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CREASE DROVE, CROWLAND

PHASE I SITE APPRAISAL FOR PARTNER CONSTRUCTION LTD

Project Ref:
P8723

Date:
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Prepared for:
Partner Construction Ltd
19 Mallard Way
Derby
DE24 8GX

This report has been prepared in accordance with GRM's Accredited Quality Procedures.

If you have any queries regarding this report please contact the project manager in the first instance.

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TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	PHASE I DESK STUDY AND SITE OBSERVATIONS	2
3	PHASE I CONCEPTUAL SITE MODEL.....	9
4	CONTAMINATION / REMEDIATION RECOMMENDATIONS	10
5	PRELIMINARY GEOTECHNICAL ASSESSMENT	10
6	FURTHER INVESTIGATION	12
7	CONCLUSIONS.....	12

APPENDICES

Data Sources, Standard Limitations	Appendix A
Proposed Development Plan	Appendix B
Site Location and Boundary Plan	Appendix C
Site Features Plan / General Site Photographs	Appendix D
Historical OS Maps	Appendix E
Environmental Data Report	Appendix F
Phase I Hazard Plan	Appendix G

1 INTRODUCTION

1.1 PREAMBLE

GRM Development Solutions Limited (GRM) has been appointed by Partner Construction Ltd to undertake a Phase I Site Appraisal (desk study). The desk study and site inspection form Phase I of the assessment and allow the geotechnical and geo-environmental setting of the site to be determined and the identification of areas of particular concern that require targeted investigation.

This site appraisal is intended to provide information that will assist decision making by identifying potential ground engineering and contamination issues.

GRM Standard Limitations of Reporting are provided in Appendix A of this report.

The Client proposes to develop the site with two storey residential houses including internal access roads and landscaping and a balancing pond. It is further understood that development would follow demolition of the existing warehouse and packing station at the site. The outline development proposals provided by the Client are presented in Appendix B.

1.2 OBJECTIVES OF THE SITE APPRAISAL

The principal aims of the Phase I Site Appraisal (desk study) are as follows:

- a) Obtain information, from easily accessible sources, about the soil and groundwater conditions within the area of the site.
- b) Determine the possible ground related geotechnical and contamination hazards within the site boundaries that may affect the proposed development.
- c) Provide preliminary development recommendations.
- d) Provide advice on further works required for the cost-effective reduction of risks to the development and procedures likely to satisfy regulators.

Whilst every effort has been made to pre-empt the likely requirements of the Local Authority and the Environment Agency, they are likely to have specific requirements that will need to be discussed and addressed at a later date.

2 PHASE I DESK STUDY AND SITE OBSERVATIONS

2.1 INFORMATION SOURCES

In addition to the general sources of information listed in Appendix A (i) the Client has supplied the following information that has been used in the assessment of the site:

- the site location plan
- proposed site plan
- outline scope of works

2.2 SITE DESCRIPTION

2.2.1 Geographical Setting

The site is located to the east of Crease Drove, some 350m north of the intersection with Harvester Way and comprises an area of approximately 1.5ha. The National Grid Reference (NGR) for the approximate centre of the site is TF 237 096. A Site Location and Boundary Plan is presented in Appendix C.

The site is bound by residential developments to the north and east and tilled farmland to the south. The western boundary is formed by Crease Drove with tilled farmland beyond.

The topography of the site is generally level with elevations of approximately 3mAOD and locally 2mAOD in the southwest corner of the site. Locally elevated topography was observed adjacent to the existing warehouses which also comprised an approximately 1m high stockpile to the south.

2.2.2 Site Inspection Observations

The Site Features Plan/General Site Photographs presented in Appendix D illustrate the salient observations made during a site inspection on 28th November 2018.

At the time of the walkover the western portion of the site was mainly occupied by adjoined warehouses comprising an approximately 60m long by 25m wide area, with associated concrete and tarmac/asphalt hardstanding to the west and south and locally to the east. Potential asbestos containing material was also observed on the guttering and roof of the warehouses. The remaining site area was generally vacant.

Grass and localised shrubs and areas of filling including gravel, concrete and brick fragments comprised a portion of the centre of the site with denser shrubs and grasses comprising the remaining site area. Localised partially buried concrete structures were observed in the centre of the site, inferred to be footings remaining following demolition of the previous structure. Localised standing water and burnt material was also observed in the centre and west of the site.

Dense plantations of trees and shrubs were observed to enclose all but the western site boundary, with various moderate to high water demand species noted, including hawthorn and maple species together with a range of medium and low water demand species. The prevalence of bramble shrubs precluded access to the site north of the warehouses and of portions in the west of the site.

Evidence of services identified on the site included an underground power cable extending east from Crease Drove to the southern corner of the existing warehouse, then northeast into the site where it was partially exposed above ground level and inferred to be redundant. Several manholes were also observed in the southwestern corner of the site. Site personnel also advised of an underground holding tank for toilet waste in the northeast of the site (access precluded by bramble shrubs) and also of a water storage tank to the southeast of the warehouses.

Evidence of a previous ground investigation was also observed on site. The investigation included a trial pit and a gas monitoring installation in the tarmac/asphalt to the west of the warehouse and also at least two other boreholes to the east of the warehouse with gas monitoring standpipes.

Significant Features identified during site inspection:

Potential Asbestos Containing Material - to be considered during demolition phases of the development – a competent contractor should be used during demolition – potential hazard to construction workers.

Existing Buildings (To Be Demolished) – development constraint – made ground likely – potential source of contamination.

Live Services – potential hazard to construction workers and unknown quality of backfill – deepened foundations.

Evidence of Burning – potential for soil and groundwater contamination.

Standing Water/Shallow groundwater – excavation instability/groundwater control.

Trees – deepened foundations in association with cohesive strata.

Adjacent Agricultural Land Use – potential for pesticides (southern boundary).

2.3 HISTORICAL DEVELOPMENT OF THE SITE

A review of the available historical Ordnance Survey (OS) maps gives an insight into the development of the site and can highlight potential hazards. Extracts of the maps reviewed (1886 to 2014) are provided in Appendix E.

The earliest map reviewed (1886-1887) shows the site and adjacent plots to be vacant and likely in use as agricultural farmland with the exception of a corn mill approximately 150m east of the development area. The site and surrounding plots remained undeveloped prior to 1950 in which the map shows scattered buildings constructed west of the current Crease Drove approximately 70m from the existing warehouse.

Initial development of the site is observed in the map for 1973-1975 and indicates the construction of the existing warehouse in the west of the site and an approximately 100m long drainage ditch running parallel to the southern site boundary. In 1995 the map indicates an additional warehouse was constructed roughly in the centre of the site with hardstanding between the two buildings. The additional warehouse and drainage channel was removed between 2010 and 2014. Following this, the site remained unchanged until the present day.

Anecdotal evidence from site tenants suggests the warehouses have previously been in use for packing and storage and the warehouse removed at around 2012 was for the storage of potatoes.

Significant Features identified on OS Maps:
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Backfilled Drainage Channel – potential source of ground gas and contamination. Current and Previous Buildings – substructures and made ground.

2.4 ANTICIPATED GEOLOGY

The BGS Geological Sheet for this area shows:

- The site is underlain by superficial deposits of the Abbey Sand and Gravel and Peat.
- Abbey Sand and Gravel is anticipated to underlay the north and west of the site and is comprised of sands and gravels, with some marine shells, including clayey, sandy gravels and pebbly sands.
- Peat is anticipated to underlay the south and most of the east of the site and is comprised of organic-rich clay.
- The superficial deposits are underlain by the Oxford Clay, comprising mudstone.

A BGS borehole drilled in 1975 is located approximately 50m to the southwest of the site and encountered 0.4m of peaty soil overlying dark brown clay to 1.0m depth then clayey sandy gravel to 4.2m depth over stiff clay to the borehole termination at 4.7m depth. Groundwater was encountered at 0.2m depth during the investigation. The clayey sandy gravel was described as River Terrace Deposits (Abbey Sand and Gravel), and the underlying clay as Oxford Clay.

As the site has been developed, anthropogenic materials are anticipated in the topsoil as a result of the development. This is not considered to represent a significant source of contamination across the site, though testing of shallow soils is proposed to confirm these findings.

Significant Features identified from geological data:
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Variable Superficial Strata - reinforcement in foundations and / or deepening.
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Low Strength/Compressible Strata (Peat) – unsuitable for support of traditional strip foundations.
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Organic Rich Strata (Peat) – gas protection measures.

Cohesive Strata – deepened foundations in association with trees.

Pyritic Strata – Oxford Clay is known to contain pyrite, upgrading of concrete class.

Uncontrolled Fill – fill of unknown depth and origin is likely in old warehouse footprint.
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Shallow Groundwater – construction constraints and excavation instability.
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2.5 HYDROGEOLOGICAL INFORMATION

Based on nearby borehole data and land topography the depth to groundwater is anticipated to be less than one metre, however the groundwater level is likely to be subject to seasonal variations.

The Environment Agency has classified the Abbey Sand and Gravel (likely located in the north and west of the site) as a Secondary (A) Aquifer – Permeable Layers, whereas the Peat (likely located in the south and east of the site) is classified as being unproductive strata. The solid strata beneath the site (Oxford Clay) are classified as being unproductive.

There are no recorded groundwater abstraction licenses within 500m of the site and the site is not recorded to be within a Groundwater Source Protection Zone.

Significant Features identified from hydrogeological data:

Secondary Aquifer – Undifferentiated Layers – potential receptor for site derived contamination.

Shallow Groundwater – construction constraints and excavation instability.

2.6 HYDROLOGICAL INFORMATION

Local surface water features include drainage channels, generally between land parcel boundaries however none were noted on or adjacent to the site.

There are no surface water abstraction licenses within 500m of the site.

Significant Features identified from hydrological data:
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Low Site Elevation – potential flood risk.

2.7 FLOOD RISK

The BGS suggests the site lies within a Zone 2 and a Zone 3 Floodplain and the Environment Agency's Internet based flood risk maps suggest there is a low to medium risk from river flooding. A Phase II ground investigation would provide information on the local groundwater regime so that the risk can be assessed by the projects infrastructure engineer. Nonetheless, a flood risk assessment is required for this site as it is over 1ha in size.

The site has been identified by the BGS as susceptible to groundwater flooding, relating to a potential for superficial deposits flooding at the surface. The risk rating is moderate.

Significant Flood Risk Features identified:
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Low to Medium Risk of Flooding from Rivers and the Sea and from Groundwater – flood risk assessment is required for the development.

2.8 MINING

The site is not within an area recorded to require a Coal Authority mining report and shallow coal is not recorded, therefore, the risk from coal mining is considered to be negligible.

Significant Mining Risks:

None.

2.9 QUARRYING

There is no evidence of any non-coal mineral extraction having taken place within, or close to, the site area.

Significant Quarrying Risks:

None.

2.10 ENVIRONMENTAL INFORMATION

An Environmental Report has been acquired for the site. The full report is presented in Appendix F. A summary of the relevant information not included elsewhere in this report is presented below:

- There are several infilled water bodies indicated between 200m and 250m north and northwest of the site. Other infilled areas indicated include an unspecified heap approximately 285m north and infilled ponds over 380m from the site. It is considered that these areas are unlikely to represent a significant source of contamination or ground gas.
- The land 425m west of the site is indicated as being a historic landfill site (household waste type).
- There is one fuel station approximately 250m north and another 440m south of the site.
- There is both a historic and existing Type B environmental permit pertaining to the respraying of road vehicles approximately 200m south and southwest of the site.
- There are three Licenced Discharge Consents between 17m and 77m to the north, northeast and south of the site comprising trade discharges to the northeast and unknown effluent to the south and north.

The above potentially contaminative land uses are considered too far from the site or to be representative of minor domestic uses to be of significance to the proposed development.

Significant Features identified from Environmental data:

None.

2.11 ARCHAEOLOGY

Archaeological information has not been sought as part of this desk study and has not been identified as an issue by the Client. Some Local Authorities require at least an initial archaeological appraisal for development sites. GRM can undertake such appraisals if required. Archaeological investigations occasionally reveal ground-related problems from ancient times (prior to the 1st Edition OS maps) and can occasionally cause foundation and contamination development hazards.

Archaeological Hazards:

Not researched.

2.12 INVASIVE PLANT SPECIES/ECOLOGY

GRM is not a specialist in this topic and has not conducted such a survey; however, we will endeavour to report easily recognisable issues such as Japanese Knotweed, Giant Hogweed, badger sets etc, when seen on site. No such issues were observed.

Invasive Plant Species/Ecological Hazards:
None observed.

2.13 RADON ASSESSMENT

The site has been assessed following the guidelines produced by Public Health England in 'Radon in Homes in England: 2016 Data Report' (reference PHE-CRCE-032).

The site is not within an area recorded to require radon protection measures.

Radon Hazard:
None.

2.14 SUMMARY OF POTENTIAL GEOTECHNICAL/GENERAL HAZARDS

Potential geotechnical/general hazards have been identified in earlier sections and are summarised below.

Potential Hazard	Potential Consequence	Action
Backfilled drainage channel	Deepened foundations	Ground investigation
Substructures of existing and previous buildings	Deepened foundations	Removal
Low strength/compressible ground (Peat)	Settlement/deepened foundations	Ground investigation Working platforms and temporary haul roads
Variable shallow strata	Deepened foundations/reinforcement	Ground investigation
Made ground	deepened foundations	Ground investigation
Standing/shallow groundwater	Surface water flooding, excavation instability	Temporary site drainage / groundwater control, excavation sidewall support
Cohesive strata / Trees	Deepened foundations in associating with trees	Ground investigation
Pyritic Soils	Damage to construction materials and environment	Upgraded concrete
Live services	Danger to personnel	Inform relevant parties for disconnection / diversion
Flooding	Flooding	Flood risk assessment

Potential sources, pathways and receptors are summarised in the Phase I Conceptual Model in Section 3, which is based on current relevant guidance, the principles of which are set out in Appendix A (iii).

2.15 CONTAMINANTS OF CONCERN

In addition to the general contaminants listed in Appendix A (ii), the following site specific contaminants have been identified:

- Pesticides.
- Asbestos.



3 PHASE I CONCEPTUAL SITE MODEL

HUMAN HEALTH			
Source	Pathway	Receptor	Level of Risk
Potentially contaminated made ground / localised areas of burning / fill associated with previous development and drainage channels.	Indoor and outdoor inhalation of soil dust, the ingestion of, and dermal contact with, contaminated soil and soil dust, ingestion of vegetables that have taken up contamination and contaminated soil attached to vegetables.	End users.	Low.
Pesticides.		Construction and Maintenance Workers.	
Potentially contaminated made ground / infilled ground / organic rich natural strata.	Inhalation of ground gas.	End users.	Low to moderate.
Asbestos containing materials associated with existing and former buildings.	Inhalation of asbestos fibres.	Construction and Maintenance Workers.	Low to moderate.
Potentially contaminated made ground.	Water pipes.	End users.	Low.
CONTROLLED WATERS			
Made ground / filled ground.	Leaching of contaminants and vertical migration to the groundwater.	Secondary Aquifer – Undifferentiated Layers.	Low.
	Surface run off.	Local land drainage system.	Low.

4 CONTAMINATION / REMEDIATION RECOMMENDATIONS

The risk from ground contamination is considered to be low.

The risk from ground gas is considered to be low to moderate.

The risk from asbestos is considered to be low to moderate.

Prior to development a ground investigation will be required, the scope of which is outlined in Section 6. At this stage, based on the desk study information available, it is considered that allowance be made for the following:

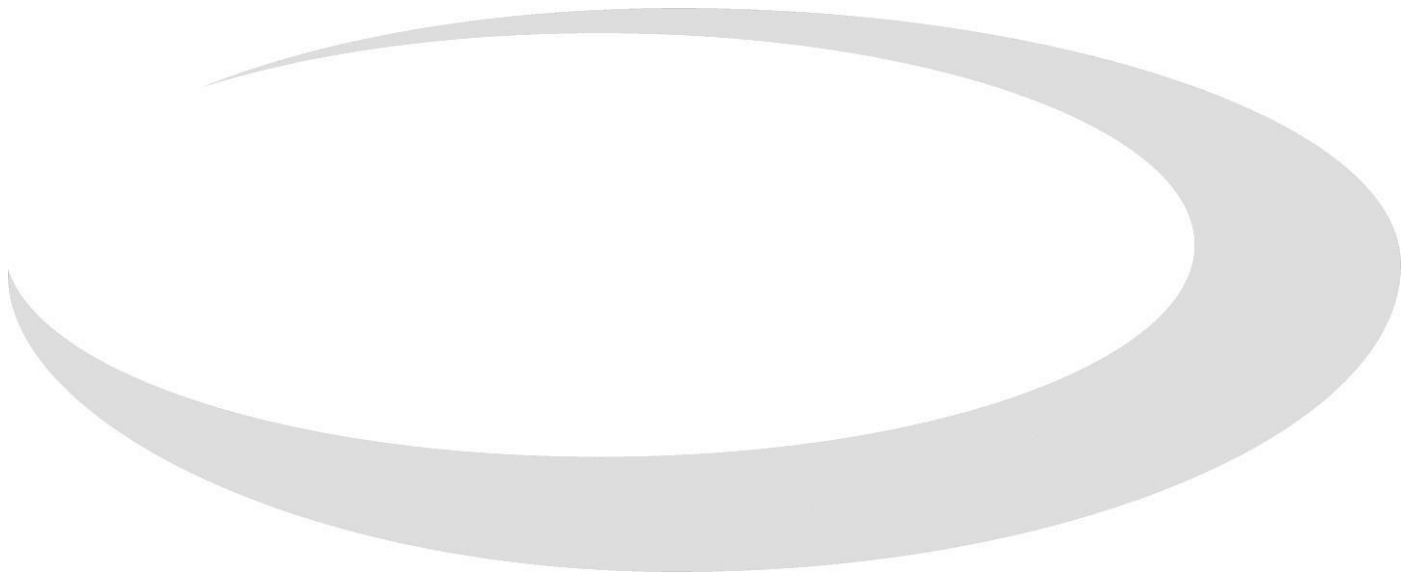
- A suitable 600mm thick capping system in all soft landscaped areas
- The use of gas protection measures until the area containing peat / infilled ground is shown to not be a significant source of ground gas
- Removal by specialist of potentially asbestos containing materials

5 PRELIMINARY GEOTECHNICAL ASSESSMENT

It should be noted that the following comments and recommendations are based on the findings of this desk study which may not give a true indication of a soils actual engineering properties (i.e. stability, mass structure etc). Prior to development a ground investigation will be required to confirm the initial recommendations outlined below, the scope of which is outlined in Section 6. However, at this stage based on the desk based information available it is considered:

- The ground conditions are likely to comprise superficial deposits of the Abbey Sand and Gravel across the north and west of the site, passing into Peat in the south and east. Oxford Clay is anticipated to underlay the superficial deposits on the site.
- Highly compressible and low strength strata are anticipated particularly in the east and south of the site which may not provide suitable support for the use of traditional foundations.
- Due to the suspected presence of cohesive soils and the presence of trees, particularly around the margins of the site, and the presence of low strength Peat deposits in the southeastern third of the site, allowance should be made for deepening foundations in accordance with NHBC standards. At this stage allow for approximately 70% of plots to be suitable for traditional foundations at circa 1m depth with 30% of plots piled.
- Aggressive ground conditions are expected and upgraded concrete should be allowed for.
- Given the anticipated geology and groundwater conditions, the adoption of a soakaway drainage system is considered unlikely for the development. A soakaway drainage system may be feasible in the north and west of the site providing favourable groundwater conditions are encountered.
- De-watering issues are to be anticipated at the site and simple dewatering methods should be allowed for to 2m depth and well pointing below this depth.
- Given the anticipated geology CBR values of 3-5% are considered likely for the sand and gravel and 1% for the Peat.

- Some reinforcement may be required to foundations where single structures encounter variable ground conditions between the Peat and the Abbey Sand and Gravels.
- If site levels are to be raised the Peat will suffer from settlement which must be accounted for in the infrastructure design for the site.



6 FURTHER INVESTIGATION

A Phase II ground investigation is recommended to determine more accurately the effect of the identified hazards on the development. Initially, this should include:

- A ground investigation designed to BS10175:2011 and BS5930:2015 and comprise window sampling to confirm ground conditions and collect samples for analysis.
- Chemical analysis of soils followed by risk assessment so that the risk to human health and controlled waters can be determined.
- Peat strata are anticipated below the site and areas of possible infilled ground and made ground pertaining to infrastructure development are present. It is considered that the latter areas are likely to comprise engineered ground and therefore the overall risk from ground gas is low to moderate. Therefore as the site is proposed for residential development ground gas monitoring standpipes are recommended, together with a gas monitoring program.
- Geotechnical soils testing of the founding strata to assess its engineering characteristics and suitable grades of buried concrete.
- Tree survey.
- Locate, remove and replace with engineered fill below ground structures.
- Asbestos survey of remaining structures prior to demolition.
- Flood risk assessment.

Following your review of this document, a copy of it should be submitted to the Planning Department of the Local Authority for comment and approval prior to any ground investigation works being undertaken, as this is often a condition of planning.

7 CONCLUSIONS

This Phase I Site Appraisal has shown the site is suitable for the proposed development, assuming compliance with all the recommendations contained within this report.



A P P E N D I X A

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GENERAL APPRAISAL COMMENTS

i INFORMATION SOURCES

Where available the following sources have been used for the identification and assessment of potential ground hazards:

- Relevant British Standards
- British Geological Survey (BGS) Geology Map Scale 1:10,000 for local area
- British Geological Survey (BGS) Geology Map Scale 1:50,000/1:63,320
- BGS Memoir
- BGS Borehole Records
- BGS online viewer: <http://www.bgs.ac.uk/data/mapViewers/home.html>
- Environment Agency Groundwater Vulnerability Maps
- Historical Ordnance Survey (OS) Maps
- Environmental Data Report
- Environment Agency Website: <http://www.environment-agency.gov.uk/>
- Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites, UKWIR, 2010.
- Coal Authority Records / Coal Mining Report
- DEFRA/Environment Agency Contaminated Land publications and DoE Industry Profiles
- BRE Guide BR211 (2015), 'Radon: Guidance on protective measures for new buildings'
- HPA-RPD-033 (2007), 'Indicative Atlas of Radon in England and Wales'
- PHE-CRCE-032 (PHE, 2017), Radon in Homes in England: 2016 Data Report
- CIRIA C665 'Assessing risks posed by hazardous ground gases to buildings'
- BS8485:2015, 'Code of Practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'
- Other technical references used throughout this document are detailed in the text.

ii CONTAMINANTS OF CONCERN

The DoE Industry Profiles are normally used to assess likely contaminants from past land use and potential nearby industrial sources. For land uses where no profile is available, likely contaminants of concern are selected by GRM based on past experience of similar sites, a general screening suite of contaminants covered by CLEA and common contaminants from the Industry Profiles.

- | | | |
|------------|-------------------|--|
| • Arsenic | • Copper | • Water soluble sulphate |
| • Cadmium | • Nickel | • PAH (polycyclic aromatic hydrocarbons) |
| • Chromium | • Zinc | |
| • Lead | • Phenols | |
| • Mercury | • cyanide (total) | |
| • Selenium | • pH | |

Asbestos and PCBs are listed in the vast majority of profiles. PCBs are listed as the profiles expect electricity substations and switch boxes on all industrial sites. There is the potential for asbestos containing material to be mixed up with made ground, following any demolition works.

CONCEPTUAL MODEL METHODOLOGY

The consideration of contamination is based upon the principles of risk assessment, using the 'source-pathway-receptor' model in order to establish the presence, or potential presence, of a pollutant linkage.

To create a risk, contamination must have the potential to cause harm to susceptible targets or receptors such as humans, the water environment or the built environment. The potential for harm to occur requires three conditions to be satisfied to form a pollutant linkage:

- The presence of substances that may cause harm (SOURCE).
- The presence of a target which may be harmed (RECEPTOR).
- The existence of a plausible migration route between the source and the receptor (PATHWAY).

In the absence of a plausible pollutant linkage there is no risk. Where a potential linkage is identified in order for it not to pose a risk to the identified receptor it must be broken.

iv INTRUSIVE INVESTIGATION SAMPLING METHODOLOGY

The ground investigation (including fieldwork, sampling, monitoring and laboratory analyses) has been designed to identify and assess potential ground related problems and to allow cost effective solutions to be advised. It has been planned on the basis of the desk study, site inspection and the proposed development layout (where available). All fieldwork and soil descriptions were carried out in general accordance with relevant British Standards.

The exploratory holes have been positioned and advanced to depths to determine the general ground/groundwater/gas conditions below the site. A general grid pattern has been adopted, where possible, to provide sufficient information based on the current proposed layout scheme. Some holes have been targeted at particular hazards identified in the Phase I assessment. The resultant exploratory hole density is considered to be commensurate with the complexity of the site conditions and detail of information required for this phase of the investigation.

v GROUND GAS RISK ASSESSMENT METHODOLOGY

Gas monitoring programmes undertaken by GRM are designed to broadly comply with the recommendations outlined in CIRIA Report C665 'Assessing risks posed by hazardous ground gas to buildings' (2007) and BS8576 'Guidance on Investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs) (2013).

To assess the risks posed by ground gases such as radon, carbon dioxide and methane, the relevant current guidance has been used. For radon the site has been assessed following the guidelines in 'Radon: guidance on protective measures for new dwellings (BR211: 2015)'. For methane and carbon dioxide the primary guidance document used to determine if protection measures are required is *BS8485:2015 Code of practice for the design of protective measures from methane and carbon dioxide ground gases for new buildings*. This uses hazardous gas flow rates (Q_{hg}), which are gas concentrations multiplied by borehole flow rates, to derive a Gas Flow Rate (GSF) for the site. The gas regime is then determined based on the GSF and other limiting factors such as gas concentrations.

Where flow is not recorded during the monitoring a default flow rate of 0.1l/hr will be used in the assessment to produce a positive result.

vi HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

Guidance contained in the Environment Agency's CLEA Reports has been used to assess the risks posed to human health.

For residential developments that include domestic gardens the default Tier 1 Assessment Criteria (TAC) for 'residential land with plant uptake' are used, i.e. a female with a start age class of one and an end age class of six. All pathways are considered including the consumption of home-grown vegetables.

For residential developments that do not include domestic gardens the default Tier 1 Assessment Criteria (TAC) for 'residential land without plant uptake' are used, i.e. a female with a start age class of

one and an end age class of six. All pathways are considered except the consumption of home-grown vegetables.

For commercial/industrial developments the default Tier 1 Assessment Criteria (TAC) for 'commercial/industrial' are used, i.e. a female with a start age class of sixteen and an end age class of eighteen. All pathways are considered except the consumption of home-grown vegetables.

The TAC used by GRM include Category 4 Screening Levels (C4SLs) published by DEFRA, values calculated by GRM using the CLEA v1.071 risk assessment, and values and Suitable for Use Levels (S4UL) developed by LQM/CIEH. The TAC used in the assessment are selected based on the lowest site specific SOM values returned as part of the chemical analysis.

Where soil chemical analysis results are found to exceed the TAC, Site-Specific Risk Assessments may be undertaken using the CLEA v1.071 risk assessment software using the age classes and pathways described above.

vii RISK TO SITE WORKERS – GENERAL COMMENTS

The risks to site workers are similar to those posed to site end users, although likely to be less severe due to the site workers' shorter exposure to the identified contamination. However, site workers (particularly groundworkers) are more likely to come into direct contact with contaminated soils due to the nature of their work. On this basis ground and construction workers should be provided with basic Personal Protective Equipment based on the site's general health and safety risk assessment, but including as a minimum safety footwear, gloves and overalls.

A site specific risk assessment should be carried out for all hazards identified within the ground investigation in accordance with current health and safety legislation. This assessment should identify any measures required to further reduce risks i.e. providing further Personal Protective Equipment, welfare facilities and if necessary preventing access to certain areas.

Demolition and dismantling of existing structures on the site must be carried out to a safe and acceptable standard, in accordance with current UK guidance and best practice. Whilst not ground related, asbestos and hazardous substances surveys should be conducted prior to any demolition.

Any unusual colours, odours and suspicious ground should be reported immediately to site management and then GRM.

Whilst this appraisal has considered the long-term effects of contamination, GRM can also help during the formulation of Health and Safety documentation, if required.

viii CONTROLLED WATERS RISK ASSESSMENT METHODOLOGY

Where the desk study and fieldwork do not reveal a potential source of contamination no leachate or groundwater testing will be performed. Where a potential source is identified the testing will comprise leachate testing on the material considered most likely to pose a risk, groundwater testing will be undertaken if water is present at shallow depth.

The UK Drinking Water Standards (UKDWS) or Environmental Quality Standards (EQS) are usually adopted for comparison with the leachate/groundwater test results. When the most sensitive receptor is considered to be the aquifer (groundwater) UKDWS will be adopted as the Initial Tier 1 screening values. Where the most sensitive receptor is a surface water feature the EQS values will be used as Initial Tier I Screening values.

ix CONSTRUCTION MATERIALS RISK ASSESSMENT METHODOLOGY

The 'screening levels' adopted for the assessment of risk to construction materials are taken from the following documents:

- UK Water Industry Research (UKWIR) Contamination thresholds for sub-surface water pipes, for the protection of buried pipes.
- Building Research Establishment (BRE) Special Digest SD1 (2005), 'Concrete in Aggressive Ground', for the protection of buried concrete.

x WASTE DISPOSAL, SITE WASTE MANAGEMENT PLANS AND MATERIAL MANAGEMENT PLANS

Under current Waste Management Regulations, waste soil materials produced from the site will require characterisation to enable it to be disposed of correctly.

The chemical analysis results included in this report should be provided to the relevant landfill operators to establish the characterisation of the waste, confirm its suitability for landfill disposal and provide estimated costings. If material is classified as hazardous, then the site will need to be registered with the Environment Agency prior to the movement of the waste. Depending on the receiving landfill's current permit, further chemical analysis, incorporating Waste Acceptance Criteria (WAC) leachate analysis, may be required.

All materials removed from the site will be classified as 'waste' and therefore must be removed by a suitably licensed carrier of waste. This applies whether or not the waste is contaminated. All waste removed to landfill will attract Landfill Tax.

The developer/builder is likely to be classed as the waste producer and therefore, has a duty of care to ensure that all waste is disposed of appropriately. This includes ensuring the waste carrier is licensed and disposes of the waste to a suitably licensed landfill site. They are also required to keep a paper trail from 'cradle to grave' including copies of the waste disposal tickets.

Efficient materials management on site is recommended as it can lead to significant cost savings when compared to the traditional side casting or single stockpile of arisings. GRM can assist in the production of Material Management Plans under the CL:AIRE Definition of Waste: Code of Practice. The DoWCoP enables:

- The direct transfer and re-use of clean naturally occurring soil materials between sites, and
- The re-use of both contaminated and uncontaminated materials on their site of origin and between sites within defined Cluster projects.

GRM can also undertake the role of Qualified Person and submit the DoW CoP project Declaration.

Likewise making the site as volume neutral as possible will reduce the costs of development. Whilst not a statutory requirement, Site Waste Management Plans allow better waste management practices, help to reduce the amount of waste produced and identify best environmental disposal options. Implementing a Site Waste Management Plan (SWMP) can reduce costs (increasing business profits) and maximise resource efficiency.

xi GEOTECHNICAL ASSESSMENT GENERAL COMMENTS

Where finished floor levels of proposed structures have not been provided by the Client, then for the purposes of initial assessment, GRM will assume that finished levels will not vary appreciably from the existing ground levels. If the depths of any underground engineering works (i.e. sewers, pumping stations etc.) are unknown they will not be taken in to account in the assessment and it will be assumed that any such works will not compromise foundation or ground stability.

Should the development proposals or finished levels be different from these assumptions then the comments/recommendations in the Geotechnical Assessment may require revising.

It should be noted that the results of window sampling and/or cable percussive boreholes may not give a true indication of a soils actual engineering properties (i.e. stability, mass structure etc). GRM consider that that prior to development trial pitting should be undertaken to confirm the recommendations in the Geotechnical Assessment.

xii GEOTECHNICAL ASSESSMENT – ENGINEERING GROUND TREATMENT

Near surface soils have the potential to be disturbed by weathering and site traffic. Precautions should always be taken to avoid this, as excessive disturbance may leads to more onerous floor slab designs, road cap thickness and increased amounts of off-site disposal etc.

Near surface soils may need treatment or reinforcing to allow safe movement of construction plant and labour. An assessment by the contractor should be undertaken once the type of machinery/plant needed to complete the development is known.

xiii GEOTECHNICAL ASSESSMENT – EXCAVATIONS

Excavation instability (over-break) can result in damage to existing services or structures (e.g. foundations, roads or boundary walls/fences) both on and off-site, as well as increased foundation concrete costs. In order to minimise this, all excavations deeper than 1.2m deep (or any excavation within 1.5m of any existing structure or service) should be supported. Full support should be provided to the full depth of all near vertically sided excavations in made ground, soft and very soft clays and granular soils. A reduction to intermediate support should be acceptable within firm and stiffer natural clays.

Wherever possible, man entry into excavations should be prevented; however, where this is not possible, entry to, and time spent in, excavations should be kept to a minimum.

The build program should be tailored to reflect the impact that deep excavations through potentially unstable strata can have on adjacent properties, so that they are not undermined.

All excavations on site should be in accordance with HSE guidelines and stability should be practically maintained at all times. Reference should be made to HSE construction information sheet No. 8 (Revision 1) 'Safety in Excavations'.

Care should be taken to ensure that falls from excavation faces do not adversely affect the integrity of foundation concrete.

If contaminated water enters excavations it should be removed and transported to an appropriate treatment facility by a suitably licensed carrier before construction begins.

xiv GEOTECHNICAL ASSESSMENT – SUBSTRUCTURES

Where practicable, existing buried construction should be fully removed; however, if this is not practicable all new foundations should be carried down to fully penetrate it and it should be broken well away from all new structures.

There may be existing structures and/or infrastructure in close proximity to the proposed development. New build foundations may be constructed next to pavements with existing underground services beneath them, or excavations may be required near existing footings associated with adjacent properties. These potential hazards need to be taken into consideration when designing foundations and the groundworker needs to be made aware of their potential impact during the redevelopment works. Foundations close to existing underground services or buildings may require alternative foundation techniques (such as piling) to protect the integrity of these structures.

The contractor for the works should carry them out in such a fashion so as to not cause excessive overbreak, concrete usage or undermine existing buildings/roads/ services that are to be retained.

xv GEOTECHNICAL ASSESSMENT – SOAKAWAYS

Soakaway testing in trial pits by GRM is broadly carried out in accordance with BRE DG 365 (2016). The testing comprises the excavation of a test pit to a suitable depth, and the placement of water into the pit. The level of water present is then monitored over time. For borehole installations, the permeability testing (falling head/rising head) is undertaken in accordance with BS5930.

If it is decided to proceed with the use of soakaway drainage, then the following general points should be noted:

- Soakaways should not be placed so that water can be discharged through potentially contaminated made ground.
- The Environment Agency may require soakaways to be sealed systems such that only roof run off falls to soakaway.

- Interceptors are likely to be required for soakaways for highway drainage. The adopting authority for the highways should be consulted at the earliest opportunity regarding the use of soakaways for highways drainage.
- Consideration of site levels and slopes should be taken into account during the design.
- The construction of all soakaways should be in accordance with the current building regulations.
- Soakaways should not be placed within 5m of a proposed building.
- Placement of soakaways needs to be considered so as to avoid ponding of water down slope.
- The base of a soakaway should not be below the highest recorded water level.
- The Environment Agency prefer 1m of dry soil to be present between the base of a soakaway and the water table to provide attenuation for contamination.

xvi

GEOTECHNICAL ASSESSMENT – FOUNDATIONS

If soft or hard spots are encountered during foundation excavation then they should be replaced with suitably compacted material or the footings deepened to suitable strata, to avoid differential settlement.

If strata of differing bearing character (e.g. sand and clay) are encountered at foundation levels within the excavations for a single plot then the excavation depths should be altered as appropriate to ensure the foundations rest on a single stratum, or strata that will not induce differential settlement. Where this is impractical then GRM should be contacted to assess a reinforced concrete detail or an alternative foundation solution (e.g. piles or vibro-replacement).

NOTES ON LIMITATIONS**General**

GRM Development Solutions Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement had been executed, or with whom an assignment had been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from GRM Development Solutions Limited; a charge may be levied against such approval.

GRM Development Solutions Limited accepts no responsibility or liability for:

- a) the consequences of this document being used for any purpose or project other than for which it was commissioned, and
- b) the consequences of this document being used by any third party with whom an agreement has not been executed.

Phase I Environmental Audits/ Desk Studies

The work undertaken to provide the basis of this report comprised a study of available documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the site and meetings and discussions with relevant authorities and other interested parties. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only to the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, GRM Development Solutions Limited reserves the right to review such information and as considered necessary and appropriate to modify the opinions accordingly. It should be noted that any risks identified in a Phase 1 report are perceived risks based on the information reviewed; actual risks can only be assessed following a physical investigation of the site.

Phase II Environmental Audits (Contamination Investigations)

The investigation of the site has been carried out to provide sufficient information concerning the type and degree of contamination, ground and groundwater conditions to allow a reasonable risk assessment to be made. The objectives of the investigation have been limited to establishing the risks associated with potential human targets, building materials, and controlled waters.

The amount of exploratory work and chemical testing undertaken has necessarily been restricted by the short timescale available, and the locations of exploratory holes have been restricted to the areas unoccupied by the building(s) on the site and by buried services. A more comprehensive investigation may be required if the site is to be redeveloped as, in addition to risk assessment, a number of important engineering and environmental issues need to be resolved.

For these reasons if costs have been included in relation to site remediation these must be considered as provisional only and must, in any event, be confirmed by a commercial adviser.

The exploratory holes undertaken, which investigate only a small volume of the ground in relation to the size of the site, can only provide a general indication of site conditions. Whilst exploratory testing is intended to gain an accurate representation of the site, the very nature of sampling and testing is such that it cannot ensure that all localised conditions are detected.

The risk assessment and opinions provided take in to consideration, inter alia, currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values.

Phase II Geo-environmental Investigations (Combined Geotechnical and Contamination Investigations)

The investigation of the site has been carried out to provide sufficient information concerning the type and degree of contamination, geotechnical characteristics, and ground and groundwater conditions to provide a reasonable assessment of the environment risks together with engineering and development implications. If costs have been included in relation to site development a commercial adviser must confirm these.

The exploratory holes undertaken, which investigate only a small volume of the ground in relation to the size of the site, can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions apparent at the site for each of the exploratory holes. There may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

The comments made on groundwater conditions are based on observations made at the time the site work was conducted. It should be noted that groundwater levels will vary owing to seasonal, tidal and weather related effects. The scope of the investigation was selected on the basis of the specific development proposed by the Client and may be inappropriate to another form of development or scheme.

The risk assessment and opinions provided take in to consideration, inter alia, currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values.



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- Civil and Infrastructure Services
- Structural Engineering Services
- Construction Management
- Site Services

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ACCOMMODATION SCHEDULE

DWELLING TYPE	GIFA	HEIGHT (STOREYS)	AMOUNT	%
1A 1B2P FLAT	45.00m ² / 53.20m ²	-	06	12
F133 2B4P HOUSE	72.54m ²	2	26	52
F113 3B5P HOUSE	84.30m ²	2	04	36
F131 3B5P HOUSE	83.66m ²	2	14	
TOTAL			50	100

DO NOT SCALE
NOTES:



Approximate Site
Boundary



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CLIENT:

Partner Construction Ltd

PROJECT:

Crease Drove, Crowland

TITLE:

Proposed Development Plan

SCALE@SIZE :

NTS

ISSUE:

FINAL

DESIGN/DRAWN by :

LB

DATE:

December, 2018

PROJECT No:

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DRAWING No:

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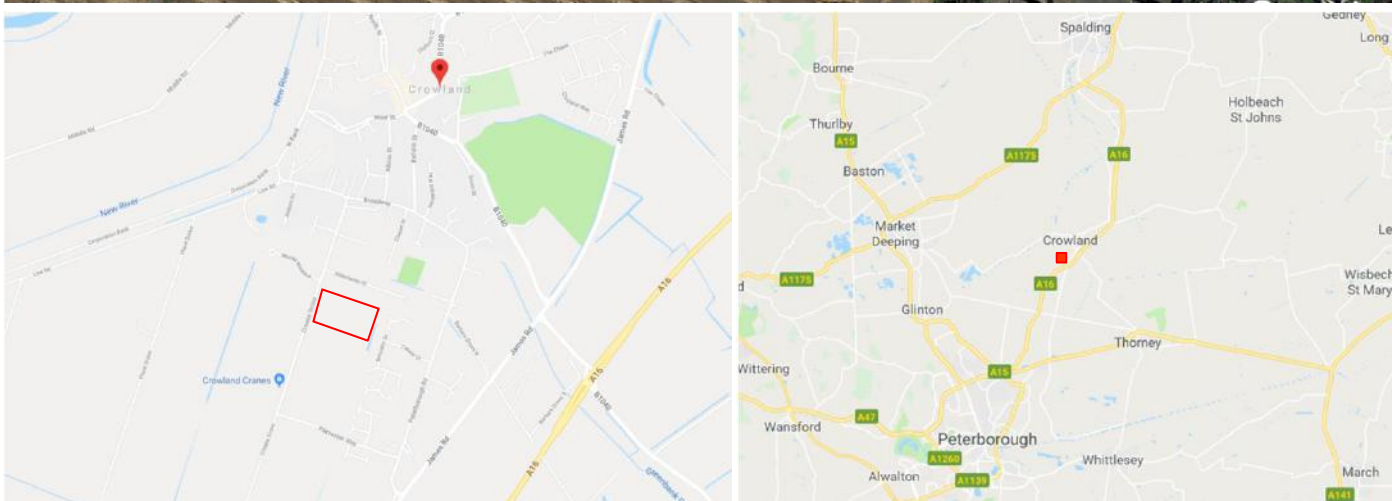
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NOTES:



Approximate Site
Boundary



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CLIENT:

Partner Construction Ltd

PROJECT:

Crease Drove, Crowland

TITLE:

**Site Location and Boundary
Plan**

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NTS

ISSUE:

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DESIGN/DRAWN by :

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DATE:

December, 2018

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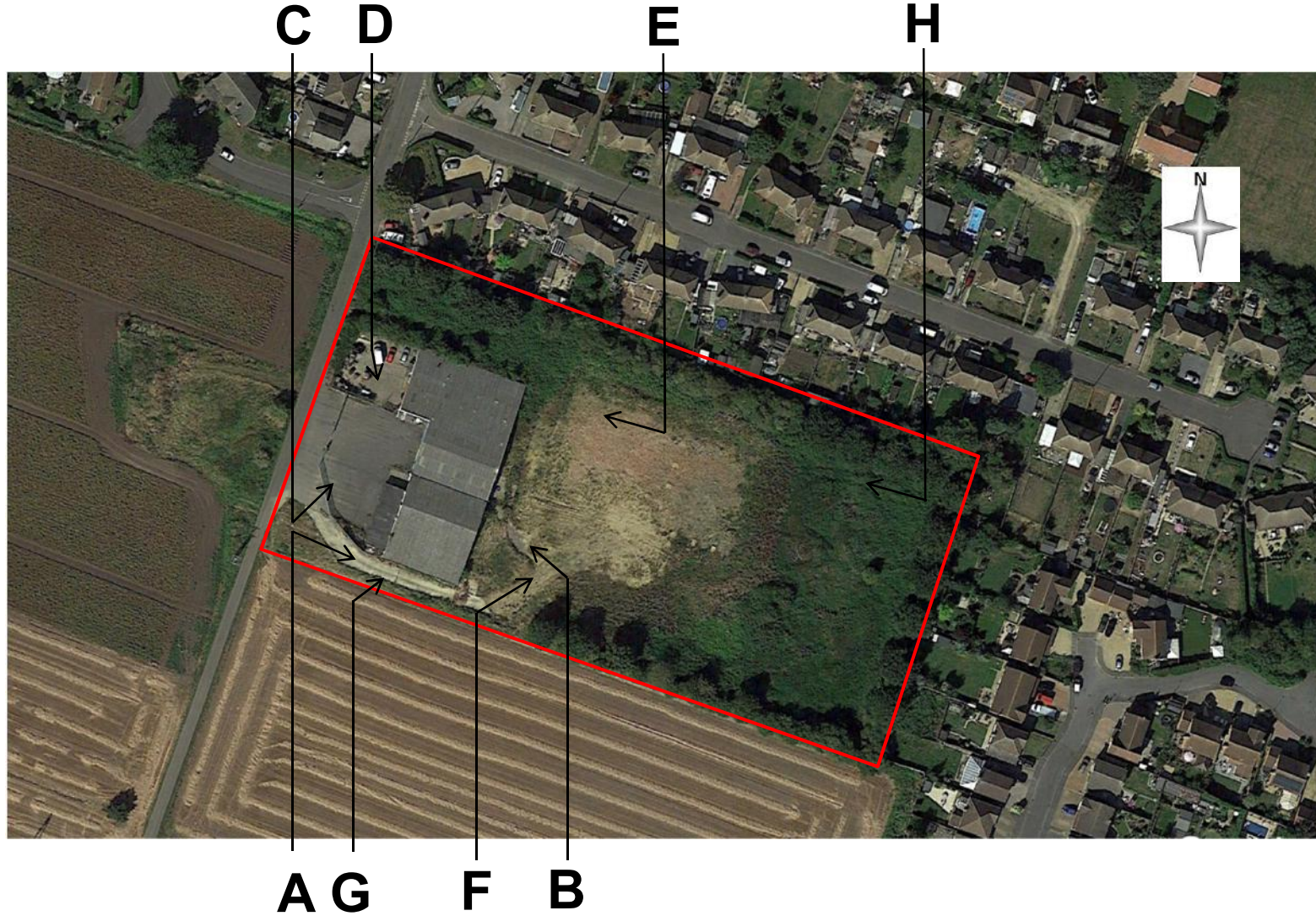
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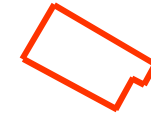
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Approximate Development Area.



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CLIENT:

Partner Construction Ltd

PROJECT:

Crease Drove, Crowland

TITLE:

Site Features Plan

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A – Site entrance, looking east.



B – Existing warehouse, looking northwest.



C – Trial pit near warehouse, looking northeast.



D – Burnt barrel in car park, looking southeast.

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CLIENT:

Partner Construction Ltd

PROJECT:

Crease Drove, Crowland

TITLE:

General Site Photographs

SCALE@SIZE :

NTS

ISSUE:

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December, 2018

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E – Overview of site, looking west.



F – Overview of site, looking east.



G – View of possible asbestos containing guttering.



H – Overview of site looking west.

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CLIENT:

Partner Construction Ltd

PROJECT:

Crease Drove, Crowland

TITLE:

General Site Photographs

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December, 2018

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