

Monckton Re-Development Site Investigation Scope of Works Former Monckton Coking Works

Envirotec Ref: ESG/FG2/SoW

Revision: -

Issue Date: 04 December 2019 v3

Client Name: Monckton Redevelopment Limited

Site Address: Former Monckton Coking Works, Royston, Barnsley

Site Investigation Strategy

Client: Monckton Developments Limited
Project: Former Monckton Coking Works
Report Type: Site Investigation Scope of Works
Report Reference: ESG/FG2/SoW
Revision: -
Report Status: **Issue 03**
Date: 04 December 2019

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For and on behalf of **Envestigate/Geo2 Ltd**



Site Investigation Strategy

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Site Investigation Strategy

1.0 Introduction

1.1 General

This report outlines the proposed Site Investigation Strategy to delineate and confirm ground conditions at the Former Monckton Coking Works, Royston, Barnsley.

A Summary of the previous phases of Site Investigation has been completed and this report should be read in conjunction with both the Main Site Summary and West Site.

- Data Review and Gap Analysis, Former Monckton Coking Works, October 2019.
19/B010.1.2. Geo².
- Data Review and Gap Analysis, Former Gas Purification Plant, November 2019.
19/B010.2.2. Geo².

This document and the information in it are provided in confidence, for the sole purpose of providing detailed, fully-costed proposals in line with this brief/specification and may not be disclosed to any third party or used for any other purpose without the express written permission of Monckton Developments Limited (Client).

1.2 Development Proposals

It is proposed to undertake the site investigation works described herein to characterise the ground conditions on the site to allow it to be put to market. At this stage there is no requirement to undertake a site investigation suitable for discharge of planning conditions.

1.3 Roles and Responsibilities

This proposed strategy has been produced by Envestigate Limited, and Geo² Remediation Limited working in conjunction.

Geo² Remediation Ltd (Geo²) are a specialist remediation contractor, they will undertake the investigation, factual and interpretative reporting with a view towards developing a detailed remediation strategy in future.

Envestigate are a specialist environmental, planning and waste management consultant and will act as planning consultant.

Any appointment should be made directly to Geo², who will engage Envestigate as a subcontractor.

Site Investigation Strategy

The contact for Geo² will be:

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1.4 Objectives

The objectives of these site investigations are:

- To investigate the shallow subsurface strata with respect to historic substructures.
- To determine the general chemical condition of site soils (suitability for re-use, remediation requirements & waste characterisation).
- To determine the extent of contaminative impact on underlying groundwater.
- To identify and determine the extent of NAPL contamination within soils and groundwater.
- Assessment of shallow and deeper coal workings where relevant.
- Provide information to allow an assessment of the ground gas regime to be calculated.

An interpretive report documenting all the above will be provided upon completion of works to inform decision making and allow detailed scoping and costing of future remediation works.

1.5 Site Location & Description

The subject site is located off Lund Hill, Royston Barnsley.

The approximate centre of the subject sites are located at Ordnance Survey National Grid Reference 437460, 412020.

The site is currently predominantly vacant and levelled, with relic partially demolished structures in the centre of the site and a series of outbuildings and occupied units including a sub-station, located onsite. For convenience many of the historic reports have separated the site into three key areas, divided by the current and historical activities which have taken place. These area designations and names will be adopted herein.

- **Stockyard Area**
The northernmost portion of the site; formerly occupied by the coke and coal stockyards. This area was the hub of the former colliery operations including numerous buildings and rail tracks.
- **Former Production and By-Products Area**

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This forms the centre of the site including the Combined Heat and Power (CHP) infrastructure, coking ovens and conveyors. This area includes plant associated with production of tar, benzole and ammonia.

- Southern Area

This area contains the effluent treatment plant and is predominantly wooded with coarse vegetation and semi-mature trees. Much of this area slopes steeply to the south.

- Western Area

This area lies to the west of the railway lines. This parcel of land is understood to be out-with the boundaries of this site. It is understood that this area was formerly linked with a bridge to the main site and historically has been used for deposition of colliery spoil and more recently gas purification, storage and distribution.

The surrounding land uses are described as follows:

North	Agricultural land and commercial facility, approximately 120m to the north. Beyond which lie disused industrial and agricultural land.
East	Lund Hill Lane (B6428), beyond which lies grassed disused industrial land and a timber recovery facility.
South	Lund Hill Lane (B6428), beyond which lies former industrial land now Rabbit Ings Country Park.
West	Railway Cutting, beyond which lies agricultural land and residential properties approx. 120m beyond the site boundary. The Barnsley Canal lies approximately 200m to the west.

1.6 Site Areas

The site is broken down into a series of sub areas. These are discussed in the Geo2 Data Review and Gap Analysis Report (October 2019) and is repeated below for ease of reference.

1.6.1 Main Site

Stockyard and Former Colliery

This area is currently level and largely demolished to slab level, with the exceptions of the Engineers Workshop building and occasional small structures. The former structures in this area were used as workshops, mobile plant refuelling, effluent handling and storage.

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The bulk of the stockyard was used for the storage of coal, with approximately 100 No. twenty tonne lorry movements delivering coal and removing coke from the site daily during operations. Tipped coal was lifted from stock and conveyed to a 1,300-tonne storage bunker, before being conveyed to a 500-tonne bunker and into the coke ovens. This area appears surfaced with a thin layer of black coke dust 'breeze'; this is clearly apparent in the aerial photo used in Figure 3.

In the northwest corner of the site remain a series of Quench Ponds which appear to remain intact and holding water.

Three mine shafts are understood to be present in this area, records indicate these have been capped.

A portion of the stockyard area, labelled on Figure 3 as 'Unused Area' is present at a higher level, matching the height of the surrounding land beyond the northern boundary. This area appears to be vegetated.

The engineering workshop was situated adjacent to a waste storage and collection area. A substation is also indicated to be in this area.

Currently large stockpiles of high silica content brickwork associated with the demolition of structures onsite remain present on the site.

Coke Production Area

Figure 4, in Appendix A, shows a layout drawing of the Coking Works onsite this process comprised coal carbonisation. Carbonisation is the thermal process for the conversion of coal into coke, involving a sustained high temperature in ovens for eighteen hours in the absence of air. On this site five batteries of ovens (42 in total) were located at the northern boundary of this area, adjacent to the stockyard giving access to coal.

The coal is heated indirectly through heat transferred through the refractory walls from flues running along each long wall, in which coal gas is burnt under controlled conditions in air. The coal gas produced is collected in a gas collection main. Recovered gas used to fire the ovens is a portion of that drawn from the coal during carbonisation. Recovered gas is purified and added to a preheated air stream back into the ovens.

Once heating is complete, coke is pushed by a ram into a rail mounted coke car. Exposure to the atmosphere allows the coke to burn, which is extinguished using a quenching rig at the rear of the ovens.

Coke is screened and cut to size at the Coke Wharf before transport back to the Stockyard area.

By Product Processing

Pre-treatment of coal gas results in the generation of a series of by-products, used in the coke works process.

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Gases recovered are treated in the Concentrated Ammoniacal Liquor plant. The gas collected from the main is cooled using five heat exchangers (Primary coolers), this separates out the tar and ammoniacal liquor. Tar is separated from gas using an electrostatic detarrer for storage and resale. Ammoniacal liquor is separated by ammonia washers, spraying water through the gas. The gas then passes through Benzole Scrubbers where wash oil recovers the benzole (a mix of benzene, toluene and xylenes). The wash oil is distilled with steam to recover the benzole as a saleable commodity. Vapours are condensed to give a saleable product with approximately 20% ammonia and 2% sulphide.

60% of the cleaned gas is used onsite in the CHP supplying steam and power for the works. Surplus power is sold on the National Grid. Treated gas was stored onsite in a 1,400m³ capacity gas holder.

Treatment is understood to have comprised mixing effluent with biological sludge and oxygen to degrade organic compounds to carbon dioxide.

More recent reports suggest that an electric substation may also be present close to an area of removed Ammoniacal Liquor tanks near to the gasholder.

Southern Site Section

This area has generally had few industrial applications and contains the Biological Effluent Treatment Plant.

The stripped liquor is pumped to a biological effluent treatment (BET) plant, which is used to treat drainage prior to discharge to sewer. It is understood that this plant also treated water from Lineside Dyke on the western boundary of the site.

The steeply sloping land levels and terraced areas of this portion of the site are noted to be suggestive of infilling with colliery spoil.

1.6.2 Western Land Parcel

This parcel of land falls out with the boundary of the site, although records indicate the deposition of colliery spoil and uses in the purification, storage and distribution of gas produced on the site.

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2.0 Areas of Uncertainty / Concern

2.1 Main Site

A review of the existing information has revealed the following areas of uncertainty / concern which will be further investigated with the proposed work herein:

- Mine shafts
- Potential Clay Pit / Railway Tunnel
- Combustible shallow soils
- PAH / Metal / Asbestos impacted Made Ground
- Hydrocarbon and Tar / Oil contamination (NAPL)
- Ground Gases

2.2 Western Area

A review of the existing information has revealed the following areas of uncertainty / concern which will be further investigated with the proposed work herein:

- Poor existing SI coverage
- Potential relic foundations
- Unknown quality of existing remedial cap/ slurry wall
- Poorly understood groundwater regime
- Lack of calorific assessment of ashy material
- Ground gas information is incomplete
- Shallow Coal Risk is unexplored

Site Investigation Strategy

3.0 Site Work

3.1 Preamble

Intrusive investigations are to be undertaken in accordance with current guidelines and accepted best-working practices (i.e. BS 5930:2015; BS 10175:2011). Allowance will be made for all necessary and appropriate Health and Safety measures and personal protective equipment.

Prior to commencement on site, Geo² will provide (and have agreed/accepted) fully-detailed Risk Assessments and Method Statements for the works.

Drilling Operatives shall be able to demonstrate their competence. This should be all of the following:

- NVQ/SVQ certificate in Land Drilling (or proof of an equivalent level of experience and continuous development).
- A current and valid Audit card as issued by the British Drilling Association or an equivalent body in a State of the European Union.
- CSCS Land Drilling card.
- Or have proof of an equivalent level of training and experience.
- The certificates and cards for Lead Drillers shall be applicable to the work and specific boring / drilling operation on which they are engaged.

Following exploratory hole formation:

- **[Off/away from site access routes]** full reinstatement of the ground surface at exploratory hole locations will not be undertaken, however, holes are to be backfilled with arisings (mounded over, where necessary) and made safe.

We will provide/ensure that a suitably-skilled and experienced geo-environmental engineer is to be present on-site at all times during site work. The engineer will have appropriate qualifications, appropriate CSCS card, safe site supervision training when acting in supervisory role or have a proof of an equivalent level of training and experience. It is assumed a welfare facility would be on site.

Locations and reduced levels of all exploratory holes are to be determined (to the nearest 0.1m and 0.01m respectively) relevant to Ordnance Survey National Grid and Datum. These are to be reported in the form of an exploratory hole location plan, at a relevant scale.

Site Investigation Strategy

3.2 Investigations of Identified Areas of Concern / Uncertainty

The following subsections detail the works to undertaken in each area.

3.2.1 All Areas

PAH, Metal and Asbestos Contamination within Made Ground

Proposed Actions: Trial pits / window sample boreholes would be advanced in a herringbone formation across this site to robustly characterise the site soils, in the western area this role will be filled predominantly by window sampling.

Geotechnical Appraisal

Proposed Actions: There is little current geotechnical understanding of the site. Whilst the existing site conditions are likely to change significantly prior to redevelopment of the site, there is value in establishing a baseline understanding of the geotechnical conditions of the natural strata and bedrock.

Ground Gas

Proposed Actions: The exploratory holes installed as part of the above works would be completed for future Gas Monitoring visits. In addition, it may be possible to re-monitor existing wells on site depending on their condition. At present, there are 6 visits planned for each of the completed wells. This would provide a baseline of current ground gas conditions.

3.2.2 Stockyard

Mine Shafts

Proposed Actions: Localised trial pits would be advanced in the areas thought to be occupied by mine shafts to locate the caps and depths with confidence. Given the current working design for the site, which proposes to leave the shafts in an area of public open space, this scope does not allow for any assessment of the decommissioning of the shafts, again to keep the costs of these works down.

Clay Pit / Railway Tunnel

Proposed Actions: Dynamic probing will be undertaken in the areas likely to be affected to determine if any soft spots / voiding is present. Dynamic probing is used to hammer a 35mm diameter cone on a rod through the ground. This is typically a geotechnical technique and does not recover samples, however it does provide information on voids or obstructions by obtaining SPT results. This is a very quick and cheap method of assessing the route of the railway. As it is likely that rather than a void, we encounter poorly compacted backfill, this approach is favoured over a geophysical survey due to its low cost.

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Combustible Shallow Soils and Asbestos

Proposed Actions: Localised trial pits / window sample boreholes would be advanced in a herringbone formation across this area to determine the extent of the combustible shallow soils and the potential presence of Asbestos containing material. All black 'breeze' type materials are considered to be likely to be highly calorific and as readily identified by visual inspection as such these works aim to delineate the extents of this material.

Clay Pit

This area was highlighted in the earlier reports as requiring further assessment to characterise the risk, the Data Review has allowed for the scope of works in these areas to be reduced to confirm the findings of earlier reports, which suggested minimal infill and therefore a reduced risk (again this cost saving was reflected in the earlier 23.08.19 proposal).

3.2.3 Production and By-Products Area

Hydrocarbon and Tar / Oil Contamination

Proposed Actions: In order to provide additional information regarding the DNAPL/ hydrocarbon contamination that is known to be on site we are proposing to undertake trial trenching in the area known to be impacted with NAPLs, former features and electric sub stations. It is expected that the NAPL and hydrocarbons will be at relatively shallow depth and as such trial trenches will be suitable to delineate the impacted area. It is proposed to install 4 rotary boreholes in areas of historic DNAPL areas. As stated above, it is expected that significant obstructions will be present, as such, it is expected that repeated 'refusals' could be encountered, to mitigate this we would pre-excavate each location to 1-2mbgl dependant on ground conditions.

Concerns have also been raised by the Environment Agency regarding the potential for DNAPL to have impacted the deeper aquifer. Whilst data from the deep aquifer is limited, the Gap Analysis does indicate low to no concentrations of contaminants in the sandstone aquifer in RBH4/4a, BH301 and BH305. Deep confirmatory rotary boreholes (approx. 4 holes to 20m in depth) in the Production area of the site would provide greater confidence in these results.

Substructures

Proposed Actions: An extensive area of substructures is anticipated in the Production and by-Products areas of the main site, with borehole and trial pit records indicating a series of infilled basements and wall structures. Additionally, relics of smaller structures likely to be present in all other areas. The trial pits and trenches aim to encounter and delineate the extent of subsurface structures, the removal of which will likely be necessary in subsequent remedial works. The extents of substructures will be recorded and logged for removal during remedial works.

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3.2.4 Southern Area

Shallow Coal Mining

Proposed Actions: The 2018 Patrick Parsons Remediation Strategy document indicated a hazard associated with shallow mining works in the South of the Main Site; the detailed Data Review has allowed this risk to be revised so that a significant programme of deep geotechnical drilling (out-with the scope of these works are that of the Planning Support scope-23.08.19) can be avoided and replaced with a series of confirmatory trial pitting as detailed above.

It should be noted that we understand the Client has no reliance upon the relevant Coal Risk Assessment report and consideration should be given to commissioning a replacement.

Sandstone Quarry

This area was highlighted in the earlier reports as requiring further assessment to characterise the risk, the Data Review considers this area to fall outside of the proposed development footprint as this is predominantly located beneath the Hargreaves offices development.

Ground Gas

Proposed Actions: The exploratory holes installed as part of the above works would be completed for future Gas Monitoring visits. In addition, it may be possible to re-monitor existing wells on site, depending on their condition. At present, there are 6 visits planned for each of the completed wells. This would provide a baseline of current ground gas conditions.

Geotechnical Appraisal

Proposed Actions: There is little current geotechnical understanding of the site. Whilst the existing site conditions are likely to change significantly prior to redevelopment of the site, there is value in establishing a baseline understanding of the geotechnical conditions of the natural strata and bedrock.

Substructures

Proposed Actions: An extensive area of substructures is anticipated in the Production and by-Products areas of the main site, with borehole and trial pit records indicating a series of infilled basements and wall structures. Additionally, relics of smaller structures likely to be present in all other areas. The trial pits and trenches aim to encounter and delineate the extent of subsurface structures, the removal of which will likely be necessary in subsequent remedial works. The extents of substructures will be recorded and logged for removal during remedial works.

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3.2.5 Western Site

Poor existing SI coverage

Proposed Actions: Trial pits / window sample boreholes would be advanced in a herringbone formation across this site to robustly characterise the site soils.

Potential relic foundations

Proposed Actions: This area is known to contain a series of historic structures which given the site history are expected to be significant and a key aspect of the schemes commercial viability. As such in this area we propose in the first instance to advance a series of Trenches/extended trial pits to ascertain a greater understanding of the extent of the 'hard material', in addition this phase of works may expose structures that are not shown on historic maps/plans.

Unknown quality of existing remedial cap and slurry wall

Proposed Actions: During any intrusive works samples of the existing cap will also be obtained, analysed and assessed. The effectiveness of the slurry wall on contaminant migration should also be assessed, at this stage the existence of the wall is unconfirmed; this should be achieved by trial pitting across the top of the wall, from the outside. Window sampling and comparison of groundwater samples from either side of the slurry wall would allow an assessment of the historical effectiveness of this barrier. The future suitability for use of this barrier would be heavily subject to the proposed development plan.

Poorly understood groundwater regime

Proposed Actions: Deeper boreholes will be emplaced to allow both perched and deeper water samples to be obtained. This should include deeper rotary drilling (4No boreholes) to assess the quality of the deeper aquifer with an expected depth of 15-20m.

Lack of calorific assessment of ashy material

Proposed Actions: During any intrusive works samples of ashy material recovered will also be tested for calorific content.

Coal Mine Risk

A Coal Mining Risk Assessment should be undertaken in order to determine potential hazards from shallow coal seams beneath the site. Subsequent drilling may be required, should a potential hazard be indicated, which is likely to entail approx. 3-6 boreholes to 30-60mbgl, this item should be costed following completion of the Risk Assessment.

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3.3 Exploratory Hole Formation

3.3.1 Main Site

See attached Figures which layout key investigating targets and borehole locations.

The window sample boreholes are to be located in appropriate positions, as shown on the attached provisional borehole plan and to be agreed with the client and site management.

Well casing will be installed to full depth in all of the window samples and boreholes (see attached plan) with the allowance of a flush fit cover, with a concrete drainage ring to aid protection and location of these features. Targeted response zones will be assessed by the site engineer.

3.3.1.1 Stockyard

The investigation work is to comprise the following, an approximate guide to investigative locations is included in the attached Figures:

- **Trial Pitting / Trenching**; allowance for 5 days to investigate mine shaft caps, asbestos impacted soils, PAH impact and undertake site wide investigation, including locating substructures, confirmation of fills and calorific soils, in the former clay pit area.
- Approx. 4no **window sample** boreholes to a target depth of 5mbgl to assess fills, allow ground gas assessment and groundwater testing.
- 15no **dynamic probeholes** to a target depth of 8mbgl to target the former tunnel.

3.3.1.2 Production and By Products Area

The investigation work is to comprise the following, an approximate guide to investigative locations is included in the attached Figures:

- **Trial Pitting / Trenching**; allowance for 8 days to investigate NAPL, hydrocarbon / PAH impacted areas, substructures and undertake site wide investigation
- 4no **window sample** boreholes to a target depth of 5mbgl to assess fills, NAPL, hydrocarbon allow ground gas assessment and groundwater testing.
- 4no boreholes to be extended by **Hollow Stem / Rotary** techniques to a target depth of 8mbgl to investigate NAPL, hydrocarbon.
- 4no boreholes to be extended by **Rotary** techniques to a target depth of 20mbgl to assess deeper aquifer quality.

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3.3.1.3 Southern Area

The investigation work is to comprise the following, an approximate guide to investigative locations is included in the attached Figures:

- **Trial Pitting / Trenching**; allowance for 2 days to investigate shallow mining in bedrock, NAPL impacted areas, substructures and undertake site wide investigation
- 2no **window sample** boreholes to a target depth of 5mbgl to assess fills, allow ground gas assessment and groundwater testing.

3.3.2 Western Site

The investigation work is to comprise the following:

- **Trial Pitting / Trenching**; allowance for 3 days to investigate slurry wall, relic structures and obstructions, NAPL impacted areas and undertake site wide investigation. Significant damage could be caused to the cap through use of this technique (which might cause environmental harm is left for a period of time) and as such this should be reserved for areas outside of the cap, or in areas where substantial buried obstructions are present. Any damage to the cap should be rectified where possible following works.
- Circa 50no **window sample** boreholes to a target depth of 5mbgl, upto 12 selected locations (from across the entire sampling area) to be installed for groundwater or gas monitoring. Sampling will use a herringbone non -targeted approach in areas without clear historical features (approx. 20No locations at a frequency of approx. 1 location per 200m²). In areas with clearly identified potentially contaminative features approx. 20No. investigation points will be targeted towards known features (at a frequency of 1 location on average per 100m²). A budget of 10 locations will remain unallocated to allow unexpected impacts to be further investigated.
- 4no boreholes to be extended by **Hollow Stem or rotary** techniques to a target depth of 8mbgl.
- 4no boreholes to be extended by **rotary** techniques to a target depth of 20mbgl.
- A Coal Mining Risk Assessment should be undertaken, in advance of any site works in order to determine potential hazards from shallow coal seams beneath the site. Any resulting additional drilling scope (if required) should be confirmed.

The window sample boreholes are to be located in appropriate positions, as shown on the attached Provisional borehole plan and to be agreed with the client and site management.

Well casing will be installed to full depth in selected window sample boreholes (see attached plan) with the allowance of a raised cover. Targeted response zones will be assessed by the site engineer.

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3.4 Sampling

Soil samples obtained for chemical analyses shall be retained in containers supplied by the laboratory appropriate to the analyses requested; including but not limited to 500ml and 50ml amber glass jars together with plastic tubs. The correct sampling media and sufficient sample quantity (no. of jars etc) should be obtained with samples couriered to the laboratory in daily batches to prevent samples from 'deviating'. Refer to chemical testing outlined for guidance.

Samples obtained for geotechnical testing should be of an adequate size and frequency for the testing schedule outlined.

Samples will be stored and maintained at sufficiently cool temperatures from the time of sampling until delivery to the analytical laboratory to minimise sample deterioration either chemically or geotechnically.

All samples will be labelled with the site name, an appropriate contract number, the date, sample reference and depth range in indelible marker pen.

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4.0 Laboratory / Insitu Testing

4.1 Preamble

All laboratory testing will be scheduled on completion of fieldwork and based upon the provisional exploratory hole records.

All testing will be undertaken such that results are reported within 10 working days of issue of a schedule. All chemical laboratory testing is to be by UKAS and MCERTS accredited testing methods where applicable. Detection limits for chemical analyses are to be appropriate for comparison with current environmental (soil and water) quality standards.

4.2 Chemical Laboratory Testing

This investigation design is tailored towards obtaining suitable information to allow a risk assessment to be undertaken, but principally towards allowing key impacts requiring remediation to be quantified allowing a detailed remediation cost and scheme to be agreed upon. All samples will be selected from the following suites to target the analysis towards the relevant analysis required to fill identified data gaps.

4.2.1 Main Site

Soils. Testing should include **70no** soil samples, these will be selected to fill the data gaps by confirming the findings of the old reports and delineating the extent and severity of these key impacts. This a sample budget is portioned up according to the perceived risks in each area as follows:

- Stockyard. Budget of 20 soil samples and 4 water samples.
- Production and By Products Area Budget of 40 soil samples with 12 water samples
- Southern Area Budget of 10 samples with 2 water samples.

Analysis selected from the following suites of chemical analysis:

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc (total concentrations);
- Speciated Poly Aromatic Hydrocarbons (USEPA 16)
- TPH CWG with Aromatic / Aliphatic Split
- VOC / SVOC analysis
- PCBs
- pH;
- Total Sulphate
- Total Sulphur
- Total cyanide;
- Total phenols; and

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- Asbestos screen & ID.

4.2.2 **Waters.** Testing should include **18no** water samples, with analysis selected from the following suites of chemical analysis:

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc (total concentrations);
- Speciated Poly Aromatic Hydrocarbons (USEPA 16)
- TPH CWG with Aromatic / Aliphatic Split
- VOC / SVOC analysis
- Total cyanide;
- Total phenols; and
- Hardness.

4.2.3 **NAPL.**, if encountered. Testing should include analysis selected from the following suites of chemical analysis:

- Calorific value;
- Forensic identification (VOC/SVOC/ Whole Oil analysis as appropriate);
- Viscosity;
- pH.

4.2.4 Western Site

Soils. Testing will include circa **40no** soil samples, 20 targeted into the known areas of structures and processing and a further 15 available for non-targeted area testing, with a reserve of 5 samples to be deployed by the site engineer)., Analysis will be selected from the following suites of chemical analysis:

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc (total concentrations);
- Speciated Poly Aromatic Hydrocarbons (USEPA 16);
- TPH CWG with Aromatic / Aliphatic Split;
- VOC / SVOC analysis;
- Calorific Value;
- pH;
- Total sulphate;
- Total sulphur;
- Total cyanide;
- Total phenols; and
- Asbestos screen & ID.

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4.2.5 **Waters.** Testing to include circa **20no** water samples for the following suite of chemical analysis:

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc (total concentrations);
- Speciated Poly Aromatic Hydrocarbons (USEPA 16);
- VOC / SVOC analysis;
- TPH CWG with Aromatic / Aliphatic Split;
- Total cyanide;
- Total phenols; and
- Hardness.

4.2.6 **NAPL.,** if encountered. Testing should include analysis selected from the following suites of chemical analysis:

- Calorific value;
- Forensic identification (VOC/SVOC/ Whole Oil analysis as appropriate);
- Viscosity;
- pH.

4.3 Geotechnical Testing

Geotechnical testing will be undertaken from samples obtained from exploratory holes on both the Main site and the Western area, this testing will include (where applicable)

- Moisture Content and Atterberg Limits;
- Particle Size Distribution;
- Re-compacted CBR Tests;
- Sulphate 2:1 testing.

4.4 In-situ Testing

- PID testing will be undertaken on all soil samples obtained to ascertain the presence of volatiles as a sample screening tool.
- SPT tests will be undertaken at 1m intervals in all boreholes.
- Geochemical parameters readings will be taken from all locations encountering groundwater using a probe, this will include, dissolved oxygen, ORP, pH, temperature and conductivity.
- Slug testing will be undertaken in boreholes from all available locations to aid understanding of the groundwater regime by testing the hydraulic conductivity of the deposits. These values will aid in any subsequent controlled water risk assessment.

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4.5 Gas Monitoring

- 4.5.1 Gas monitoring should be undertaken in all installed exploratory holes on the site. 6 gas monitoring visits should be undertaken over a 3 month period (evenly spaced).
- 4.5.2 The investigation works will allow a more detailed assessment of the gas generation potential of the subsurface or mine gas, at this stage we have assumed a limited scoping assessment to manage costs, which could be extended if considered necessary. In line with CIRIA C665, we would assume that the site should be considered to be of high sensitivity, it is harder at this stage to assess the gassing potential of the source, however this scope of works should inform decision making on this point. Should the gassing risk be considered to be Medium, this scope could be extended out to 12 visits over 6 months, this should be appraised upon the completion of the first 3 months of testing.
- 4.5.3 Gas monitoring should record Methane (steady state and peak), Methane LEL, Carbon Dioxide (steady state and peak), Oxygen, Hydrogen Sulphide, Atmospheric Pressure, borehole flow (steady state and peak), water level and weather conditions.
- 4.5.4 If possible, two visits (over the first three months) should be undertaken when atmospheric pressure is below 1000mb.

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4.6 Surface Water Sampling

4.6.1 To appraise the condition of the surface water, identified in the Gap Analysis reports as a potential receptor for migrating contamination, sampling should be undertaken. It is proposed that five rounds of sampling are undertaken, the first during the investigation and the remainder undertaken concurrently with the gas monitoring programme to allow a more representative indication to be achieved.

4.6.2 The investigation works should comprise collection of upstream and downstream samples from the adjoining Lineside Dyke and Wakefield Brook, the two closest receptors, at locations to be determined following a walkover to ensure safe and reproducible access and sampling.

A total of 20 samples should be tested for

- Arsenic, cadmium, chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium and zinc (total concentrations);
- Speciated Poly Aromatic Hydrocarbons (USEPA 16);
- TPH CWG with Aromatic / Aliphatic Split;
- Total cyanide;
- Total phenols; and
- Hardness.

Site Investigation Strategy

5.0 Reporting

5.1 Requirements

5.1.1 All the data and information obtained during the investigation shall be presented in a sufficiently detailed “Ground Investigation Interpretive Report”; this document is to include the following:

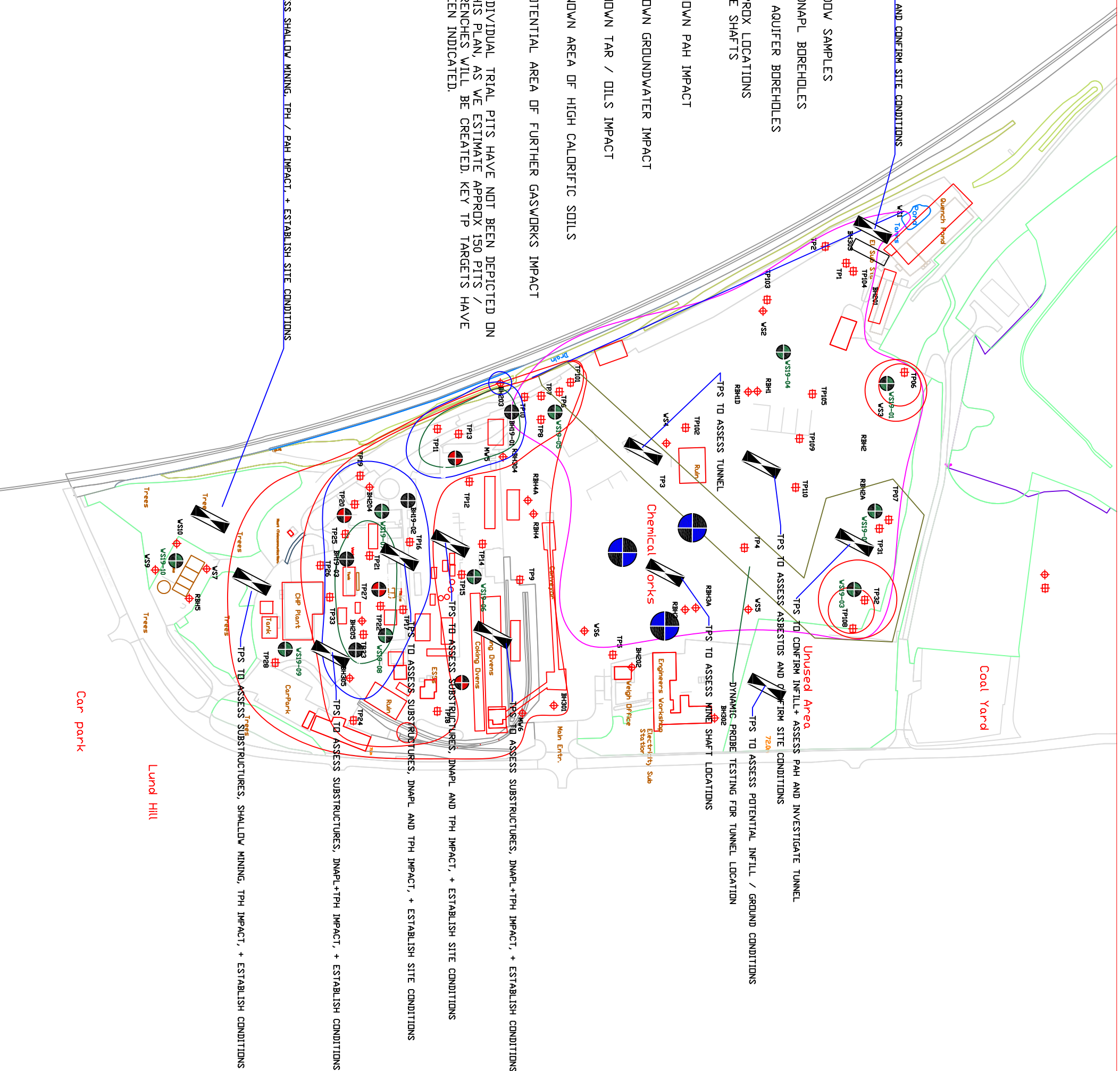
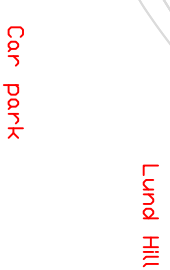
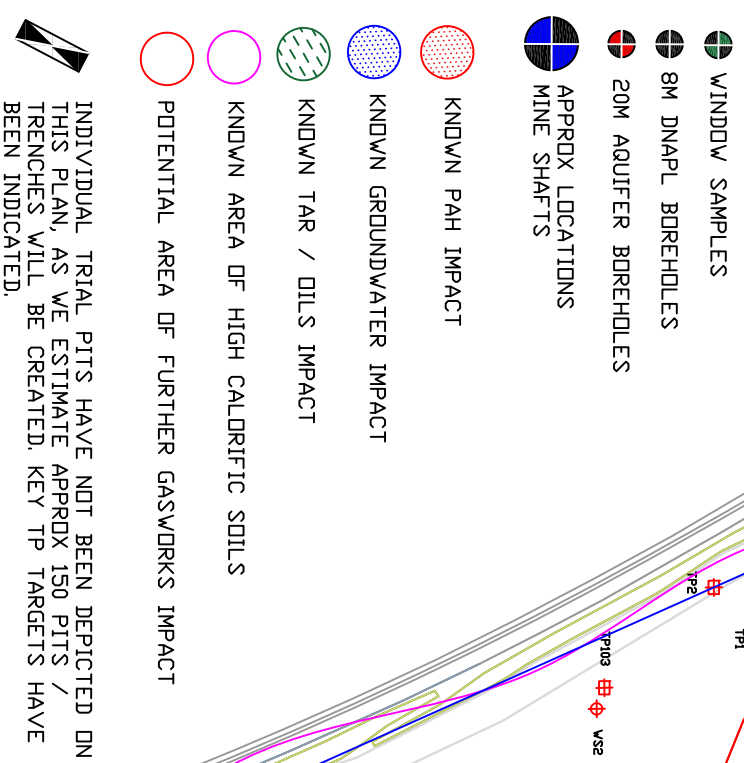
- Introduction;
- Site Description;
- Description of fieldwork and intrusive investigations undertaken;
- Description of the laboratory testing undertaken;
- Engineer’s exploratory hole records;
- Exploratory hole location plan;
- Identification and description (in the form of an inventory or similar) of all obstructions encountered;
- Geotechnical test results;
- Chemical analytical test results;
- All methodologies used;
- Gas Monitoring results
- Undertake contamination risk assessment (including gas monitoring results) and provide updated conceptual site model;
- Interpretation of geotechnical test results and provide assessment of foundation / hardstanding design requirements;
- Conclusions;
- Any limitations on the work undertaken.



Site Investigation Strategy

Appendix A – Drawings







Assess former bund location

WS to assess site condition and cap.

Assess former bund location

WS to test slurry wall

WS to test composition of former stockpile.

TPs to assess
slurry wall and slope

TPs to assess
slurry wall and sumps

WS to test slurry wall

WS to assess substructures and
hydrocarbon / PAH contamination

TPs to assess shallow soils and sumps

WS to investigate former oxide shed

411800N

437300E



Trial Pit indicative areas



Window sample indicative areas



Rotary Borehole 20m



Rotary / HS Borehole 8m



Targeted Sampling Area.



Non Targeted
Sampling Area

Geo²™



Proposed West Area Site Investigation

Drawn from Pro-soil Surveys Ltd. 1997

It should be noted that features
shown on this plan are historic and do
not reflect the current condition of
the site.



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