacts during remediation
- To carry out remediation in accordance with good technical practice
- To achieve successful phased remediation within the timescales required by the development and at a cost that is commensurate with the level of revenue generated though the development proposed.

### ***Technical Objectives***

- The remediation options employed must be effective in reducing or controlling the risk;
- The remediation options must be feasible and practical taking into consideration factors such as the ground conditions, environmental setting, ecological issues and the phasing of the development;
- The remediation options employed must be durable and provide a robust solution over the lifetime of the project (and beyond)
- Sustainability of the strategy in terms of how it fits other environment objectives e.g. habitat enhancement, use of natural resources, and avoids or minimises adverse environmental impacts e.g. transportation, water environment, air, off site landfill
- To consider the additional benefits of the strategy in terms of enhancement of amenity and ecological value

## 1.6. Requirements of the Development

In order to develop an appropriate remediation strategy it is necessary to consider the future use of the Site. The proposed regeneration of the Site will result in areas of land with the following intended future uses (see Figure 2):

### Core Development Area (CDA)

- Residential (mixed type; with and without gardens)
- Community facilities (e.g. school, health centre)
- Leisure / recreation (e.g. parks/playing fields within the development area)
- Commercial and Employment
- Publicly Accessible Open Space

### Recreational Open Space (ROS)

- Recreational uses not yet fully defined
- Ecological and woodland park
- Landfill
- Agricultural

### Retained BAE Systems land (RL)

- Existing BAE Systems' Environmental Test Facility and surrounding area

The remediation options employed will be relevant to the intended future uses outlined above, ensuring that remediated land is suitable for its next use.

## 1.7. Legislative Framework

For an assessment in support of a planning application for a change of use the relevant guidance is Scottish Executive PAN33 – 'Development of Contaminated Land'. PAN33 directs planning authorities to be aware of the provisions of Part IIA of the Environmental Protection Act 1990 and to ensure that their decisions are consistent with it.

Therefore, in the context of the redevelopment, it would be unacceptable if there were any pollutant linkages that meant that the Site would meet the statutory definition of 'contamination land' under Part IIA, i.e.

"any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that -

- (a) significant harm is being caused or there is a significant possibility of such harm being caused; or
- (b) significant pollution of the water environment is being caused or there is a significant possibility of such pollution being caused."

It should be noted that the statutory definition above is the revised definition as amended by The Contaminated Land (Scotland) Regulations 2005 (SSI 2005/658), which were fully implemented on 1 April 2006.

## 1.8. Current Planning Status

This report supports the Outline Planning Application for a mixed use development as described in the Masterplan Statement (CASS, 2006). The site is of strategic importance and is referred to in a number of national and local plans.

The National Planning Framework was published in 2004 by the Scottish Executive and provides a framework to guide the spatial development of Scotland to 2025. Bishopton is specifically identified as the preferred location for long-term expansion to the west of Glasgow: "Good transport connections make Gartcosh and Bishopton the preferred locations for long-term expansion to the east and west of Glasgow." [Paragraph 155].

Strategic Policy 1 of the Glasgow and the Clyde Valley Joint Structure Plan Alteration 2006 designates the site as a Community Growth Area. A proposal for a Community Woodland Park at Bishopton is included as a strategic greenspace project for the Structure Plan's Green Network.

The Local Plan states that "there are a number of areas of potential change, and development opportunity sites, where co-ordinated action is required or which are of a size and nature which make them a high priority for Renfrewshire Council. There will be a presumption in favour of the redevelopment of these brownfield sites, provided such redevelopment is consistent with the principles of sustainable development and accords with the policies of the structure and local plan." (paragraph 2.14) One of these sites is Royal Ordnance Bishopton.

## **2. SITE BACKGROUND AND ENVIRONMENTAL SETTING**

This section provides a summary of the Site's history and physical setting. Reference should be made to the Preliminary Risk Assessment for Land Contamination (PRALC), (BAE Systems Environmental, 2005) and Factual Report (BAE Systems Environmental, 2006) for further details.

### **2.1. Site Details**

Prior to development the Site was predominantly agricultural land.

Industrial development of the Site can be divided into two eras, the first being the Scottish Filling Factory ('Georgetown') operational during the First World War.

Georgetown, an ordnance filling factory, occupies approximately 194 ha in the southern part of the Site, within the factory fence. Structures associated with the Georgetown factory were demolished shortly after the Second World War (WWII) and the area is now predominantly wooded with some incidental evidence of former infrastructure remaining.

The Royal Ordnance factory was built from 1937 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 production until 2002.

The Royal Ordnance 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 has varied over the years. Of particular note were 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.

The Royal Ordnance factory ceased manufacturing in 2002 and the Site is currently owned by BAE Systems.

### **2.2. Site Description**

The Site is located to the south-west of Bishopton village in Renfrewshire, Scotland, approximately 15 km west of Glasgow city centre. The Site is centred on National Grid Reference (NGR) NS 433 691.

The Site is roughly rectangular in shape and occupies an area of approximately 1005 hectares (ha). The land surrounding the Site (with the exception of Bishopton village to the north west) is predominantly agricultural, being a mix between arable, pasture and woodland.

Some 766 ha of the Site is securely fenced and contains the former Royal Ordnance factory, accessed via Station Road, Bishopton. The 230 ha of land between the factory fence and the Site boundary is predominantly arable and pasture land except for Barochan Moss, an area of afforested peat. The arable and pasture land within the BAE Systems ownership is leased to local farm businesses.

The centre and south of the Site is generally flat lying at between 5 and 15 metres above Ordnance Datum (m.AOD). The land rises steeply in the north and north-west of the Site to elevations of around 60 m.AOD.

There are currently some 1,300No. buildings remaining on site and of these some 80No. fall within the Retained Land area (21 of which are actually in use). In addition, there are a number of other structures such as around 105No. 'save-alls'/ponds/lagoons/burning grounds/ etc. and around 775No. slabs of former buildings previously demolished.

The Site also has other infrastructure such as some 16.60 km of external fence, 330km of roads, 73km of narrow gauge rail route, 27km of standard gauge rail route and 575 km of water main.

## **2.3. Geology and Soils**

### **2.3.1. Made Ground**

Made ground was encountered in every zone from approximately 0.2 to 2 m.bgl. Two types of made ground were found, the first generally comprised fragments of brick, blaes, glass, metal, ash, concrete and other anthropogenic materials. The second was reworked natural material comprising mainly natural sands, silts and clays with minor constituents of anthropogenic materials.

### **2.3.2. Superficial Deposits**

Natural superficial deposits were encountered in most exploratory holes and were found to extend over the entire Site with the exception of relatively small areas in the northwest, northeast and east where bedrock is at or near the surface. Superficial deposits encountered belonged to the four geological formations listed below:

- Clippens Peat Formation – spongy fibrous dark brown/reddish brown peat
- Killearn Formation – brown silty gravelly sand
- Linwood/Paisley Formations – soft light brown/orange mottled slightly sandy silt frequently containing plant remains
- Wilderness Till Formation – stiff to very stiff brown/dark grey gravelly clay with some cobbles and boulders of mixed lithology

The descriptions given above are typical of materials encountered on site although colours, strengths and textures were found to vary slightly depending on the location of the material.

Glacial till of the Wilderness Till Formation (Fm.) was found on higher ground particularly in the north of the Site and near the eastern and western boundaries of the northern half of the Site.

In the lower-lying central and southern areas the till was overlain by glaciomarine silts and clays of the Linwood Fm. and underlying Paisley Fm. (These deposits were practically indistinguishable from each other in the field so are referred to in this document as Linwood/Paisley Fm.)

The interface between till and the glaciomarine silt was often marked by beach/deltaic sands and gravels of the Killearn Fm, which were found overlying both the Wilderness Till Fm. and the Linwood/Paisley Fm.

Peat of the Clippens Peat Fm. was found on low lying land in the east and west in the southern half of the Site.

Figure 3 shows the superficial geological map of the Site, which was constructed using the findings from exploratory points.

### **2.3.3. Bedrock**

Bedrock outcropped mainly in the northwest and northeast corners of the Site and comprised volcanic rocks of the Upper Carboniferous Clyde Plateau Volcanic Formation.

The bedrock of the lower lying areas is described in published maps as comprising interbedded sandstone, mudstone, limestone and coal of Upper Carboniferous age (Lawmuir Fm., Limestone Coal Fm. and Lower Limestone Fm.).

The Upper Carboniferous strata are shown by published maps to be intruded by two quartz-dolerite dykes and displaced by a number of predominantly east-west trending faults.

## **2.4. Hydrogeology**

### **2.4.1. Bedrock Aquifers**

The Clyde Plateau Volcanic Fm. is indicated by published maps to have low productivity (0.1 – 1 l/s) arising from fracture flow. The Carboniferous sedimentary rocks are indicated to be moderately productive (1 – 10 l/s) comprising both fracture and intergranular flow.

The regional flow pattern of deeper groundwater associated with the solid geology has not been determined due to the limited information available.

The Scottish Environment Protection Agency (SEPA) have advised that according to BGS records, Messrs J. Craig, Barr and Cook own a disused borehole located on Old Bishopton Estate. This tapped the Carboniferous, Calciferous Sandstone Measures. Although there is no information available concerning yield or water quality, SEPA advise that the presence of this borehole suggests that the aquifer has been important locally.

### **2.4.2. Superficial Aquifers**

Groundwater was encountered in boreholes at depths of 0.26 to 3.34 m.bgl with the exception of one relatively shallow borehole that was dry. In the south of the Site bedrock is overlain by significant thicknesses of low permeability superficial deposits.

Groundwater levels encountered in boreholes were used to map the general direction of shallow groundwater flow for the Site. Flow was found to have no apparent regional characteristics and with few exceptions the flow within the Site follows topography towards the main watercourses. The only exceptions to this are in the east and south of the Site. In the east of the Site there is an area where groundwater is flowing out of the Site, possibly as a result of an inactive drain, which has resulted in a boggy area of land close to the Site boundary. In the south of the Site, near the location where Dargavel Burn exits the Site, groundwater flow was shown to be in an east-southeasterly direction.

The Superficial Deposit Aquifer Productivity Map (BGS, 2004) indicates that the superficial deposits are moderately productive and flow is intergranular.

### **2.4.3. Groundwater Vulnerability**

The Site is classified by SEPA as 'vulnerability category 2', which is defined as 'vulnerable to some pollutants, but only when continuously discharged/leached'. It should also be noted that in areas where fractured igneous bedrock is exposed at the surface the highest category of vulnerability should be applied. This is defined as 'vulnerable to most water pollutants with rapid impact in many scenarios' and is due to the absence, under these circumstances, of intergranular flow.

## **2.5. Hydrology**

Dargavel Burn runs through the centre of the Site flowing into the River Gryffe at the southernmost tip of the Site. Along its length the Burn is joined by numerous ditches, drainage pipes, former process water drains and small streams, some of which emanate from outside the factory boundary. The main tributaries that flow through the Site into Dargavel Burn include Craighton Burn, Cordite Burn and Picrite Drain.

The SEPA database suggests that the Dargavel Burn upstream of the Site has an overall classification of 'A2' (good).

The majority of surface water at the Site eventually drains into Dargavel Burn and leaves the Site at the southern boundary. The western edge of the Site may drain around Southbar landfill into Lin Burn.

## **2.6. Ecological Constraints**

Aspects of the Site ecology have been examined over several years, with some areas, some species and some habitats examined to a greater degree, depending on the source and particular reason for the survey. This information, which includes casual survey by a visiting wildlife interest group, the regional Phase 1 Habitat survey and a close examination by Dr R. Stebbings of the 'Georgetown' area of the Site, were used initially to build up a picture of the habitats, species, and the ecological dynamics of the Site. Subsequent, more systematic surveys concentrated on rare/protected species and habitats. This work was directed at establishing the locations and dynamics of these species in relation to the Site habitats and certain Site features, including the drainage system and built structures, identified as the areas where there was likely to be greatest conflict with wildlife interests during the proposed remediation and development. Details of all these surveys can be found within the Environmental Statement (CASS Associates, 2006)

The following species (and in some cases their habitats) have been identified as being present at the Site and have been considered in the selection of appropriate remediation options:

- Resident and migratory birds (including barn owls)
- Bats
- Otters
- Badgers
- Water Voles

- Mink
- Aquatic species

## **2.7. Archaeological Constraints**

The site archeological interest has been documented in the Environmental Statement (CASS Associates 2006). The Environmental Statement outlines the key issues and potential for impact on both standing buildings and below ground archeology. It is proposed that a Site Archaeological Handbook (SAH) be adopted as the management system for the development proposal. The SAH applies an overarching strategy for handling the archaeological elements of the site so that work can be structured and managed efficiently and more effectively. The advantage that the SAH has over a more fractured approach is that the archaeological mitigation for the whole development is clearly defined at the beginning of the project in the SAH and agreed upon by all interested parties, negating the requirement for changes ten years down the line.

An outline of the SAH will be prepared and submitted in support of and to inform the detailed planning application for Remediation and Earthworks and its contents will be taken into account in the preparation of the Draft Detailed Remediation Strategy.

### 3. SUMMARY OF RELEVANT POLLUTANT LINKAGES

#### 3.1. Introduction

The remediation strategy has been developed to deal with unacceptable risks identified at the Site in relation to its proposed new use. In the context of land contamination, there are three essential elements to any risk:

- **Source** – a substance which is in, on or under the land and has the potential to cause harm or to cause pollution of the water environment
- **Receptor** – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system or a water body, and
- **Pathway** – a means by which a receptor can be exposed to, or affected by, a contaminant.

The term pollutant linkage describes the inter-relationship between a particular source and receptor and the linkage between them. All three elements of the linkage must therefore be present for a risk to exist. If one of the elements of the pollutant linkage is absent, there can be no risk.

Once the presence of a pollutant linkage has been established, the next step is to determine its significance through risk assessment.

#### 3.2. Data used in Risk Assessment

Previous investigations have taken place in localised areas of the Site as shown in Table 1. However, the most comprehensive investigation was the Stage 1 Site Investigation undertaken between 6 June and 4 October 2005.

The principal objectives of the investigation were:

- 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

These objectives were achieved by characterising the potential contamination sources and their related pathways and receptors as identified by the desk study. In addition, the investigation provided a degree of confidence that any unexpected or unknown potential contamination sources had been detected. The investigation was designed to supplement the existing information gained through previous targeted investigations and monitoring. Full details of the investigation strategy are presented in the Investigation Strategy Report (BAE Systems Environmental, 2005)

For the purposes of the investigation the Site was divided into 18 No. zones (A to R) based on the locations of former manufacturing sections and, to a lesser extent, the outline of the Core Development Area.

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 was independent of the proposed land use. However, in terms of remediation activity and criteria, these will be based on the actual use proposed for each area.

The Stage 1 Site Investigation included the following works to supplement the existing data:

- Excavation of 770 No. exploratory points
- Visual inspection of 16 km of narrow gauge railway.
- Collection of 28 No. surface water samples and 90 No. groundwater samples
- Geophysical survey of 1.6 ha and subsequent excavation of anomalies
- Laboratory chemical analysis of 1529 No. soil samples and 118 No. water samples
- *In-situ* and laboratory geotechnical tests

The analytical suite for each sample was determined based 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.

In addition, a number of other investigations have been undertaken in particular areas of the Site as follows:

Organisation	Report Title/Purpose of Investigation	Exploratory Holes	Testing
Aspinwall & Co., 1989	Investigation into Location of Picrite Lagoons	13 TP, 14 PH	Soil and water analysis.
RO ESG, 1995	Analysis of Groundwater – Picrite Lagoons	10 BH	Soil and groundwater analysis. Geotechnical.
RO ESG, 1995	Preliminary GI for Contamination at the Burning Grounds	23 TP	Soil and groundwater analysis.
RO ESG, 1996	SI and Remediation Strategy – Georgetown	20 BH, 193 TP, 32 PH	Soil and groundwater analysis. Geotechnical.
BAE SYSTEMS Environmental Services, 2002	Perimeter Groundwater Monitoring Boreholes	24 BH	Groundwater analysis. Geotechnical.
BAE SYSTEMS Environmental Services, 2002	Boghall Dump, Burning Ground 16/007J and 'Vegetation Tip'	14 TP	Soil analysis.
BAE SYSTEMS Environmental Services,, 2003	Preliminary Site Investigation, Picrite Lagoons	7 PH 27 HA	Soil and surface water analysis.

Organisation	Report Title/Purpose of Investigation	Exploratory Holes	Testing
BAE SYSTEMS Environmental Services, 2003	Preliminary Geotechnical SI	11 TP, 9 BH, 85 PH	Soil, water and geotechnical analysis.
BAE Systems Environmental, 2006	Stage 1 Site Investigation	441 TP, 74 HA, 37 BH, 13 WS, 122 HS	Soil, water and geotechnical analysis.

**Table 1 – Previous Investigations**

The information gained through all these investigations has been assessed as part of the Stage 1 Site Investigation and reported in the Generic Quantitative Risk Assessment report (GQRA), (BAE Systems Environmental, 2006).

In summary, the risk assessment is based on 2,125 No. soil samples, 190 No. groundwater samples and 65 No. surface water samples from 1,189 No. exploratory points as follows:

Investigation	Year	Exploratory points with soil samples	No. soil Samples	Exploratory point prefix
Burning grounds	1995	23 No. trial pits in the main burning grounds area	31	BGS
Georgetown	1995	193 No. trial pits and 32 No. window sample holes in Georgetown	391	GT
Boghall Dump	2002	14 No. trial pits in Boghall Dump and the Vegetation Tip	28	BOG
Picrite Lagoons	2002	7 No. window samples and 27 No. hand augers in the Picrite lagoons	44	PIC
Preliminary Geotechnical	2003	13 No. trial pits, 9 No. boreholes and 78 No. starter pits for cone penetration tests (CPTs)	79	PPG
Ecological Risk Assessment	2004	23 No. hand dug holes.	23	ERA
Stage I Site Investigation	2005	A total of 770 No. exploratory points, see Factual Report for details	1,529	None

**Table 2 – Relevant previous investigations**

In addition to the above, boreholes from other previous investigations were used for the collection of groundwater samples. These were boreholes around the Picrite Lagoons installed by Aspinwalls in 1989 (prefix ASP) and Royal Ordnance in 1995 (ESG), and boreholes positioned around the Site boundary installed by BAE Systems Environmental in 2002 (PER).

Data from 7 No. rounds of monitoring between June 2003 and October 2005 are included in this assessment.

A summary of the findings of the GQRA is provided in the following sections.

### 3.3. Significant Pollutant Linkages – Human Health

The investigation data indicates that there are a number of sources of contamination that have the potential to impact humans in the proposed development. Generally, these relate to known sources of contamination such as the burning grounds, process buildings and steam mains.

For a number of these sources the concentrations of contaminants combined with the presence of pathways and receptors means that they contribute to potentially significant pollutant linkages that are likely to require risk management. These are listed in Table 3 below:

Source	Pathway	Receptor	Contaminants
Spillages and leakage associated with process and storage buildings.	Inhalation, direct contact, ingestion, detonation, deflagration, burning	Humans in CDA, ROS & RL	Explosives residues (NG, NC, RDX, TNT, picric acid, 2,4-DNT, 2,6-DNT, picric acid), fragments of explosives, carbamate
Spillage and leakages during transportation of materials.	Detonation, deflagration, burning	Humans in CDA, ROS & RL	Fragments of explosives
Burning grounds.	Inhalation, direct contact, ingestion, detonation, deflagration, burning	Humans in CDA, ROS & RL	Metals (including arsenic, lead and antimony), PAHs, TPH, explosives residues (NG, NC, RDX, TNT, picric acid, 2,4-DNT), fragments of explosives
Asbestos-containing materials used for steam pipe lagging.	Inhalation	Humans in CDA, ROS & RL	Asbestos
Asbestos-containing materials in building fabric.	Inhalation	Humans in CDA	Asbestos
Electrical sub-stations.	Inhalation, direct contact, ingestion.	Humans in CDA	PCBs
Coal storage areas	Inhalation, direct contact, ingestion.	Humans in CDA	TPH, potentially combustible materials
Metal salts storage building	Inhalation, ingestion.	Humans in CDA	Metals (including lead and antimony)
Firearms proof range near Dargavel House	Inhalation, ingestion	Humans in CDA	Metals (including lead and antimony)
White Phosphorus Section	Inhalation, ingestion	Humans in CDA	White Phosphorus
Fragments of tarmac in made ground	Inhalation, direct contact, ingestion	Humans in CDA	PAHs
Fuel storage tanks	Inhalation, direct contact, ingestion	Humans in CDA	TPH, PAHs

**Table 3 – Human Health - Significant Pollutant Linkages**

### Uncertainties

A number of sources of contamination listed in the table above could lead to significant pollutant linkages in Retained Land and Recreational Open Space. This can only be determined with reference to a refined model based on the actual land use in these areas. Specific sources of contamination in this category include Boghall Dump (Arsenic, Nickel), Netherfield Tips (Arsenic, TPH) and the Refuse Coup (Lead).

Confirmation is required that there are no significant undetected sources of contamination in between exploratory points and beneath buildings in the Core Development Area.

Confirmation is required that there is no significant contamination around other tanks and chemical storage areas not yet investigated.

The final development platform levels are not known at the present time and could have an effect on the presence/significance of a number of pollutant linkages.

Contamination was observed in a number of unexpected locations that require further investigation. These include, but are not limited to, the Works Department area, laundry area, proof range at Dargavel house, possible storage areas along the main road, the former Boilerhouse No. 2 slab and an area of made ground outside building ref no. 24/305C in Factory III NG Section.

There is insufficient dataset to determine the significance of soil gas concentrations found at the site and the risk that they may pose to occupiers.

It is uncertain whether buried explosives devices are present in former storage areas and in the ammunition breakdown section.

Further assessment is required to determine if explosive devices are present in ROS areas of Georgetown and the White Phosphorus Section within the CDA.

### 3.4. Confirmed Pollutant Linkages – Water Environment

The Stage 1 Site Investigation, together with historical monitoring data, has indicated a number of sources of contamination that either have the potential to impact or are indicted to be impacting the water environment. Generally, these relate to known sources of contamination such as the Picrite Lagoons and ash tips.

In particular, correlation between leachability data and water quality suggests continuing entry of contaminants to the water environment in the Tier 1 assessment, and so confirms the following pollutant linkages outlined in Table 4 below:

Source	Pathway	Receptor	Contaminants
Picrite Lagoons	Soil leaching and migration in unsaturated zone	Shallow groundwater	picrite, ammonia, sulphate, nitrate
	Soil leaching, migration in unsaturated zone and shallow groundwater. Direct run-off.	Surface water	picrite, sulphate, ammonia
Ash tips	Soil leaching and migration in unsaturated zone	Shallow groundwater	As, B
Netherfield Tip 1	Soil leaching and migration in unsaturated zone	Shallow groundwater	As, B, PAHs
Refuse Coup	Soil leaching and migration in unsaturated zone	Shallow groundwater	B, Zn
Sulphur Dump	Soil leaching and migration in unsaturated zone	Shallow groundwater	Cu, Ni, Zn, Al, sulphate, low pH
Diesel UST (near BH1621)	Soil leaching and migration of NAPL.	Deep groundwater	TPH

**Table 4 – Water Environment - Confirmed Pollutant Linkages**

Shallow groundwater is taken to be groundwater associated with superficial deposits and made ground. Deep groundwater is taken to be groundwater associated bedrock aquifers.

The contaminant sources associated with Netherfield Tip 1 and the diesel UST near BH1621 are likely to be removed because they also contribute to significant human health pollutant linkages.

## Uncertainties

The hydrogeological and hydrological regime in the vicinity of the picrite lagoons is complex and is likely to have been changing in recent years since production ceased. Further monitoring and assessment is required to determine the significance of the ongoing impact to groundwater and surface water.

The extent of ash tips, Netherfield Tip 1, the Refuse Coup and the Sulphur Dump is uncertain and so the significance of these as ongoing sources of pollution of the water environment is unclear.

Contamination was observed in a number of trial pits where there are no nearby monitoring boreholes to determine whether there is a pollutant linkage to groundwater. Further assessment is required in a number of these situations, such as the hydrocarbon contamination identified in TP1078.

Slight contamination has been observed at a number of monitoring points, particularly groundwater, where there is no obvious source. A number of these require further investigation and/or continued monitoring, such as the occurrence of bis(2-ethyl hexyl)phthalate in BH1089.

This tier of assessment considers concentrations at the point of entry. The effects of dilution, dispersion and attenuation are likely to be significant in reducing the concentrations of contaminants at the points of assessment. It is considered that the concentrations observed are unlikely to be significant once these factors have been taken into consideration although this will be subject to further evaluation in the Stage 2 Site Investigation.

### 3.5. Other Receptors

There is insufficient dataset to determine the significance of soil gas concentrations found at the site and the risk that they may pose to the built environment. In particular significant methane concentrations have been encountered at one location in the proximity to an existing operational building (building ref no. 70/004) in the Retained Land. More recent monitoring has recorded much lower concentrations in the borehole and no detectable methane within the nearby buildings. The source of this gas is thought to be nearby peat deposits and further investigations are required to assess the risk to building structures (as well as human health).

Based on the lack of potential contamination sources in these areas, and the results of the site investigation, it is considered unlikely that pollutant linkages involving crops and livestock will be significant, and that no further assessment is required.

## **4. LAND REMEDIATION OPTIONS APPRAISAL**

### **4.1. Introduction**

The key output from the GQRA has been to identify pollutant linkages that are considered to be significant and therefore require remediation. The Outline Remediation Strategy has therefore been developed to effectively manage the risks identified. It is our opinion that the dataset used to complete the GQRA is sufficient to enable a robust Outline Remediation Strategy to be developed.

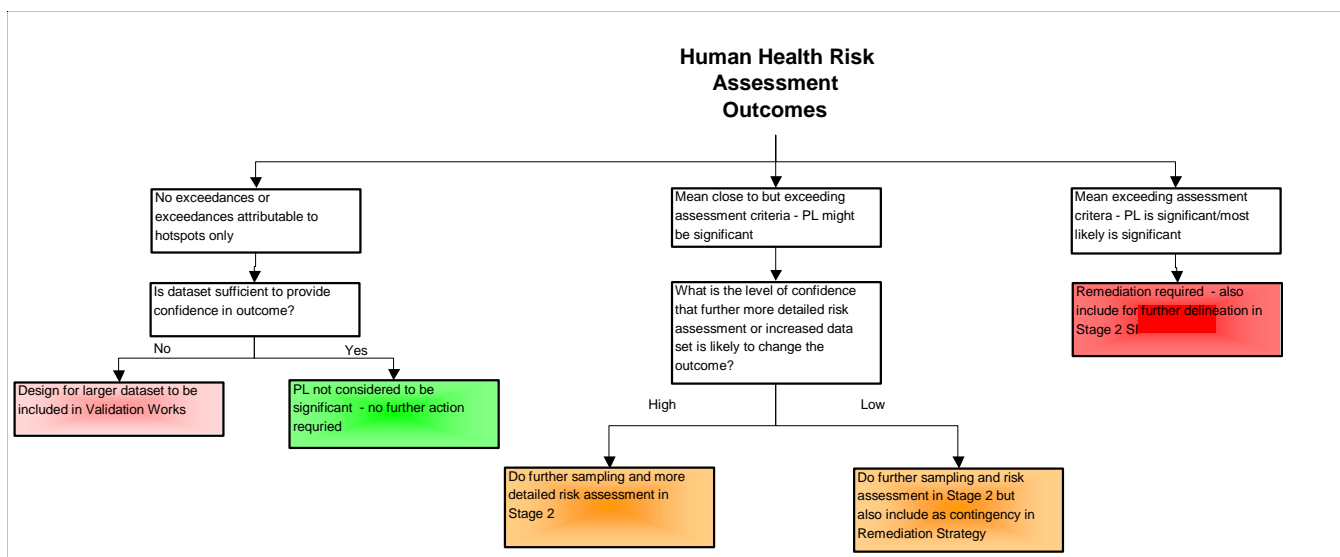
There are however further investigation works that are required in order to either confirm that significant pollutant linkages exist (eg further more detailed risk assessment) or to gain further information about already identified linkages (such as delineation of contamination sources or source types). The majority of these works will be undertaken during the Stage 2 Site Investigation that is planned to take place following a successful outline planning consent application. In addition, validation of pollutant linkages that have been assessed as not being significant will be undertaken as part of the remediation verification process.

These further investigations could result in other significant pollutant linkages being identified. We have therefore used our professional judgement and previous experience gained through the remediation of similar sites to make allowances for this possibility. The Remediation Strategy therefore combines all the remediation options that are considered necessary to ensure that the Site is suitable for its new use.

### **4.2. Identifying Key Risk Drivers**

Our assessments have identified that the main risk drivers are generally associated with human health risks and, as such, these form the principal consideration for remediation. In concentrating on the human health risks, it is believed that the majority of the risks identified in relation to the water environment will also be dealt with, as these were generally associated with the same sources of contamination. Therefore, in adopting a remediation strategy for areas where there are risks to both human health and the water environment, the remediation has been designed such that all receptors are considered. Where pollutant linkages to the water environment have been identified with no corresponding risks to human health, separate remediation options are proposed.

The outcome of the risk assessment, either from the GQRA or DQRA where appropriate, is that Pollutant Linkages (PLs) have been categorised according to their likelihood of significance as outlined in Section 3. The following flow chart has been used as an aid to assessing the outcomes of the human health risk assessment:



### PLs not significant / likely not significant

For contaminants where there have been no exceedances of assessment criteria other than for identified hotspots, an assessment has been made as to how robust the dataset is that has been used in the evaluation. This appraisal has been made based on:

- the likelihood of such contaminants being present at locations other than at point sources;
- statistical analysis of the dataset to ensure that a normal distribution of concentrations has been obtained.

Where a contaminant passes both these criteria, it is considered that no further action is required.

Where a contaminant fails such an assessment, if for example there is a higher likelihood of contaminants being found at other locations, then further analysis is proposed on a tighter grid. However, implicit in this decision is that there is confidence that upon obtaining a larger dataset, the outcome will be that the PL is not significant. Such decisions can be made using professional judgement based on the targeted nature of the current investigation and examining how close the mean concentration, for a particular contaminant, is to the assessment criteria being applied. For these reasons, it is proposed that such validation is undertaken during the remediation phase as opposed to during the Stage 2 Site Investigation.

### Further Investigation/Risk Assessment requirements

Where the initial DQRA has indicated that a particular PL might be significant, i.e. where the mean concentration is exceeding but close to the assessment criteria, an assessment has been made to determine whether an increased dataset or more complex risk assessment would change the outcome. In undertaking such an appraisal, consideration has been given to the following:

- The effect of the targeted nature of the current investigation on the resultant mean

- The degree of conservatism inbuilt into the assessment criteria used in terms of exposure characteristics etc

Where there is high confidence based on this appraisal that an increased dataset or more sophisticated risk assessment might change the outcome, then this is what is proposed. Where confidence is low, we would propose to undertake the additional work but also make an allowance in the remediation strategy for dealing with these particular linkages.

### Risk management strategy requirements

A number of pollutant linkages have been identified as significant or most likely to be significant, and, in such cases risk management is proposed. In these situations there is no requirement for further data collection or risk assessment other than where there is a requirement for further delineation for the purposes of remediation planning. Such work will be fully validated through appropriate testing and risk assessment.

### 4.3. Summary of Risk Assessment Outcomes

The outcome of this assessment is provided in the following table (Table 5) which summarises the key contaminants of concern (principally for human health) and the proposed way forward:

PL Sources	Core Dev. Area	Rec. Open Space	Retained Land
<b>Metal sources e.g. burning grounds, proof range etc</b>	Remediation likely to be required	Remediation likely to be required	Remediation likely to be required
<b>Lead, arsenic, cadmium, nickel, excluding sources</b>	Design for larger dataset to be included in Validation works	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required
<b>Metals, excluding sources and lead, arsenic, Cd, nickel</b>	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required
<b>PAHs sources e.g. tarmac</b>	Remediation likely to be required	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II
<b>PAHs exc. sources</b>	Design for larger dataset to be included in Validation works	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II
<b>Explosives residues round buildings</b>	Remediation likely to be required	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II
<b>Explosives residues – other sources e.g. burning grounds, effluent lagoons</b>	Remediation likely to be required	Remediation likely to be required	Remediation likely to be required
<b>Explosives residues excluding sources</b>	Design for larger dataset to be included in Validation works	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II
<b>Explosives fragments sources e.g. narrow gauge</b>	Remediation likely to be required	Remediation likely to be required	PL not considered to be significant – no further action required
<b>Explosives fragments excl sources</b>	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required
<b>Visible asbestos directly beneath steam mains</b>	Remediation likely to be required	Remediation likely to be required	Remediation likely to be required
<b>Asbestos distributed in soil</b>	Design for larger dataset to be included in Validation works	Air sampling and/or RA in Stage II	Air sampling and/or RA in Stage II

PL Sources	Core Dev. Area	Rec. Open Space	Retained Land
Asbestos in Georgetown	NA	Air sampling and/or RA in Stage II	Air sampling and/or RA in Stage II
Devices – Ammo breakdown & storage	NA	Further sampling and/or RA in Stage II	NA
Devices – Georgetown filling factory	NA	Further risk assessment in Stage II	PL not considered to be significant – no further action required
Devices – White Phosphorus Section	Remediation likely to be required	NA	NA
PCBs sources	Remediation likely to be required	Further sampling and/or RA in Stage II	NA
PCBs excl. sources	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required
Dioxins	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required	PL not considered to be significant – no further action required
TPH sources	Remediation likely to be required	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II
TPH excl. sources	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II
Soil gas	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II	Further sampling and/or RA in Stage II

**Table 5 – Human health assessment outcomes**

#### 4.4. Dealing with other identified risks

In addition to the above, there are other pollutant linkages that have been identified that require further action as follows:

- Further assessment of the significance of risks to the water environment from identified sources namely picrite lagoons, sulphur dump, waste dumps ('refuse coup') and ash tips. This will be undertaken through further intrusive investigation and more sophisticated risk assessment.
- Further investigation to identify any additional pollutant linkages associated with other sources. This is required where sources of contamination have been identified but there was no nearby groundwater monitoring borehole present.

There is also further investigation works required during the Stage 2 Site Investigation in order to reduce the uncertainties identified in the human health risk assessment as follows:

- Confirmation is required that there are no significant undetected sources of contamination beneath buildings in the Core Development Area.
- Confirmation is required that there is no significant contamination around other tanks and chemical storage areas that were not targeted in the current investigation.

- Contamination was observed in a number of unexpected locations that require further investigation. These include, but are not limited to, the Works Department area, laundry, possible storage areas along the Dargaval Road, the former Boilerhouse No. 2 slab and an area of made ground outside 24/305C in Factory III NG Section.

There is also a requirement for delineation works to be undertaken in relation to the identified sources in Table 5. These again will form part of the Stage 2 Site Investigation.

#### 4.5. Standard of Remediation and Validation

At this outline stage, prior to undertaking any further data collection as part of the Stage 2 Site Investigation, the remediation objectives have yet to be translated into specific remediation criteria or targets. The remediation criteria will provide a quantitative measure against which compliance of the objectives can be measured.

Remediation will be undertaken such that each area of the Site is suitable for its proposed new use (as outlined in section 1.6). There are no generic UK statutory standards for acceptable concentrations of contaminants in soil. The decisions on whether an area is suitable for its proposed new use will be based on a site-specific risk assessment approach and as agreed with Renfrewshire Council.

The required standard of remediation will be achieved through a variety of techniques as outlined in the following sections. The implementation of the remediation strategy will be in accordance with documented quality assurance procedures. These will include the following:

**Verification plan** – This document sets out the requirements for gathering data to demonstrate the effectiveness of the remediation in terms of meeting the remediation objectives. A draft plan will be submitted as part of the Draft Detailed Remediation Strategy which supports the detailed planning application for the remediation works. The plan will then be finalised and agreed with the local authority prior to implementation of the works. More detail is provided in section 7.17.

**Verification Report** - this will provide a complete record of the remediation activities on the Site and the data collected as part of the verification plan to support compliance with remediation objectives and criteria. It will also include descriptions of the works with associated 'as built' drawings and details of any unforeseen conditions encountered during the works and how they were dealt with. In view of the size of the Bishopton project, verification reports will be submitted to cover individual phases of remediation to allow for the phased release land for development to progress in accordance with its phasing requirements.

#### 4.6. Remediation Options

Table 6 below provides a broad outline of contaminant sources and their respective risk management options. These have been selected in order to break significant pollutant linkages and taking into consideration all the management and technical objectives outlined in section 1.5 as well as our experience in remediating similar sites. Figure 5 provides a pictorial representation of the extent of remediation activity proposed as well as an indication of the other related earthworks that are considered to be required.

In some instances there may be a number of treatment options identified although the best practicable option cannot be determined until further information is known in

relation to quantities etc. These will be further appraised following the Stage 2 Site Investigation.

Source	Risk Management Options	Quantum Estimates
Hydrocarbon hotspots	Bioremediation and reuse (preferred option), Excavate and remove (may also involve pre-treatment by bioremediation)	To be determined in Stage 2 Site Investigation.
Explosives residues contamination around process buildings	Excavate and remove to landfill	500No. process buildings – quantities still to be estimated – further SI required. However, assuming average propellant building size (1500m <sup>2</sup> ) and taking 10m around mound excavated to depth of 200mm, this equates to 300m <sup>3</sup> per building. Assuming all 500 building require remediation – 150,000m <sup>3</sup> worst case.
Burning grounds	Excavate and remove Soil Washing (feasibility to be assessed) Soil stabilisation (feasibility to be assessed) Visual inspection for small devices	Approx. area of burning grounds (excluding RL) = 6.1ha. Assuming all made ground + 0.2m natural material needs to be removed - average depth is approx 1.5m. Total volume estimate is therefore 100,000m <sup>3</sup> .
Boghall Dump	Surface Encapsulation	1.9ha land area. Assuming 500mm cap and 100mm topsoil then requirement for approximately 10,000m <sup>3</sup> of material.
Sulphur Dump	Possible excavate and removal – Surface Encapsulation	Estimated 0.4 ha land area affected. Assuming 1m of made ground, this equates to approx. 4,000m <sup>3</sup> .
Netherfield tips	Excavate and removal preferred	Estimated 1ha land area affected and assuming 2m of fill = 20,000m <sup>3</sup> this could be v. conservative. Depth appears to vary and so more investigation required to delineate. Conservative estimate made on quantities at this stage.
Visible asbestos (predominantly bonded around buildings that have had asbestos cement cladding etc and directly beneath steam mains (near stanchions).	Hand picking, possible machine surface scrape in some cases around buildings. Feasibility of handpicking beneath steam main to be determined during Stage 2 Site Investigations. Contingency allowance for excavation and removal directly beneath steam mains to provide confidence of bulk asbestos removal. Accompanied with visual inspection either side of trench and further removal as required.	Will be quantified during asbestos survey.  <b>Contingency</b> - Best estimate of length is 49 km. Assuming 300 mm scrape in 1m wide trenches equates to approximately 15,000 m <sup>3</sup> of material.
Devices risk in ammunition breakdown, Georgetown and other storage areas	Inspection and further investigation and assessment required but options may involve active management or possible surface encapsulation. Remediation in ammunition breakdown area may be	Possible excavation of 16,500m <sup>3</sup> to prepare landfill.

Source	Risk Management Options	Quantum Estimates
	coincidental with works required for proposed landfill, depending upon final design.	
Asbestos dispersed in soils beneath steam mains – <b>Contingency only</b>	More information is required to determine if actual risk. Contingency allowance to be made for excavation and removal directly beneath steam mains and to defined width.	To be confirmed after Stage 2 Site Investigation
Picrite Lagoons	Monitored Natural Attenuation likely to be required. Possibly also reed bed system for intercepted groundwater. Perhaps impermeable barrier although further assessment required.  Note - contained in BAE Systems retained land, risk management plan required	
Explosives (propellant) fragments	Vacuuming from hard surface areas and destruction by burning; surface excavation either side of hard areas - if not landfilled then destruction by burning or screening / burning.	Length of narrow gauge in CDA = 36 km. This is the single rail total - approx 8 km of this is counted twice because it is double line.  Length of remaining narrow gauge = 28km. This is also single rail total -approx 5km of this is double line.
Coal stores area	Further investigation in the Stage 2 SI to ascertain whether removal is required. 50% is contained within the BAE Systems retained land (ETF) and a risk management plan will be required.	Estimated 1.4ha land area affected. Depth of made ground is approx. 1.5m equating to approx. 21,000m <sup>3</sup> of material.
Other areas including scrap yards, areas of mineral workings, stores yard	Excavate and refill/reprofile Encapsulation	Not yet delineated - Allowance of up to 1.5m fill over area of 2.5ha.
White Phosphorus open storage areas	Excavate and removal/treatment including visual inspection for explosives devices	Up to 1ha but more likely 0.5ha.
Vegetation tip	Surface Encapsulation	0.5ha capped – 200mm cap with 100mm topsoil – approx 1500m <sup>3</sup>
Waste Dump ('Refuse Coup')	Excavate and remove Soil Washing (feasibility to be assessed) Soil stabilisation (feasibility to be assessed)	Estimated 0.5ha land area affected with up to 3m of made ground anticipated. This equates to a volume of 15,000m <sup>3</sup> .
Other small areas of incidental waste tipping outwith CDA	Allowance to be made; lift and sort waste for disposal/treatment streaming	Allowance of 1000m <sup>3</sup>
Roads, rail, narrow gauge – other hard standing	Excavate and remove Assess for re-use in other parts of Site	CDA – 11ha road, 7ha narrow gauge, broad gauge and other hardstandings allowance required – 11,000 m <sup>3</sup> with 15% recycled concrete (1500m <sup>3</sup> )

**Table 6 - Remediation Options**

The quantities provided in the table above have been estimated based upon the information gathered to date. A key objective of the Stage 2 Site Investigation will be to delineate identified sources to provide more precise estimates of the quantities of materials requiring remediation through treatment or disposal.

It is considered that significant quantities of materials will require to be disposed of to landfill where no other suitable treatment is considered feasible. It is therefore proposed to construct a licensed landfill facility within the Open Space area to accept wastes generated from the remediation of the Site. The Site will be licensed by SEPA under the Pollution Prevention and Control (Scotland) Regulations and will require a separate planning application. Further details on the facility can be found in the documentation related to both these regulatory approval processes.

## **5. PROJECT PHASING AND TIMESCALES**

### **5.1. Overview**

The regeneration of the Site is to be carried out in logical stages (phases). In general terms this is the process of transforming the Site from a derelict factory to a site suitable for proposed new uses. Proposed new development will be built out over six phases. In order to prepare the Site to receive new development the remediation process must be carried out first. Given the size of the Site and the extent of the task, the remediation will also be phased similarly to the development phases but ahead in a timely fashion. An essential consideration is to maintain a remediated buffer zone between remedial activity and new development completions and occupations. A further consideration in the phasing plan is the provision of remediated green space land to be made available for public recreational uses as soon as is practical in the phasing programme.

### **5.2. Draft Phasing Plans**

The remediation is currently phased over a period of 15 years. Reference to the Phasing Plans Drawings 1-8 of this report shows the boundaries and timescales of each remediation phase. These have been developed based on the current remediation requirements and proposed development phasing. The phasing will therefore be subject to some adjustment and will be finalised in the Detailed Remediation Strategy.

## 6. REMEDIATION SEQUENCE

### 6.1. Arrangement of Activities

The basic sequence to be undertaken is as follows:

- Enabling works;
- Ecological mitigation;
- Asbestos Survey
- Phased decontamination of former manufacturing and storage buildings;
- Phased demolition of all structures;
- Phased land remediation to remove contamination where identified by the site investigation and assessment process and verified by a validation procedure agreed with the appropriate regulating authority;
- Other groundworks required to reprofile specific areas in preparation for new development;
- Essential landscape works;

Table 7 below shows the Phasing of all key remediation processes and is described in more detail in section 7.

Key Remediation Activity	Completion per Phase Period						
	0	1	2	3	4	5	6
<b>Decommissioning</b>	Completed prior to Phase 0						
<b>Enabling Works</b>	Prior to Phase 0	N/a	N/a	N/a	N/a	N/a	N/a
<b>Ecological Mitigation</b>	Yr 1 & 2	Yr 1 & 2	Yr 3 & 4	Yr 5 & 6	Yr 7 & 8	Yr 9 & 10 & 11	Yr 12 & 13
<b>Land fill</b>	Constructed in Yr1 and in use to restoration in Yr 15						
<b>Selective Tree Removal</b>	Yr 1 & 2	Yr 1 & 2	Yr 1 & 2	Yr 3 & 4	Yr 3 & 4	Yr 5	Yr 5 & 6
<b>Asbestos Survey and Removal</b>	Yr 1	Yr 2	Yr 2	Yr 3	Yr 3	Yr 3	Yr 3
<b>Building Decontamination</b>	Yr 1 & 2	Yr 2 & 3	Yr 2 & 3	Yr 3 & 4	Yr 3 & 4	Yr 4 & 5	Yr 5
<b>Building Demolition</b>	Yr 1 & 2	Yr 2 & 3	Yr 2 & 3	Yr 3 & 4	Yr 3 & 4	Yr 4 & 5	Yr 5
<b>Land Remediation including building foundation removal in CDA</b>	Yr 1 & 2	Yr 3 & 4	Yr 5 & 6	Yr 7 & 8	Yr 9 & 10 & 11	Yr 12 & 13	Yr 14 & 15
<b>Other earthworks e.g. landscaping, landforming</b>	Yr 1 & 2	Yr 3 & 4	Yr 5 & 6	Yr 7 & 8	Yr 9 & 10 & 11	Yr 12 & 13	Yr 14 & 15

**Table 7 - Remediation Sequencing**

## **7. REMEDIATION ACTIVITIES**

The main remediation activities are described in the following sections. A pictorial representation of the proposed extent of remediation in terms of earthworks activities is presented in Figure 5. It shows not only the activities related to treatment and removal of contamination, but also other related activities such as mineral extraction to win uncontaminated materials from the site and excavations to facilitate the Sustainable Urban Drainage System (SUDS).

### **7.1. Decommissioning**

The Site occupier is responsible for bringing the factory to a satisfactory close and as such has already completed a building decommissioning programme following the cessation of manufacturing in 2002. All facilities have been decommissioned to a standard that leaves the Site in a safe, stable and secure condition.

An in-depth study into the previous (and for some at the time, current uses) of over 2000 individual structures and land areas on site was undertaken in 2002 with the output being a comprehensive Buildings Desk Study.

The information derived from the Buildings Desk Study proved invaluable in the preparation of safe decommissioning plans. During the decommissioning process all residual wastes and redundant product were identified, collected and appropriately disposed of by either controlled burning of explosives at burning grounds or disposed of to off-site licensed landfill for other wastes.

As an additional stage in the decommissioning of the Site, a Type 2 asbestos survey of the Site was undertaken. This was followed by the safe removal of fibrous asbestos pipe lagging materials deemed necessary and appropriate at this stage (to facilitate safe decommissioning). This work was undertaken by specialist contractors within the strict controls set by the relevant asbestos regulatory regimes and the waste generated was containerised and removed from site to a licensed landfill. During site remediation the remaining asbestos containing materials (mainly cement bonded and insulating board) will be identified via a Type 3 asbestos survey followed by a programme of complete removal and disposal.

The Desk Study reports for each building and land area were updated after decommissioning to state works carried out, highlight new information gathered, and the current status of the building etc. at that time.

The decommissioning process with the benefit of more detail derived from the direct intervention (noted in the updated Desk Study) enabled a wider strategy to fully ascertain the potential for contamination across the Site to be developed (i.e. Stage 1 Site Investigations described in Section 3 of this report and the proposed Stage 2 Site Investigations (BAE Systems Environmental, 2006)).

### **7.2. Enabling Works**

Enabling works are likely to be carried out as a pre-cursor to the main remediation activities before the granting of outline planning consent.

It is considered that in order to assist / facilitate a timely start with the main remediation of the Site some works may be undertaken at an early stage. These enabling works may include the following:

- Stage 2 Site Investigation and further Detailed Quantitative Risk Assessment (DQRA) as outlined throughout this report and detailed in the GQRA report (BAE Systems Environmental, 2006). The completion of the assessment of the Site for contamination to provide essential data to fill in the information gaps identified by the Stage 1 Site Investigation and to further delineate areas that require remediation.
- Type 3 asbestos survey of buildings and other structures in Phase 0 and Phase 1 remediation zones, an intrusive investigation to identify and quantify all remaining asbestos containing materials. The purpose of the Type 3 is to access all areas and involves intrusive inspection, such as opening up of the structure, to view inside cavities, floor voids, risers and services ducts etc. Samples are taken as with the Type 2 survey and the type and size of the ACM is recorded;
- Removal of all asbestos containing materials in the Phase 0 remediation zone;
- Habitat mitigation work e.g. preparatory work for the creation of new badger habitat to facilitate translocation of badgers where their existing setts will hinder / prevent essential remediation works. Works at this stage to facilitate access to Phase 0, 1 and 2 of the remediation zones. This involves further survey work and agreement of mitigation proposals with the appropriate regulating body, Scottish Natural Heritage (SNH);
- Diversion of live utility services and drainage required for continued site operational requirements and where isolation or termination is not possible at an early stage in the remediation process;
- Preparation of alternative site access for construction plant and workers vehicles in order to provide an alternative to accessing the Site via the existing village infrastructure;
- Preliminary tree clearance in the remediation Phase 0 & Phase 1 zones where required to facilitate decontamination works in areas where buildings and ground is to be disturbed / removed during the main remediation works;
- Building preparation work in the remediation Phase 0 zone – includes removal of smoke emitting materials from former explosives buildings identified for decontamination by burning. The types of materials to be removed at this stage are plastics, bituminised material and asbestos.

### **7.2.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

### **7.3. Ecological mitigation**

An appropriate ecological survey has been undertaken at the Site. Habitats identified in areas where intervention and soil removal etc. is proposed will be properly dealt with prior to any soil removal with appropriate consents being obtained and specialist advice sought. All methodologies and strategies will be formulated and agreed with the appropriate authorities and regulatory bodies. Works may be restricted to specific time periods / seasons within a year.

### **7.3.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

## **7.4. Tree Removal**

Selected tree removal will be a requirement prior to undertaking remedial action. The following scenarios will dictate where tree removal will occur:

- Trees which exist in locations where contaminated ground is to be removed will be felled and root systems removed during the ground remediation works;
- Trees which exist adjacent to buildings which will be decontaminated by burning will be felled as a health and safety requirement to prevent spread of fire;
- Trees will be removed in the CDA and root systems grubbed up where ground remodelling will be required to smooth out excessive changes in surface level.

Trees will be identified where removal is essential with due consideration being given to qualitative assessment and negotiation with the appropriate authorities in respect of valuable species. A tree replacement scheme will be designed to facilitate landscaping requirements in the CDA, and to enhance the Forest Park zone where appropriate.

### **7.4.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

## **7.5. Asbestos Surveying / Removal**

A Type 2 asbestos survey was undertaken previously as part of the decommissioning phase (see Section 7.1) and identified a number of types and forms of asbestos containing materials (ACMs), however a more detailed Type 3 survey is required. The purpose of the Type 3 is to access all areas to assess and confirm the presence of ACMs. This involves intrusive inspection, such as opening up of the structure, to view inside cavities, floor voids, risers and services ducts etc. Samples are taken as with the Type 2 survey and the location, type and quantity of the ACM is recorded. The results of this survey are fully documented in a report with supporting drawings, photographs and diagrams to clearly indicate the location and extent of ACM found.

This type of survey is designed to be used as a basis for tendering the removal of the ACMs from the building prior to the commencement of the planned works i.e. decontamination and demolition. The survey and subsequent removal works will be undertaken by a suitably qualified and experienced specialist contractor, under contract to BAE Systems Environmental. The works will be undertaken within the strict control of the current asbestos regulating regime. Inspection, testing, air monitoring and validation of the works will be carried out by an independent specialist under contract to BAE Systems Environmental.

It is proposed that the waste asbestos containing materials are disposed of at a dedicated, specialist designed, licensed landfill facility within the Recreational Open Space area of the site.

### **7.5.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

## **7.6. Building Decontamination**

### **7.6.1. Background**

A number of buildings (approx. 520No.) on the Bishopton site have Explosive Licences issued by the Health and Safety Executive Explosives Inspectorate (HSE Expl.). These are former explosive manufacturing, processing and storage buildings. In order for these licences to be revoked they need to be confirmed both out of use for explosives storage and processing and safe to the HSE. Decontamination is the accepted method of achieving this and seen as best practice by the HSE Expl. The HSE Expl. view is that until a building has been fully decontaminated and demolished the licence shall remain in place with the full regulating regime governing all activity associated with that building operative. Once a building has been decontaminated and removed a report will be issued to the HSE Expl. and it is agreed that individual licences will be revoked on a 'block' basis taking approx. 50 buildings at a time. Once the HSE Expl. have satisfied themselves that the decontamination and removal has been completed satisfactorily the licence revocation procedure will be activated.

These buildings need to be decontaminated because of the known or likely presence of traces of explosive materials in disused plant, building systems and building fabric. Potential explosive contamination presents a hazard of ignition during building works or demolition and a toxic hazard to the environment if released from the buildings by uncontrolled demolition.

The decontamination method appropriate to each building has been decided on the basis of a detailed desk study assessment of its past uses, supplemented by on-site inspection. BAE Systems Environmental holds information for each building (desk study reports). The assessment process divides buildings into three basic categories, each with an appropriate remediation method:

- 1) Suspected or known to be contaminated by explosives - The building requires treatment by "firing" to destroy all traces of explosive. (*"Firing" is the process of specially preparing and then burning each building in a controlled manner – see below*). This is a 'specialist procedure' and will be undertaken by highly experienced BAE Systems Environmental personnel. Asbestos containing products will require removal prior to 'firing'. Following decontamination the building will be removed by traditional demolition and recycling.
- 2) Suspected or known to be contaminated only by gunpowder based compositions and/or hazardous chemicals, or lightly contaminated and suitable for effective cleaning - The building requires jet washing or steam cleaning to destroy gunpowder and wash any chemicals/explosives from building surfaces. Effluent will be collected for appropriate treatment/disposal. Asbestos containing products will require removal prior to decontamination. Following decontamination the building will be removed by traditional demolition and recycling.
- 3) Past use which could not lead to explosive or chemical contamination. Decontamination is not required. Asbestos containing products will require removal prior to traditional demolition and recycling.

The overriding decision determining the appropriate decontamination method is the health and safety of workers engaged in the process and the due consideration of neighbouring residences.

The categorisation of buildings has been undertaken and numbers of buildings identified in each category are provided in Table 8 below. The preliminary assessment has been conservative in nature, placing more buildings in Category 1 than may be necessary. In order to reduce the number of buildings to be burnt to a minimum, a further more detailed assessment is currently being undertaken and so it is possible that some buildings may be downgraded to Category 2 or 3. This further assessment will include further detailed inspection and likely the taking of swab samples from surfaces for laboratory analysis.

<b>Building Category</b>	<b>Core Development Area</b>	<b>Recreational Open Space</b>	<b>Retained Land</b>
<b>1</b>	310	170	20
<b>2</b>	-	-	0
<b>3</b>	200	590	5
<b>Totals</b>	<b>510</b>	<b>760</b>	<b>25</b>

**Table 8 - No.s of Buildings requiring Remediation**

BAE Systems Environmental has extensive experience in the decontamination of explosives contaminated buildings. We have successfully carried out the procedure at a number of sites in the UK including over 400No. buildings at Chorley, 300No. at Waltham Abbey, 2No. at Faldingworth and 50No. at Powfoot.

Alternatives to burning of buildings will be considered for those buildings close to neighbouring residences and will be adopted wherever they can be used without compromising the health and safety of demolition or remediation workers. Methodologies for these circumstances will be developed with the regulating authority.

### **7.6.2. Methodology**

The burning of any explosive contaminated buildings on the Site will follow a detailed procedure, designed to minimise the environmental impact of the process. The decontamination process includes a number of steps as follows:

- Risk assessment of all activities and production of methodologies and work instructions for personnel;
- All services to the building will be confirmed disconnected and isolated away from the structure (most of this work was undertaken during the decommissioning period);
- Materials left in the building which may give rise to the release of excessive dark smoke and air borne particulate matter during building firing will be removed (i.e. ACMs, plastics, rubber, bituminous materials etc.);
- All plant and fume / dust extraction ductwork will be cleaned of visible gross explosive or other residues. Hydraulic sumps and pipes will be drained and

the oils disposed of. This has been carried out during the previously described decommissioning stages and will be double checked during the preparation for 'firing'.

- When equipment is to be burned in-situ it will be dismantled to such an extent as to ensure there are no un-vented pockets, which could cause detonation during firing.
- Flooring and roofing materials will be removed to limit toxic emissions/black smoke and/or to eliminate suspected presence of explosives in cracks in/or under the flooring
- Depending upon the building design, the building is loaded with combustible material (primarily clean timber and different varieties of natural straw, namely wheat straw, barley straw, rapeseed oil straw). These materials have been found to be most effective in generating the heat required to decontaminate the structure and its contents. These materials will keep dark smoke to a minimum whilst ensuring the minimum temperature required is achieved and maintained for approximately 4 hours. Digital temperature sensing equipment is used to monitor the heat outputs from the fire.
- Areas of the building or specific items requiring specific attention will be adequately encased with the combustible material to ensure thorough decontamination during firing.
- Firing will only take place when the weather is "suitable" (i.e. no high winds or heavy rain is forecast, and wind direction is forecast to be away from built up areas. Wind socks will be employed to monitor wind direction). Notification will be provided to the Environmental Health Department of Renfrewshire Council and other relevant bodies i.e. Health and Safety executive, local police, local fire brigade, Network Rail, Glasgow Airport Authority (BAA), and to Bishopton Community Council at least 24 hours before the planned "firing".
- Buildings will be monitored to ensure that the fire does not flare up due to high winds. The following day, when the building has cooled, it will be inspected to ensure that it was fully decontaminated by the burn. Suspect or failed procedures will be investigated and documented then repeated.

### **7.6.3. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the HSE Expl. after demolition has been carried out.

## **7.7. Building Demolition**

For previously contaminated structures on completion of burning, the structure will then be demolished using traditional methods and the materials arising separated for recycling. Manufacturing and process plant left in buildings to be decontaminated with the building (by burning) will be segregated for recycling during the demolition process.

'Uncontaminated' buildings will be stripped of asbestos containing materials, demolished using traditional methods and the resulting materials segregated for recycling.

Building ground slabs will be removed in the CDA. Existing building foundations will be removed in the CDA, however piles deeper than 2 metres below existing ground level (bxgl) will be cut off at that level and the remainder surveyed and recorded and left in

situ. Similarly other foundation configurations existing at or 2 metres below ground level will be left in situ. The locations of retained substructures will be surveyed and recorded to facilitate future new foundation positioning etc. The resulting materials (uncontaminated) will be recycled.

Ground slabs and foundations will remain in-situ in the non CDA parts of the Site. These floor slabs will be perforated by cracking to allow drainage. These ground slabs will be capped over with clean soils to an average depth of 300mm to provide sufficient material to sustain plant growth. The finished form will be hydroseeded to advance the growth of vegetation. Soils for this capping will be sourced from local building mounds etc. The addition of soil ameliorants such as compost may be required to improve the quality of the soils. The locations of retained substructures will be surveyed and recorded.

### **7.7.1. Recycling**

Concrete and brick will be separated and crushed / screened mechanically to provide aggregate for use within the remediation infrastructure (creation of plant access roads) and / or the development infrastructure e.g. road sub-base, drains. This material may also be used to improve public access in the Recreational Open Space.

### **7.7.2. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the HSE Expl. for agreement to revoke explosives licensing on those buildings which have licences attached and are now decontaminated and demolished.

## **7.8. Above Ground Utility Services**

Above ground utility service routes will be removed for recycling or disposal as appropriate. Asbestos insulated steel steam mains have been stripped during the decommissioning of the Site in readiness for removal of pipework and support structures.

Electrical substation plant will be decommissioned by a specialist contractor under the supervision of BAE Systems Environmental. Thereafter, the structures will be removed in the CDA and demolished to ground level in other areas of the Site.

PCB contaminated soils have already been identified in the vicinity of the selection of substations investigated in the Phase 1 Site Investigation. The identified contamination will be further delineated as part of the Stage 2 Site Investigation and the other substations will be similarly investigated. Contaminated soils will be treated in a similar manner to other contaminated soils on the Site. This may also require pre-treatment of contaminated soils prior to landfilling.

### **7.8.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

## **7.9. Foul and Surface Water (Process) Drainage**

The potential exists for contaminants to accumulate within foul and process drainage runs. Process drainage runs are defined as any drainage receiving process

effluents/trade wastewaters. A programme of inspection of representative drainage runs across the Site will be undertaken as part of the Stage 2 Site Investigation. This will involve detailed visual inspection of a representative number of drainage runs as well as sampling and analysis of samples of sediment from within the runs and in some cases the surrounding soils. The information gained from this process will allow risk assessments to be undertaken to facilitate the safe decommissioning and removal of contaminated drains within the CDA. In the remainder of the Site, the information will be used to identify drainage runs that require to be decontaminated and/or removed. Uncontaminated drains will be left in-situ except where they occur coincidentally with removal of contaminated ground.

The ground surrounding any removed drains will be subject of confirmatory testing and any contamination dealt with in an appropriate manner i.e. either treated or disposed of to landfill.

Surface water drains e.g. clay pipe, may be removed, particularly where they occur coincidentally with removal of contaminated ground. Any surface waters drains that it is proposed to leave in-situ will firstly be checked for contamination and dealt with accordingly.

#### **7.9.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

#### **7.10. Bulk Storage Tank Removal**

A number of above ground storage tanks (AST's) and underground storage tanks (UST's) exist across the Site. These are mainly associated with former production areas and have been used for the storage of various substances/liquids.

The locations and contents of these tanks have been identified within the Desk Study and the majority have been emptied as apart of the decommissioning works already undertaken. However, each tank will be inspected, tested and certified as gas free prior to full decommissioning. All above ground tanks as well as below ground tanks in the CDA will be removed following this process. Below ground tanks in the remainder of the Site may be grouted up and left in-situ with their locations surveyed and recorded. The emptying and safe removal/treatment of the tanks will be proposed on an individual basis.

The area surrounding the tanks will be subject of a confirmatory testing regime with any contaminated soil being remediated.

#### **7.10.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

#### **7.11. Roads, Rail and Narrow Gauge**

All roads, broad gauge and narrow gauge railway will be removed in the CDA except for roads to be used during the implementation phase of the remediation works. These will be removed when no longer required. More information is required in relation to the potential for contamination to exist beneath these areas and it is considered likely that some remediation will be required where significant quantities of ash and clinker are

present. The additional sampling will be undertaken during the Stage 2 Site Investigation and an appropriate management plan built into the final detailed Remediation Strategy.

As similar programme of inspection and analysis will be undertaken outwith the CDA. Where contamination is found and is assessed as contributing to significant pollutant linkages then it will be removed or treated, for example by encapsulation. However, the general philosophy in the woodland park would be to employ remediation methods that minimise disturbance to existing habitats as far as is reasonably practicable. It is also desirable to retain as many existing access roads as possible as these could be used for future access and management of the woodland park, avoiding the construction of new roads for this purpose which could further impact on exiting habitats.

#### **7.11.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

#### **7.12. Explosives Fragments**

Propellant strands (discrete pieces of propellant) have been identified as contributing to significant pollutant linkages along the lengths of narrow gauge within the gun propellant section of the former factory. Removal of propellant from hard surfaces is proposed by mechanical sweeping and vacuuming.

Various methods to deal with the adjacent soft verges or other soft surfaces are currently being considered such as controlled burning along the verges, excavation and sorting or washing, although the final method to be employed will be dependent upon the actual areas that require to be remediated (this will be further delineated through the Stage 2 Site Investigation) and the effectiveness of the various techniques being considered. It is proposed to undertake trials during the Stage 2 Site investigation.

Validation of effective treatment/removal will be by systematic visual inspection. If required, the excavated areas will be backfilled with 'clean' soils generated on site.

#### **7.12.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

#### **7.13. Explosives Devices**

Further inspections and investigation is required in the former munitions storage areas and former Georgetown filling factory of the Site during the Stage 2 Site Investigation. This will involve a combination of visual inspection, clearance of demolition materials and geophysical surveying and excavation of anomalies. In addition, visual inspection for small devices (eg fuzes) will be undertaken during the remediation of the burning grounds. Any discovered munitions will be dealt with by a qualified and experienced explosive ordnance disposal (EOD) operative. Should any explosive devices be discovered then the location will be marked and the advice of the EOD operative will be sought as to safe removal, storage and disposal of the item.

#### **7.13.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

## **7.14. Earth Mounding (Traverses) Surrounding Buildings**

Earth mounding (traverses) exists around a number of structures on the Site. Contamination has been found to be present around such process buildings although appears to be concentrated in areas around the access and egress to the building. Further delineation of the contamination at such 'hotspots' will be undertaken in the Stage 2 Site Investigation to determine the extent of such contamination. Contaminated mounding material will be dealt with in a similar manner to other contaminated soil identified on the Site.

If the remainder of the mound material is proven suitable for use by sampling and appropriate testing, this material will be re-used on the Site for landscaping or engineering works. The potential exists for gravel and sand materials to be recovered from some types of moundings and, subject to quality testing, this will be retained on the Site for future re-use as fill material.

### **7.14.1. Record Keeping**

Records will be strictly maintained at all stages of the process for inclusion in close out reports for submission to the regulating authority.

## **7.15. Earthworks**

### **7.15.1. General Philosophy**

The earthworks strategy includes measures to ensure that final ground conditions on the Site are acceptable in terms of the following:-

- To remove significant pollutant linkages where necessary to protect development workers and future residents to residual low-level contamination.
- The possible affect on other features of the development such as trees, other vegetation and construction materials.
- The potential for off-site effects through contaminant migration in groundwater or surface water run-off.

The strategy proposed for ground remediation at the Site is designed to be:-

- Sufficiently robust to satisfy and provide confidence to the various authorities, the developer and future residents.
- Capable of providing protection and confidence over the full lifetime of the proposed redevelopment.
- Robust enough to take account of predictable changes in legislation and public perception of the implications of potentially contaminated land.

### **7.15.2. Identified Contamination**

All materials identified in the GQRA (and as summarised in sections 3 and 4) and DQRA as requiring remediation will be either treated (such that it can be reused) or removed to a licensed landfill. Excavations will generally be limited to the extents of the identified source area that will be further informed during the Stage 2 Site Investigation. In the

event that the interface with the underlying 'virgin ground' is contaminated, a further 0.25m of soil will be removed/treated. Excavation surfaces will be subject to confirmatory sampling and analysis as described above and further removal/treatment undertaken if concentrations still pose a risk.

In some instances, for example at Boghall Dump, contamination will be dealt with by breaking linkages through the installation of barriers i.e. encapsulation with uncontaminated materials. It is proposed to use material won from site to undertake such works when possible.

### **7.16. Waste disposal**

Remediation of the Site will generate a significant quantity of waste material that either has to be removed as part of a risk management strategy (see Section 7.12) or due to its unsuitability for other purposes e.g. geotechnically unsuitable material. The principles of the waste hierarchy (reduce-reuse-recover-disposal) will be followed on site with a dedication to reducing the amount of waste generated, reuse as much material as possible and recovering all allowable material/energy. Waste for disposal will, however, be generated on site and the final disposal of this waste will need to be decided following the best practicable environmental option.

A strategy for an on-site facility for the disposal of contaminated materials (including soils) and waste arising from remediation has been identified as a necessary component of the remediation strategy in view of the scale of the project.

There are many benefits to on-site disposal, including:

- Supports the proximity principle that waste should be disposed of as close to the production source as reasonably practical
- Economic viability
- Reduction / minimisation of off-site traffic movements and, therefore, disturbance to local environment (noise, dust, fuel use, wear and tear of local roads etc)
- Convenience of immediate availability causing no disruption to project programmes

The estimated quantity and variable nature of material to arise from the remediation of the Site will require a facility capable of receiving all envisaged waste categories but principally contaminated soils (heavy metals, hydrocarbons, explosives residues, asbestos), burning ground materials, other previously tipped materials and asbestos containing materials from buildings.

Bulk explosives and liquid wastes will not be disposed of within the facility. Explosive wastes will be disposed of at dedicated and licensed burning grounds within the Site, whilst liquid wastes will be treated/disposed of off-site to an appropriately licensed facility.

The facility will require to be licensed and regulated by the Scottish Environment Protection Agency (SEPA) under the Pollution Prevention and Control Regulations 2000 and will comprise engineered containment cells, most likely a land raise facility. It will be required to be licensed to accept 'hazardous waste'. Construction of the facility will require significant quantities of uncontaminated low permeability strata, such as boulder clay, which it is intended to win from the Site itself.

Considering the future likely development growth scenario, and assuming that the rate of remediation is similar (following a phased approach), a dedicated on-site facility will be required to remain operational throughout the development period (2008 – 2023).

Other categories of waste may include materials that are either surplus or unsuitable for use within the Core Development Area. Providing such materials are suitable for use at other locations on the Site (i.e. do not pose a risk to either human health or the water environment in that new use), they will be used in accordance with any regulatory controls that are required such as waste management exemptions. It is proposed that these areas will be landscaped to provide a useful, aesthetically pleasing feature(s).

BAE Systems will liaise closely with stakeholders to progress a sustainable waste management strategy that complies with best practice and relevant legislative controls.

### **7.17. Verification Plan and Verification Reporting**

The verification plan sets out the requirements for gathering data to demonstrate the effectiveness of the remediation in terms of meeting the remediation objectives. A draft plan will be submitted as part of the Draft Detailed Remediation Strategy that supports the detailed planning application for the works. The plan will then be finalised and agreed with the local authority prior to implementation of the works.

The plan will include, but is not limited to, the following information:

- Introduction and background
- Remediation Criteria
- Outline of the remediation works to be undertaken
- For each element of remediation, the measures to be employed to validate its successful completion
- Responsibilities for carrying out measurement and tests
- Reporting requirements
- Procedures to deal with non-performance
- Schedule of third party contacts
- Key criteria to be met to discharge any planning conditions

#### **7.17.1. Key Consideration**

The following key considerations will be included in the verification plan:

##### ***Confirming that identified pollutant linkages are not significant***

As outlined in sections 4.2 and 4.3, there are a number of pollutant linkages that have been determined as not being significant although it is recommended that a larger data set be obtained to confirm this in the CDA. It is therefore proposed to undertake additional sampling in the CDA as follows:

- 30m grid in residential areas with analysis for Lead, Arsenic, Cadmium, Nickel, speciated PAHs, asbestos and explosives.

- 50m grid in commercial/employment areas with analysis for Lead, Arsenic, Cadmium, Nickel, speciated PAHs, asbestos and explosives.

### ***Confirming effectiveness of remediation***

The finalised sampling protocols will be appropriate for the eventual remediation techniques employed such that the effectiveness of the remediation can be measured with confidence. However, some of the key principals to be employed in developing the plan are outlined below:

- As built drawings will be produced where appropriate to detail the actual extent of works that have been undertaken e.g. excavations, encapsulation etc
- For point source contamination, sampling will generally be in the base and sides of excavations to confirm sufficient removal. This will apply to burning grounds, tips, hydrocarbon sources (from tanks, PCB sources).
- For propellant on narrow gauge and asbestos beneath steam mains, systematic visual inspection will be undertaken to confirm sufficient removal.
- Further information is required in relation to the extent of remediation required around buildings. Once the delineation works have been completed and excavation extents agreed with the regulatory authorities, the validation will be undertaken by the production of as-built drawings verifying the removal. Confirmatory analysis will also be undertaken as a part of the general validation works (i.e. on 30m grid in residential areas and 50m grid in commercial/employment land).
- Linear sources such as roads (tarmac) and broad gauge, will be sampled at an appropriate frequency along their lengths. The frequency will be determined following the Stage 2 Site investigation works where more information will be available on the vertical and lateral extents.
- Where treatment processes are being undertaken and the intention is to reuse the material on site, acceptability criteria will be agreed with the regulatory authorities as well as the level of sampling required to demonstrate compliance
- Analysis will be for determinands that contributed to significant pollutant linkages for which remediation was required.

### ***Other Monitoring***

The frequency of other monitoring and testing will also be set out in the verification plan. This will include:

- Testing of quality of any imported materials or materials won from site to ensure that they are suitable for use.
- Water quality monitoring programme (both groundwater and surface water) to measure the effectiveness of mitigation measures employed and to ensure compliance with any regulatory discharge consents or controls. A groundwater and surface water monitoring programme is already being implemented to provide baseline data prior to the works commencing.
- Topographical surveying to produce as built drawings for capping thicknesses, excavation depths, changing profiles etc

- Air monitoring programme at agreed locations (e.g. dust)
- Measurement of other specific remediation parameters required for remediation treatments e.g. various parameters during bioremediation, effectiveness of soil stabilisation

### **7.17.2. Verification Reporting**

The output from the Verification Plan will be reported in a series of verification reports as each phase of remediation is completed. These reports will include, but not be limited to, the following elements:

- Details of the actual remediation works undertaken including emissions controls employed and their effectiveness
- All outputs from the Verification Plan to demonstrate attainment of remediation objectives
- Final site condition status and any post-remediation management required
- Any post-treatment management needs such as on-going monitoring, constraints on future activities etc
- Supporting information in a series of appendices such as photographic records, as-built drawings, in-situ test results, laboratory analysis, plans showing sampling locations (referenced to OS Grid), health and safety documentation, quality management systems employed etc.

### **7.18. Recompaction**

Any recompactation of filled materials will be carried out in accordance with Highways Agency, Manual of Contract Documents for Highway Works, Volume 1, 'Specification for Highway Works', Method Specification. Compaction trials may be performed prior and during the works, to assist with the selection of appropriate materials.

It should be noted that Method Compaction does not guarantee any particular geotechnical performance.

Materials placed in Landscape Areas and areas outwith the CDA will be lightly recompacted by 'tracking in' during placement to help minimise future settlement.

### **7.19. Landscaping**

#### ***Interim Landscaping***

Fully remediated disturbed areas of the Core Development Area on which new development is not expected to proceed for a period in excess of 1 season will be hydroseeded in accordance with the following specification:

Apply by hydraulic seeding method:

- Legume mix, Perryfields Ltd Pro 105 or similar
- Rate of application: 5g/m<sup>2</sup>

Note that the surface treated above will consist of relocated sub-soils, clays and sands. These materials will be capable of sustaining at least minimal growths of hydroseeded cover.

Remediated areas outside the development area will be left to allow the natural vegetation to develop unless other requirements are specified by the landscape architect. This will aid the wildlife in these areas.

### ***Final Landscaping***

Provision of final landscaping solutions in the Core Development Area will remain subject to detailed development design. It is not anticipated that landscaping will be carried out during the remediation process. However in order to rationalise the levels across the CDA it will be necessary to undertake a 'cut and fill' profiling exercise to create a suitable development platform. The material generated will provide a surplus of approximately 225,000m<sup>3</sup> of which some selected geotechnically suitable material may be used for filling in the CDA and likewise some in the non CDA areas; the balance being used to construct landscape / recreational features in appropriate parts of the Site.

Outwith the CDA, provision of final landscaping solutions will also remain subject to detailed development design. Unlike the CDA it is anticipated that final landscaping will be carried out during the remediation process and therefore advantage will be taken of the likelihood of significant quantities of filling material being available for construction of landscape / recreational features in appropriate parts of the Site.

## **8. WORKING PRACTICES**

### **8.1. Control of the Project**

It is essential that the remediation works proceed in a controlled manner, supervised by appropriately experienced and qualified personnel. The following personnel will be appointed.

**Planning Supervisor** - The Planning Supervisor is required by law (CDM Regulations) to be a competent person appropriate for the risks involved. The risks associated with this project include contaminated land, explosive articles/contamination, demolition and ground works.

**Project Manager** - A Project Manager will be appointed who is a competent person to assess any requirements emerging from changing or unexpected site conditions as the works proceed.

**Principal Contractor** - The Principal Contractor will be BAE Systems Environmental who will manage the works and sub-let specialist work packages as required. The sub-contractors appointed will have a demonstrable capability to work with the specialist risks present on the Site, and insurances policies to cover such risks. The Principal Contractor will employ a management team on site during the works.

It is currently intended that BAE Systems Environmental we fill all three roles above. This model has been successfully used on other BAE Systems projects. The Health and Safety Executive are the regulatory authority for the Construction Design and Management regulations and will monitor the works under these regulations.

In addition, various other regulatory controls and consents will be required in relation to waste storage and treatment, works on water courses etc which the Scottish Environment Protection Agency (SEPA) regulates and monitors.

Other controls are likely to be enforced by the local Planning Authority through conditions on Planning Consents for the Remediation and Earthworks. The local authority also has powers to deal with specific environmental issues such as noise, nuisance etc.

### **8.2. Health & Safety**

The basis of UK health and safety law is the Health and Safety at Work etc Act 1974. The Act sets out the general duties that employers have towards employees and members of the public, and employees have to themselves and to each other. Specific regulations made under the 1974 Act will be applicable to the remediation works. These regulations require action in response to particular hazards, or in industries where hazards are particularly high. Some of these are listed below:

- Management of Health and Safety at Work Regulations 1999
- Personal Protective Equipment at Work Regulations 1992
- Provision and Use of Work Equipment Regulations 1998
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR)

- Noise at Work Regulations 1989

The family of regulations made under the 1874 Act are supported by much guidance and approved codes of practice. The Health and Safety Executive is the regulator for the regime.

In particular, the project will come under the Construction Design and Management Regulations 1994. The Site will have its own Health and Safety plan which will be updated as the project progresses. This will incorporate best practice guidance published by the HSE, Scottish Executive and DEFRA. The Health and Safety plan will cover all aspects of the project including training records, accident book, risk assessments and method statements or procedures.

All employees will undergo a site induction before starting work and all work will be risk assessed before commencement.

Procedures will be developed for:

- Identification and handling of potentially hazardous materials/articles
- Personal Protective equipment to be used
- Permits to work, restricted areas, prohibited operations
- Personal hygiene, housekeeping and safety
- Actions to be taken in an emergency (Contingency Plans)

Buffer zones will be created between any new development and the works. All remediation works will be a minimum distance of 130m from any new development, except new roads under construction. No building decontamination, will be nearer than 300m to any new development except new roads under construction.

Before appointing any contractor, BAE Systems Environmental must be reasonably satisfied that those being appointed have demonstrated that they are competent and have allocated sufficient resources to complete the project and fulfil their obligations under all relevant health and safety legislation.

Contractors are preferably selected from our Approved Suppliers List, and where appropriate a competence assessment will be carried out.

### **8.3. Remediation Lighting**

The lighting requirements for the works will include lighting of the site compound (necessary for safety and security). Lighting may be required during normal working hours in winter months. Light will also be generated by construction traffic moving around the Site. This impact will be limited by restrictions on working hours and is expected to be less than when the Site was operational.

### **8.4. Noise Control**

The Principal Contractor will ensure that statutory guidance thresholds are not exceeded. The measures will include:

- Working hour restrictions for general operations

- Regular plant maintenance ensuring plant is operating within acceptable noise levels
- Use of sound minimising techniques for plant and equipment used in noise sensitive areas
- Where appropriate minimising noisy operations at unacceptable times
- Positioning of stone crushers centrally on the Site, if required, at least 100m from the nearest private dwelling.
- Maintaining tree cover / screening where possible
- Monitoring activities where appropriate with action levels triggering remedial response

### **8.5. Dust Control**

Inevitably dust will be generated by plant and machinery undertaking remedial activities, particularly in dry conditions. A detailed mitigation plan will be developed and agreed with the regulatory authorities for the minimisation of airborne dusts etc. before any works commence. Minimisation of dust nuisance and windblown pollution will be undertaken by the following;

- Damping down with water;
- Fine water mist curtains;
- Maintaining tree cover/screening where possible;
- Monitoring activities where appropriate with action levels triggering remedial response;
- Active traffic management.

### **8.6. Community Consultation**

The remediation strategy will contain a community consultation programme to follow throughout the period of the works. The programme will be based on regular forums continuing the work of the existing Bishopton Community Liaison Group to include the following components;

- Exchange of information about site activities;
- Inform on progress;
- Co-ordinate traffic movements off site;
- Receive and act upon complaints;
- Discuss concerns and eliminate anxieties.

It is proposed to include this project in the Considerate Constructors Scheme. This scheme looks at the competent management, efficiency, awareness of local environmental issues and above all neighbourliness.

This scheme commits those contractors to be Considerate and Good Neighbours, as well as Clean, Respectful, Safe, Environmentally conscious, Responsible and Accountable.

BAE Systems has previously won awards under this scheme.

### **8.7. Record Keeping**

A daily site record will be kept on site that will record all significant day to day activities carried out, weather conditions, visitors and incidents etc.

A report file will also be developed containing all sample and analysis records. The file will include such drawings and plans as are necessary to identify the location of samples.

A Health & Safety File will also be kept in accordance with the requirements of the CDM Regulations.

### **8.8. Explosive Licensing Issues**

Explosive Licences for the former explosive processing and storage buildings on the site are in the process of being reduced to a nominal 1 kg limit per building. This is at the request of the Explosives Inspectorate of the Health and Safety Executive to reflect the contaminated status of the buildings.

As part of the decontamination process, working methods and the proposed programme will be agreed with the HSE. As the buildings are decontaminated within each area, the Explosive Licences will be surrendered following sign off from the HSE. As decontamination progresses, the red line that demarks the explosive licence boundary will gradually contract to allow development to proceed on a phased basis.

### **8.9. Vehicle Routing and Access**

Remediation construction traffic will access the Site from a new access to be formed off Houston Road (subject to planning approval). Other traffic will be limited to remediation workers arriving and departing each day by private car.

During the works it will be necessary for various plant, equipment, etc to be transported to the Site. Traffic movements will be kept to a minimum. Wherever possible we will recycle site arisings e.g. crushed concrete, timber, etc. and use local resources where there is a requirement to import materials. Off-site vehicle movements will be restricted to minimise contamination of public highways. This will be supplemented, if necessary, by road sweeping and measures to prevent material being tracked off-site

We propose to use innovative techniques such as the use of geotextiles and geogrids to minimise the effect of vehicle movements, not only on the haul roads, but also on the land adjacent to the haul roads. We have experience showing the positive benefits of such measures, not only on the direct impact on the roads themselves, but also in terms of noise, vibration and dust generation on the immediate environment. Innovation will also be sought from personnel involved in traffic movements during project reviews and team talks to identify any further areas for improvement or an alternative, more effective approach.

### **8.10. Protection of the Water Environment**

We intend to incorporate into the scheme pollution prevention measures and emergency procedures. The main risks to the Site during the works is silt run off to surface waters although there is also the risk of mobilisation of contaminants to groundwater through the exposure of new surfaces during the movement of contaminated materials. There

are also risks associated with other activities such as refuelling, fuel storage, waste treatment and disposal. These will be covered in the general site procedures.

The works on the Site will follow the SEPA guidance provided in their pollution prevention guidance notes and in particular the following:

- PPG1 'General guide to the prevention of water pollution'
- PPG5 'Works in, near or liable to affect watercourses' and
- PPG6 'Working at construction and demolition sites' PPG 6.
- PPG7 Refuelling facilities

They will also be in accordance with any requirements under The Water Environment (Controlled Activities) (Scotland) Regulations 2005. These regulations will cover any discharges, abstractions or impoundments that may be required as well as specific engineering works.

In particular, and in relation to silt control, the following measures will be used:

- Site roads will be brushed, scraped or sprayed and approaches to stream crossings will be brushed or scraped to reduce dust and mud deposits.
- There will be a number of large stockpiles of crushed brick and concrete. These will be positioned away from the surface waters on site and will be kept to a minimum by recycling this material on site.
- When specific areas have been remediated they will be hydro seeded with grass to minimise the amount of exposed soil.
- While areas are being remediated, existing drains will be blocked at manholes to prevent accidental discharges. Run-off surface water will be channelled to settling ponds.
- Temporary lined lagoons will be constructed to allow settlement of solids prior to discharge of water to existing surface waters. They will be constructed such that the retention time is sufficient to meet discharge standards permitted although use may also be made of flocculants to aid settlement in the lagoons and reduce the retention time required. The lagoon construction details and locations as well as the licensing arrangement for controlled discharges to the existing watercourses will be as agreed with SEPA. We will endeavour wherever possible to choose settlement lagoons locations that are coincidental with the proposed retention ponds as part of the developments SUDS scheme. However, it is recognised that the settlement lagoons used for remediation will require to be 'decommissioned' prior to use in the SUDS scheme. Use may also be made of the existing concrete lagoons as temporary settlement / retention ponds.
- The settlement lagoons will be decommissioned when no longer required. This will include the cleaning out of silt deposits with appropriate disposal.
- Where final polishing is required to meet discharge consents then wetlands may be introduced.

### **8.11. Preservation of Trees and Natural Habitats**

Where any trees are identified as adding value (mature broadleaf) to the completed development and if remediation permits, these will be left in place during the remediation phase. They will be protected by a 1m chestnut pale fence or similar, positioned at a minimum distance from the outer tree trunks equal to the crown spread of the trees or along the edge of adjacent roadways if necessary.

There will however be a requirement to remove some trees as follows:

- To ensure effective remediation
- For health and Safety reasons during the decontamination process
- Habitat enhancement for wildlife on site.

Due to environmental constraints (e.g. the nesting season for birds) some of this work can only be carried out during part of the year. Approvals will be gained from the appropriate authorities prior to undertaking felling works.

Recycling of the arisings will be undertaken where possible. Some timbers from the tree felling operation may be a suitable fuel in the decontamination process. Other uses may be as mulch as soil enhancement medium.

### **8.12. Protection of listed buildings**

On site there is one listed building just outside the development area, Dargaval House. This will be protected during the works to prevent unauthorised access. The building will be fenced with 2m temporary fencing, placed a minimum of 15m from the building. This does not preclude any authorised remediation works taking place within the protective fenceline where required.

### **8.13. Stockpiles**

During the course of the reclamation and recycling works, volumes of crushed concrete and brick will need to be stored on site. Currently it is proposed to store crushed brick and concrete at a number of locations through each phase of the project such that they can be easily accessed when required, do not interfere with remediation/redevelopment and are positioned away from surface waters. Approximate locations are indicated on Drawings 1-8.

Storage of other materials will be carried out in discrete areas of the site. Soft-strip activities will temporarily produce piles of timber, metal and other materials that will be removed by the Demolition Contractor for disposal or recycling.

### **8.14. Recycling of Construction Materials**

The remediation has been carefully planned to be fully sustainable. All arisings will be recycled wherever possible, it is estimated that recycling will generate approximately 300,000m<sup>3</sup> of crushed concrete and brick hardcore.

Any scrap metal will necessarily be reprocessed off site, as no alternative exists to off site disposal.

Crushed concrete and brick hardcore are resources of value to the redevelopment, and thus significant volumes will be re-used on site during the redevelopment. It is not

possible at this stage to estimate the total proportion required by the redevelopment, since there are many variables, the principal one being the level of acceptance by the statutory authorities (i.e. Building Control Officers, Highways Engineers etc) of the use of secondary aggregates.

Building decontamination and demolition will produce a variety of materials with potential for recycling. Metals will be sent for recycling off-site whilst concrete and brick will be separated for potential future use on site. Specific uses may require these materials to be crushed, screened and graded to comply with specific engineering specifications to facilitate its reuse in the development works.

#### **8.15. Japanese Knotweed**

There are a number of locations where Japanese Knotweed is present. This is currently being actively managed through a programme of spraying. Any areas that still remain during the period of remediation will be treated as 'contaminated' and will be removed as a controlled waste to landfill in accordance with the regulations (The Wildlife and Countryside Act 1981 (as amended by the Nature Conservation (Scotland) Act 2004)) and Horticulture Code of Practice (Scottish Executive).

#### **8.16. Site Security**

The current perimeter fence and 24hr security arrangements at the Site are deemed adequate to prevent unauthorised access.

As remediation progresses and areas of the Site are released for development, the security fence will be moved accordingly. This will comprise 2m high chain link type sectional fencing system appropriately secured to prevent unauthorised access. Security arrangements will be sufficient to maintain the security and integrity of the remediation areas.